Robert D Osei
Fred M Dzanku
Isaac Osei-Akoto
Felix Asante
Louis S Hodey
Pokuaa N Adu
Kwabena Adu-Ababio
Massa Coulibaly

Impact of voice reminders to reinforce harvest aggregation services training for farmers in Mali

December 2018

Impact Evaluation Report 90

Agriculture

3ie 10 YEARS
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 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, *Impact of voice reminders to reinforce harvest aggregation services training for farmers in Mali*, as partial fulfilment of requirements under grant TW4.1016 awarded through Thematic Window 4, the Agricultural Innovation Evidence Programme. 3ie has copyedited and formatted the content for publication. Due to unavoidable constraints at the time of publication, a few of the tables or figures may be less than optimal.

The 3ie technical quality assurance team for this report comprises Benjamin Wood, Diana Lopez-Avila, Mark Engelbert, Deeksha Ahuja, Stuti Tripathi, Marie Gaarder, Emmanuel Jimenez, 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 Sahib Singh and Akarsh Gupta, with Beryl Leach providing overall editorial supervision.

 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, Robert D Osei at rdosei@yahoo.co.uk.

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: Osei, RD, Dzanku, FM, Osei-Akoto, I, Asante, F, Hodey, LS, Adu, PN, Adu-Ababio, K and Coulibaly, M, 2018. *Impact of voice reminders to reinforce harvest aggregation services training for farmers in Mali*, 3ie Impact Evaluation Report 90. New Delhi: International Initiative for Impact Evaluation (3ie). Available at: https://doi.org/10.23846/TW4IE90

Cover photo: KODAKovic / Shutterstock

Impact of voice reminders to reinforce harvest aggregation services training for farmers in Mali

Robert D Osei
Institute of Statistical, Social and Economic Research (ISSER)

Fred M Dzanku
ISSER

Isaac Osei-Akoto
ISSER

Felix Asante
ISSER

Louis S Hodey
ISSER

Pokuaa N Adu
ISSER

Kwabena Adu-Ababio
ISSER

Massa Coulibaly
Groupe de Recherche en Économie Théorique et Appliquée

3ie Impact Evaluation Report 90

December 2018

Acknowledgements

We wish to acknowledge 3ie for providing the required funding, technical support and a thorough review of this study. We are also indebted to the Alliance for a Green Revolution in Africa (AGRA) for providing funds for the intervention. We would like to thank the implementing partner, Association Malienne d'Eveil au Développement Durable (AMEDD), with whom we had an excellent working relationship throughout the study. Our sincere gratitude goes to our research partners in Mali, Groupe de Recherche en Économie Théorique et Appliquée (GREThA), and their field assistants who were immensely helpful in implementing the two rounds of impact evaluation surveys. We would like to thank Image-AD, which was the organisation that set up the voice-messaging platform that enabled the voice message reminders to reach the farmers.

Finally, this work would not have been successful without the cooperation and input from all the other participants: the farmers who participated in the experiment, and those who made invaluable comments and suggestions during our stakeholder meetings and other engagements.

Summary

The Alliance for a Green Revolution in Africa (AGRA) funded a programme aimed at enhancing grain marketing support services in the Sikasso region of Mali. This programme was implemented by the Association Malienne d'Eveil au Développement Durable (AMEDD) between 2014 and 2017. This report contains the evaluation of the impact of selected components of the programme. This was achieved using two rounds of data collected before and after the implementation of the specific components of the programme.

The overall aim of the AGRA-funded programme was to strengthen the capacity of aggregators (i.e. farmer cooperatives and private aggregators) to provide adapted services to smallholder grain farmers (maize, millet, sorghum and rice) and to link them to bulk output buyers through contracts. A key aspect of the programme's theory of change was that good-quality grains are a prerequisite for successfully linking smallholder farmers to specific bulk buyers. However, grain quality is influenced by pre- and post-harvest handling practices. Therefore, improving farmers' knowledge of appropriate pre- and post-harvest handling practices through training is important for a successful aggregator–farmer–buyer linkage.

Based on this theory of change, farmers in all programme villages were trained using the training of trainers approach. In addition to the programme's theory of change that the training of farmers would help to reduce pre- and post-harvest grain losses and improve grain quality, however, the Institute of Statistical, Social and Economic Research also hypothesised that a one-time face-to-face training would not be adequate to ensure effective application of what was learned, and that reminding farmers about what they had learned during training at specific periods when such knowledge should be applied would have an impact over and above a one-off training.

Based on the above hypothesis, all AMEDD-targeted farmers in 99 programme villages located in the Koutiala, Sikasso and Yorosso cercles (subregions or districts) of the Sikasso region received the same training on pre- and post-harvest grain handling and quality management. Following the randomised control trial design, 44 villages were randomly assigned to treatment: in these villages a random sample of the AMEDD-targeted farmers also received specific mobile phone reminders based on the training module. The reminders were sent at the time when such knowledge needed to be applied. The rest of the 55 villages served as the control group, and farmers in these villages did not receive any reminders.

The random sample of AMEDD-targeted farmers in each village consisted of an average of 14 (between 12 and 15) trained-farmer households, yielding a total sample size of 1,434 (control = 821; treated = 613) upon which this impact evaluation is based. This impact evaluation therefore focuses on the questions: what is the added impact on pre- and post-harvest behaviour and outcomes of mobile phone reminders about face-to-face training received?

Specifically, we have evaluated the impact of the mobile phone training reminders about pre- and post-harvest grain handling and management activities on the following indicators: time of grain harvesting and harvesting costs, sale of grains through

aggregation centres, adoption of improved storage methods, pre- and post-harvest grain losses, grain commercialisation, food crop income, and household food security. This has been achieved using the difference-in-difference estimation approach.

The key results can be summarised as follows:

- The mobile phone reminders had a significant impact on the timing of the grain harvest;
- The mobile phone reminders had a significant positive impact on the adoption of improved grain storage methods;
- The mobile phone reminders had no impact on the likelihood of selling grains through aggregation centres;
- The mobile phone reminders lowered the incidence of pre-harvest grain losses significantly but had no impact on post-harvest grain losses; and
- The mobile phone reminders reduced the incidence of hunger significantly but had no impact on food crop incomes.

Contents

List of figures and tables

Appendix figures and tables

Abbreviations and acronyms

AGRA	Alliance for a Green Revolution in Africa
AMASSA	L'Association Malienne pour la Sécurité et la Souveraineté Alimentaires
AMEDD	Association Malienne d'Eveil au Développement Durable
ATE	Average treatment effect
DID	Difference-in-difference
FBO	Farmer-based organisation
FCFA	Franc Communauté Financière Africaine
GDP	Gross domestic product
GREThA	Groupe de Recherche en Économie Théorique et Appliquée
ICC	Intra-cluster correlation
ISSER	Institute of Statistical, Social and Economic Research
SD	Standard deviation

1. Introduction

Although agriculture remains the main form of livelihood for most households in Sub-Saharan Africa (SSA), farmers in the Sahel region in particular, contend with more precarious agricultural production conditions leading to even lower yields than the SSA average. For instance, while the average yield for cereals in SSA was 1,303.6 kilograms per hectare for the period 2010–2014, Mali recorded 433.7 kilograms per hectare for the same period (FAOSTAT 2017). Apart from the unfavourable weather conditions, this situation is attributable to a myriad of problems relating to poor access to agricultural inputs, poor post-harvest and grain quality management, poor organisational skills of farmers, limited credit access, and underdeveloped output markets.

Agricultural activity in Mali, especially in Sikasso (a region that is known as the 'breadbasket' of Mali), is dominated by cereal production (maize, sorghum, millet and rice), although cotton is by far the most commercialised crop. Notwithstanding the enormous potential of cereal cultivation in the region, productivity remains low, with the country consequently importing large volumes of cereals. Agricultural production in the Sikasso region is characterised by smallholder farmers with farm units dispersed throughout the rural space. Existing cooperatives are weak and not effective at providing the desired services to their members. Since opportunities are poorly structured downstream, smallholder farmers' access to markets is limited, and there are no contract relationships between producers and buyers.

Farmers in Mali consider post-harvest crop losses an important problem, particularly because of the threat to their food security (AGRA 2014). Although grain production in Mali still has great potential, in spite of the challenges, access to certain types of markets is hampered by poor grain quality and low output. Adequate training and information on pre- and post-harvest crop handling and aggregation is lacking, resulting in poor-quality grains and low prices, which consequently affect farmers' incomes.

To ensure sustainable transformation of agriculture the Sikasso region in the face of these constraints, the need for a coordinated action in the areas of production, grain quality management, processing and marketing services is paramount. In response to this, the Association Malienne d'Eveil au Développement Durable (Malian Association for Sustainable Development; AMEDD) received a grant from the Alliance for a Green Revolution in Africa (AGRA) in 2013 to implement agriculture-related interventions in Mali's largest grain-producing region, Sikasso. The interventions are aimed at addressing some of the key constraints faced in agriculture in Sikasso, which include poor access to agricultural inputs, poor post-harvest and grain quality management, poor organisational skills of farmers, limited credit access, and underdeveloped output markets. The overall expected outcome is increased smallholder farmers' incomes in the region.

This report provides an analysis of the impact of mobile phone reminders about pre- and post-harvest grain handling and aggregation training on smallholder farmer behaviour and outcomes in the study region. Based on the stipulated theory of change, we compare changes in key impact and outcome indicators between the treatment and control groups. Since our population of interest is all farmers who received training on various aspects of pre- and post-harvest grain handling, our overall objective is to

analyse the impact of mobile phone reminders about key training messages on pre- and post-harvest management and aggregation behaviour, as well as on selected outcomes, in the Sikasso region of Mali. Specifically, the study aims to answer the following research questions:

- Will training reminders about pre- and post-harvest grain handling and management activities lead to increased demand for related inputs and services?
- Will training reminders about optimal grain harvesting time lead to change in grain harvesting costs?
- Will training reminders about the availability of sales contract arrangements have a positive impact on selling grains through aggregation centres?
- Will training reminders about recommended grain storage methods have a positive impact on grain storage decisions and the adoption of improved storage methods?
- Will training reminders about pre- and post-harvest grain handling and management lead to a reduction in crop losses?
- Will training reminders about good grain handling and quality management lead to increased commercialisation and higher grain prices received by farmers?
- Will training reminders have an impact on the cost of market transactions?
- Will training reminders have a positive impact on farmers' incomes and the food security of their households?

The rest of the report is structured as follows. The programme intervention, the underlying theory of change, and the research hypotheses are described in section 2. Section 3 presents the context of the study, with timelines following in section 4. We then present the evaluation design, methods and implementation in section 5. Section 6 details the programme design, methods and implementation. The impact analysis and results are presented in section 7, which is followed by a general discussion of the threats to internal and external validity and the key lessons in section 8. Finally, section 9 outlines the specific findings for policy and recommendations for fruitful future research.

2. Intervention, theory of change and research hypotheses

2.1 Programme intervention

The AGRA-approved programme intervention was aimed at increasing smallholder farmers' participation in factor and product markets via their linkages to aggregators. The programme engaged with two types of aggregators: cooperatives and private aggregators. The cooperatives are essentially farmer organisations that aim at providing specific services to their members. In areas where cooperatives were not available, private aggregators were identified and selected to provide similar services to farmers. The two groups of aggregators were expected to provide the same range of services to farmers to whom they were linked. The strategy of linking farmers to aggregators is expected to help reduce transaction costs associated with smallholder output marketing. The interventions were expected to:

- Strengthen the capacities (organisational, technical and institutional) of cooperatives to provide production, post-harvest and marketing services to smallholder farmers;

- Strengthen the capacities (technical and business) of private operators to provide production, post-harvest and marketing services to smallholder farmers; and
- Improve smallholder farmers' output marketing by developing business contract linkages between aggregators and buyers.

These interventions involved activities at the cooperative, private agro-enterprise and smallholder farmer levels. The activities at the first two levels were largely the same, except for the difference in the service provider. The following key activities were undertaken as part of the intervention:

- Training of cooperatives and private aggregators in organisational management, collective marketing, contracting and bulk purchasing of inputs, and post-harvest handling and quality management;
- Training of farmers in cooperative principles, contracting and post-harvest handling and quality management;
- Establishing aggregation centres; and
- Facilitating contractual relationships between cooperatives/private aggregators and buyers.

The interventions were based on aggregating farmers around cooperatives and private aggregators (in communities where there are no existing cooperatives) and thereby providing a platform for access to more structured and reliable factor and product market services. All farmers in our population of interest received face-to-face training through the training of trainers approach. In addition, a random sample of the trained farmers also received mobile phone reminders on selected training modules during selected periods of the agricultural production cycle (section 5). The content of the reminders was related to pre- and post-harvest grain handling and quality management, as well as marketing activities (Appendix B). The impact evaluation is on the mobile phone reminders component of the intervention (section 6.1.4).

2.1.1 Theory of change

Our theory of change centred on raising smallholder farmers' incomes and improving their food security status by reinforcing lessons learned during face-to-face training about grain aggregation, sales contracting, pre- and post-harvest handling and grain quality management using mobile phone reminders. AMEDD identified a number of problems confronting grain farmers in the Sikasso region, which include losses in grain quantity and quality due to poor pre- and post-harvest management, poor access to appropriate post-harvest inputs, poor organisational skills of farmers, and the lack of access to better grain output markets. Some of these problems have resulted in increased transaction costs and reduced grain market participation, which subsequently leads to low farmers' incomes and high food insecurity. AMEDD therefore put together a number of activities – including farmer training – aimed at addressing these challenges, with the overarching goal of increasing farmers' incomes and reducing household food insecurity.

AMEDD's activities included: (i) training of cooperatives and private aggregators in organisational management, collective marketing, contracting, bulk purchasing of inputs, pre- and post-harvest handling and grain quality management; (ii) training of farmers in cooperative principles, collective marketing (grain aggregation), sales contracting, collective bulk input buying, pre- and post-harvest handling and quality management. AMEDD's theory of change is that providing pre- and post-harvest grain handling and

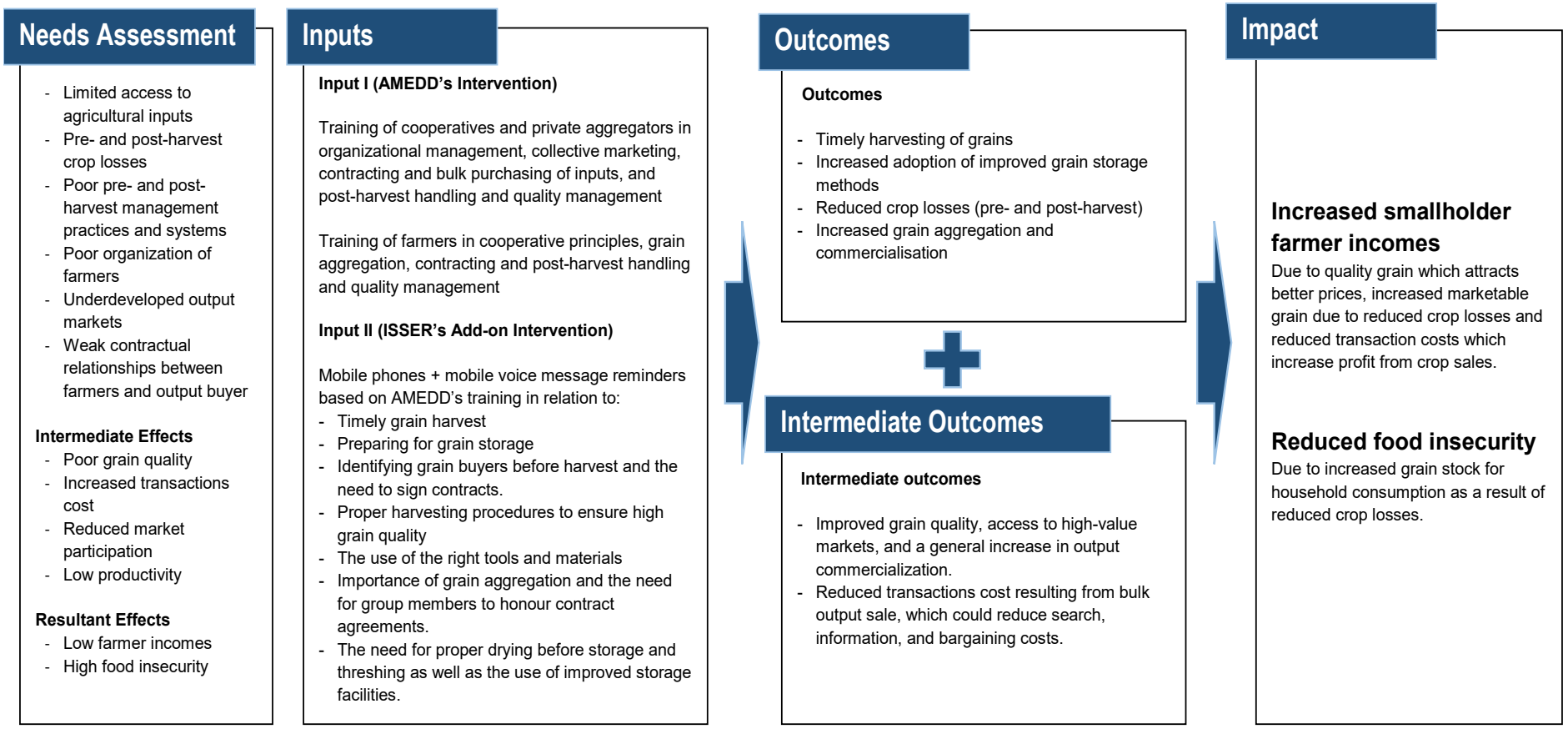
quality management training to aggregators and farmers will reduce losses in grain quality and quantity, allowing farmers to access higher market niches.

In addition to AMEDD's assumption that training would lead to behavioural change, which would translate into impact on key outcomes, we argue, based on the theory of change, that reinforcing training lessons through reminders enhances knowledge retention and subsequent application, all else being equal (VanLehn 1996; Kim et al. 2013). Therefore, the impact that our study seeks to evaluate is based on the assumption that a one-time face-to-face training in pre- and post-harvest handling and quality management, and related activities, will not be enough to ensure that farmers fully assimilate and apply the knowledge. Suppose one is able to remind farmers at specific periods when they need to apply what they learned during the face-to-face training, will this increase adoption rates over and above receiving training only? Fortunately, general developments in information and communication technology (ICT) (as well as increased penetration of mobile phones among farmers), and, in particular, mobile phone voice reminders, makes it possible to test this hypothesis. Our theory of change is that the reminders increase the likelihood of adoption of better pre- and post-harvest practices. Why could this be the case? The psychology literature (Schmidt and Bjork 1992; VanLehn 1996; Kim et al. 2013) suggests that repetition matters for retention of what is learned, and that spacing out repetitions has an even greater effect, such that allowing time between training and the reminders, rather than massing repetitions, works best. This constitutes an important foundation for this study (Figure 1).

The actual training content covered pre- and post-harvest activities. We therefore expect reminders about knowledge acquired through training to have an impact first on farmer behaviour, second on crop output and marketing, and finally on smallholder farmers' incomes and household food security. The impact on farmer behaviour may be observed through indicators such as harvesting time, harvesting cost and an increased likelihood of using improved storage methods. The impact on crop output and marketing is captured using indicators such as reduction in pre- and post-harvest grain losses, increased output commercialisation, and selling through aggregation centres.

Mobile phone reminders of training on pre- and post-harvest handling and grain quality management are expected to promote farmers' uptake of enhanced pre- and post-harvest management practices, such as timely harvest and the adoption of post-harvest technology in the form of improved storage methods. These are expected to reduce grain losses (Kumbhakar and Bokusheva 2009) and therefore make increased volumes and better-quality grains available to the household. While reductions in quantity losses are expected to increase marketable surplus, improved grain quality is expected to attract higher grain prices. The combined effect of increased marketable grain surplus and higher grain prices is expected to result in higher food crop incomes for farmers and reduced food insecurity.

Figure 1: Theory of change: Impact of mobile phone reminders



Source: Authors' construct 2017

Further, we expect mobile phone reminders of farmers' training on cooperative principles and collective marketing (grain aggregation) to promote sales through aggregation centres, which benefit from higher prices as a result of collective bargaining and which could lead to higher farmers' incomes. Collective selling through aggregators (cooperatives and private aggregators) is expected to reduce the cost of transactions such as search and information cost. We expect farmers to enter sales contracts with aggregators following mobile phone reminders of training on sales contracting. Sales contracts are a major means of reducing the incidence of low and volatile prices associated with grains during the harvest season. It is therefore expected that guaranteed prices through sale contracts would have a positive impact on farmers' incomes and subsequently reduce household food insecurity.

In the medium to long term, the intervention could increase farm investment as farmers get guaranteed and stable output markets, which allow them to plan more effectively and efficiently. However, we do not evaluate this impact because of the relatively short time span between treatment and endline data collection; we expect such benefit to start accruing.

The rationale for these expected results is that a more structured market, resulting from the smallholder–aggregator–buyer linkage, helps to overcome underdeveloped input and product markets and leads to higher adoption rates. The assumption is that farmers are willing and have the incentive to sell through aggregation centres, and that these centres are available at a reasonable distance from farmers. Even then, we are not oblivious to the issue of side-selling and contract non-adherence (Minot and Sawyer 2016); farmers often compare the marginal gains from selling through aggregation centres with those available by selling through other markets, and then choose the option they believe optimises their returns, at least in the short run. Our key informant interviews suggest that this is common.

The expected impacts could be threatened by a number of factors. First, there is the threat of influence or sabotage from established middlemen/women. There is also the possibility that farmers divert inputs away from targeted crops or even sell these inputs in the market. If this happens, the expected impact of the programme would not be observed. The impact of the programme also depends on the timeliness of factor input availability from aggregators. If inputs are not available to farmers at the time when they should be applied, then farmers will effectively have 'void' contracts with aggregation centres and adequate volumes will not be available to meet contracts. The risk of product diversion may not necessarily be a price issue. If, for example, aggregators do not collect produce on time, this increases the side-selling risk.

Additionally, two more issues pose threats to the programme not being successful in achieving its core goals, and these relate to the fact that it is grain which is the channel through which farmers' incomes could be increased in the study area. The first issue surrounds the goal of reducing post-harvest grain losses by farmers. Estimates of these losses suggest they are already very low, about 5 per cent (AGRA 2014), and, although driving down the current levels is laudable, it may be difficult to see a significant impact in the short term. The second issue relates to the goal of raising smallholder farmers' incomes through grain market participation. Ex-ante, grain market participation is generally low, with less than half of all grain farmers selling any output. Thus, it could

take some time for this to change, meaning that we may not be able to detect an impact for the period during which we have observed the farmers.

In sum, the theory of change is that, since all farmers and aggregators received the same level and quality of training, reinforcement through the add-on intervention of mobile phone reminders will encourage application of knowledge among treated farmers (those who received mobile phone reminders) over and above what is observed among control farmers (those who received face-to-face training only). This should lead to lower crop losses among the treatment group compared with the control group, which will further lead to higher grain value, and increased household incomes, all other things being equal.

2.1.2 Research hypotheses

Good-quality grains have higher market value and attract large buyers such as the World Food Programme. Poor pre-and post-harvest handling and quality management, however, threaten access to such higher value markets, in addition to reducing the overall realised grain output. An important component of the proposed programme is therefore to provide farmers with the requisite knowledge that could help to overcome the challenges above. All farmers in our study sample received the same relevant knowledge in terms of the content and also the quality of the training through face-to-face sessions. Our hypothesis is that sending mobile phone reminders to farmers before, during and after harvesting – at the time when they need to apply the knowledge learned from the training – has an added impact on farmers' adoption of effective pre- and post-harvest activities and aggregation services, subsequently reducing pre-and post-harvest crop losses and increasing crop aggregation beyond the rate achievable through face-to-face training only.

We expect the reminders to have an impact on grain harvesting cost. This is because the training also focused on timely harvesting in order to avoid crop losses. Based on the training modules, we sent specific reminders on appropriate harvesting procedures (Appendix B). We therefore expect an impact on the cost of harvesting. It could increase due to increased investments in harvesting procedures. On the other hand, efficiency gains could lead to cost savings if farmers use hired labour less frequently or choose to harvest themselves because they believe that hired labour would not know the correct harvesting methods.

Post-harvest technology adoption is an important determinant of post-harvest losses (Kumbhakar and Bokusheva 2009; Tefera et al. 2011). The AMEDD training modules had specific sections on type of material and methods to use for storage in order to minimise losses. We therefore expect the timely reminders on recommended grain storage to have a positive impact on the adoption of improved storage methods. This should also increase the likelihood of storing grains as opposed to selling soon after harvest.

Collective selling through aggregation centres because of sale contracts is one of the major ways the proposed programme could improve farmer market participation and raise smallholder farmers' incomes. Yet the literature suggests that non-adherence to contracts and side-selling of output is not uncommon (Dawes et al. 2009; Narayanan 2012). If the aggregation model is working well, then we expect more farmers in the

treatment group to sell their grains through aggregation centres as well as receive related services from aggregators. Even if they do not store their grains directly at aggregation centres, they should use more improved methods of storage at home in order to be able to meet the quality standards demanded by aggregators linked to 'big buyers'.

Given the explanations above, our overall hypothesis can be stated as follows. Mobile phone reminders about pre- and post-harvest handling and quality management, and related services, lead to reduced crop losses, improved grain quality and value, increased incomes, and reduced household food insecurity. If we let T(0) denote farmers in the control group (i.e. farmers who received only face-to-face training), and T(1) those in the treatment group (i.e. farmers who, in addition to the face-to-face training, also received mobile phone reminders), then our hypothesis is a test of the difference in the outcomes between the two groups: that is, T(1) – T(0).

3. Context

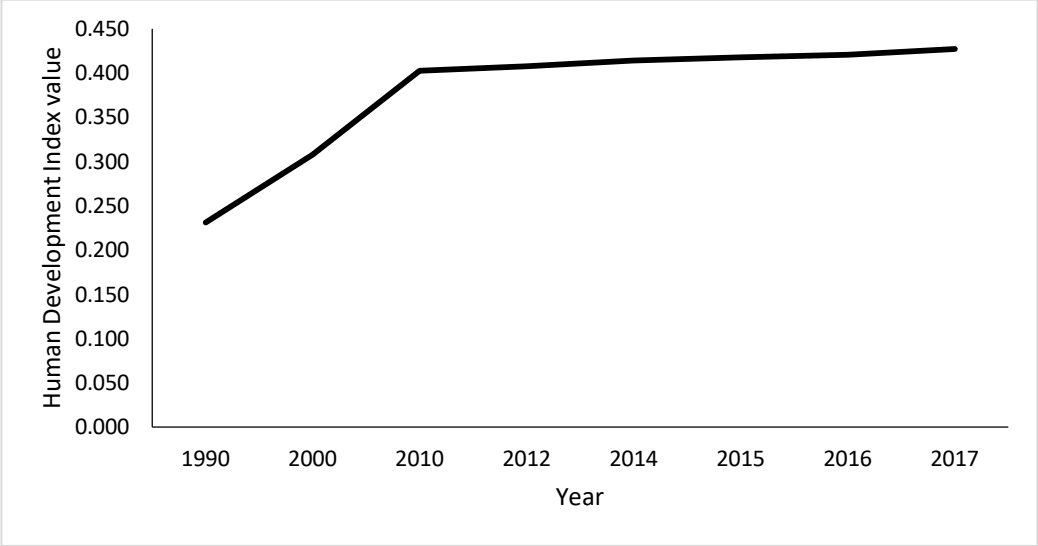
3.1 Country background

Mali is a land-locked country in West Africa, covering a land area of about 1.2 million square kilometres with an estimated population of about 18.5 million as at 2017 (World Bank 2018). About 90 per cent of the people in Mali live in the southern region, close to the Niger and Senegal rivers, far from the Sahara Desert. The population of Mali comprises several sub-Saharan ethnic groups, the largest being the Bambara ethnic group, which accounts for about 37 per cent of the population. Although the official language of Mali is French, about 80 per cent of the population speak Bambara (the main local language spoken in the study region).

The economy of Mali is heavily dependent on agriculture, with the rural population mostly engaged in semi-subsistence agriculture. The economic environment is characterised by weak economic growth and per capita income combined with high unemployment and high poverty rate. Mali has one of the lowest standards of human development in the world, with a Human Development Index rating of less 0.5 (Figure 2), and is classified among the world's 10 poorest nations.

Mali's potential wealth lies in mining and the production of agricultural commodities, including livestock and fish. The total size of Mali's economy in 2013 was about US$10.9 billion. Annual average real gross domestic product (GDP) growth over the period 2010–14 was 3.5 per cent, with 2011–13 seeing even lower average real growth rates (Table 1). During the period of the socio-political crisis in 2012, growth stagnated, with the secondary and tertiary sectors experiencing negative growth rates of -2.9 per cent and -6.7 per cent, respectively. These were offset, however, by the dynamism of the agriculture sector, which grew by 8.6 per cent, sufficient to cancel out the fall in the other sectors.

Figure 2: Evolution of the Human Development Index of Mali



Source: UNDP 2018

Table 1: GDP and sectoral growth (%)

	2010	2011	2012	2013	2014	2015	Annual average
GDP	**5.8**	**2.7**	**0.0**	**1.7**	**7.2**	**5.5**	**3.8**
Primary	**11.4**	**-1.3**	**8.6**	**-7.4**	**10.4**	**4.5**	**4.4**
Rice	24.0	-24.6	10.0	15.6	-2.2	4.9	4.6
Cotton	6.5	81.6	1.8	-2.1	24.5	1.5	19.0
Livestock	4.3	4.0	0.0	4.0	3.7	3.7	3.3
Secondary	**-2.1**	**8.1**	**-2.9**	**5.5**	**9.1**	**4.3**	**3.7**
Extraction	-14.3	0.0	9.2	1.5	-2.2	0.6	-0.9
Agribusiness	4.0	18.6	-16.0	14.1	35.0	3.2	9.8
Construction	7.0	5.0	-25.0	10.0	5.0	5.6	1.3
Tertiary	**4.5**	**3.8**	**-6.7**	**8.9**	**4.2**	**6.9**	**3.6**
Commerce	5.5	4.0	1.0	8.0	2.0	6.0	4.4
Transport & telecom	5.0	5.2	0.0	9.0	7.4	9.8	6.1

Source: INSTAT 2017

In order to consolidate the economic gains made by the country and address the perennial food insecurity issues, several interventions have been implemented by government and non-governmental organisations. Most of the interventions focus on three main outcomes: increased productivity, food security and increased incomes. In many cases, these outcomes are to be achieved through access to agricultural inputs, training on input use, post-harvest practices and price information. For example, AGRA alone has invested more than US$17.5 million in Mali, mainly in the Sikasso region, to build the capacity of farmer-based organisations (FBOs) to access improved planting materials, adopt integrated soil fertility technologies and to enhance the market power of smallholders.

3.2 Background of the study area

Mali has eight administrative regions. The AMEDD-funded AGRA intervention is being implemented in the Sikasso region, which is in the south of the country. By land area, the

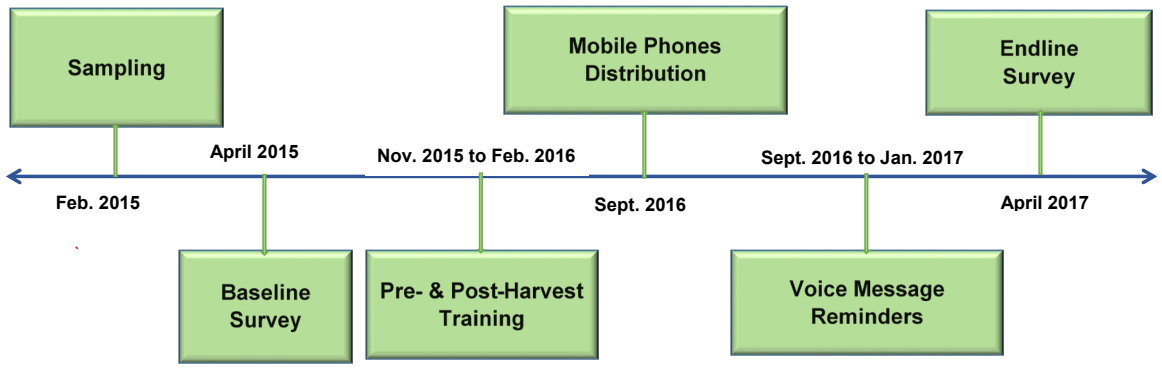
Sikasso region represents only about 6 per cent of Mali's land area, but has a much higher population density than the country average, accommodating over 18 per cent of Mali's population, according to the 2009 census (INSTAT 2011). At the subregional level, the Sikasso region is made up of seven districts known as cercles. The AMEDD intervention is being implemented in three of these cercles: Koutiala, Sikasso and Yorosso.

The Sikasso region is considered the 'breadbasket' of Mali, mainly due to its relatively more favourable climatic conditions in a rather dry country, where the agriculture production is largely rainfed. For example, while Mali as a whole usually experiences an annual rainfall average of about 540–740 millimetres (as low as 50–250 millimetres in the Saharan north of the country), Sikasso – with its Sudano-Guinean climate – experiences a mean annual rainfall of about 1,200 millimetres. Consequently, agriculture (crops and livestock production) is the main economic livelihood activity in Sikasso, although trade and artisanal gold mining are also important economic livelihood options. Maize, sorghum, millet and rice dominate the food crop sector, while cotton is the major cash crop.

4. Timelines

The activity timeline for the study is shown in Figure 3. Sampling, based on information received from AMEDD, took place in February 2015, after which baseline data collection followed in April 2015. Although AMEDD processes and interventions took place between May 2014 and March 2017, the relevant training activities for which our mobile phone reminder impact evaluation is based actually took place between November 2015 and February 2016. There was a stakeholder workshop in October 2015 with the aim of interrogating results obtained from the baseline survey. We also received input for subsequent refinement of the endline quantitative instrument. Stakeholder engagement activities followed in June 2016 prior to the implementation of the mobile phone reminder component of the study. Mobile phones were procured and distributed to farmers in September 2016. During the distribution of the phones, we also conducted a few focus group discussions to help understand some of the baseline quantitative results. This also provided some information towards the implementation of the endline quantitative survey. The endline survey was conducted in April 2017.

Figure 3: Activity timeline for the study



Source: Authors' own construct

5. Evaluation: design, methods and implementation

5.1 Evaluation design (including randomisation)

5.1.1 Design

The sample population for the impact evaluation is made up of farmers who received the interventions implemented by AMEDD in three cercles of the Sikasso region of Mali: Koutiala, Sikasso and Yorosso. The coverage villages within these cercles, 99 villages in all, form the clusters for the randomisation. All AMEDD project farmers who were registered as part of the intervention in the 99 villages received training on pre- and post-harvest grain quality management. After the training, 44 villages were randomly assigned to treatment and the rest to control. Therefore, the assigned experimental arms are:

- T(0): Control–villages where farmers received only face-to-face training.
- T(1): Treatment–villages where farmer received mobile phones and reminders after training.

Our power calculations indicated that drawing 12 households per cluster would provide adequate power for detecting impact based on the stated assumptions in section 5.2. However, we targeted 15 households per cluster in order to be insulated against the risk of attrition reducing the power of our statistical tests.

5.1.2 Randomisation

The randomisation followed two stages. At the first stage, we obtained a list of 99 villages that received training from AMEDD. We then randomly assigned each of the villages to one of the two arms: T(0) and T(1). The distribution of the villages by cercles is shown in Table 2. Across the cercles, the distribution was consistent with what the implementer made available for the study – about 31% in Koutiala, 29% in Sikasso and 39% in Yorosso. The random assignment was done together with the implementer using the Stata software. At the second stage, we listed households in the 99 selected villages in the three cercles. Finally, 15 households were randomly drawn from each of the villages that had been listed.

Table 2: Distribution of villages across cercles (subregions)

Cercle	Frequency	%
Koutiala	31	31.3
Sikasso	29	29.3
Yorosso	39	39.4
Total	**99**	**100**

Source: AMEDD administrative data

5.2 Sample size determination

The sample size used for this study was arrived at by undertaking a power analysis based on ex-ante assumptions and ex-post realisations about key parameters. The key assumptions that informed our power analysis and consequent sample size were as follows:

- Level of significance (α) = 0.05
- Intra-cluster correlation (ICC) = 0.03

- Clusters per treatment = 44
- Cases per cluster = 12
- Effect size = 0.20

These assumptions gave 80 per cent power, meaning that there is 0.80 probability that the impact estimates based on the selected sample will find a statistically significant difference when such a difference actually exists. AMEDD trained 29,700 farmers in all 99 programme villages (or clusters). We have used all these 99 villages for the mobile phone reminder experiment (55 for control and 44 for treatment). We oversampled at baseline, achieving a total sample size of 1,483 (15 households per cluster in 97 cases, 12 per cluster in 1 case, and 16 per cluster in another case). The sample dropped to 1,481 during the endline survey (12 and 14 in a village each, and 15 in the rest of the 97 villages). However, our analysis is based on 1,434 households (821 control and 613 treatment) because we excluded 47 households which did not receive the full complement of the mobile phone voice messages (196 messages in all). We have verified that the households that did not receive the messages are not systematically different from those that did (Table A2 in Appendix A).

Some of the assumptions outlined above hold for some of the indicators at endline so that we still have adequate power. However, the post-intervention ICCs are higher for some of our indicators, meaning that for those indicators (Table A1 in Appendix A) our study is not adequately powered to detect an impact. For example, with an ex-post average cluster size of 14 and an ICC of 0.008 for the post-harvest loss indicator, the study is adequately powered to detect the impact of the reminders on post-harvest losses. For food crop income, however, we have ex-post ICC of 0.462, which means that our study of the impact of the reminders on food crop income is underpowered. This should be borne in mind when interpreting some of the results.

5.3 Survey methodology

5.3.1 Sampling

The sampling protocol was as follows. AMEDD furnished the research team with a list of all eligible villages together with the list of aggregators who serve the programme villages. Since a full list of farmers to be served was not available, this was generated through a listing exercise in each village in collaboration with AMEDD and the aggregators (private and cooperative). After the careful listing of all farmers in each village, trained research assistants randomly selected 15 members from each selected aggregator using Microsoft Excel©. Before taking the random draw, the list generated was always validated by the leaders of the aggregators to ensure that it contained only members of the cooperative or private aggregator-linked farmers. The 99 villages comprised 60 villages served by cooperatives and 39 by private aggregators. The target of 15 members from each aggregator was achieved in 96 villages; 13 members were enrolled in one village, and 14 in two villages. The final sample thus consists of 862 and 572 farmers reached through cooperatives and private aggregators, respectively.

5.3.2 Data collection

Two rounds of data were collected for this study using an identical quantitative data survey instrument – at baseline and endline. The baseline data collection was undertaken in April and May 2015, while the endline data was collected in March and

April 2017. The survey instrument used focused on the farming activity of farm households. Although some household non-farm activity data were included in the instrument, the emphasis was on data relating to agricultural production, harvesting and marketing. Particular attention was paid to getting information on farmers' incomes and crop losses – two key impact indicators. The period for the survey was chosen so that it preceded the start of the rainy season when farmers are busiest.

The actual surveys were led by researchers from Groupe de Recherche en Économie Théorique et Appliquée (GREThA) with supervision and guidance from the Institute of Statistical, Social and Economic Research (ISSER). Before each of the surveys, enumerators were trained over a number of days. The objective of the training was to ensure that enumerators had a good and common understanding of the questionnaire. As part of the training, the enumerators undertook role-play exercises. Additionally, there was pre-testing of the questionnaire, which involved administering it to selected farmers in a community outside the programme area. Following the pre-tests, the team organised debriefing sessions, where the concerns and challenges encountered during the pre-tests were discussed. The actual survey started immediately after the training. Each of the supervisors and their team was assigned a subregion (or cercle).

6. Programme implementation and internal validity

6.1 Programme implementation

Details of the ex-ante programme intervention are given in section 2.1. Here, we focus more on actual implementation issues. The implementation spanned a three-year period covering May 2014 to March 2017 in three cercles of the Sikasso region: Koutiala, Sikasso and Yorosso. A core component of the programme was the training of aggregators and farmers, the main goal being to equip them to reduce the level of grain losses, increase grain quality, increase the value of output sold, and thereby increase smallholder farmers' incomes. Apart from the goals of the AMEDD programme specified in section 2.1, ISSER funded an add-on intervention, which had the goal of reinforcing the training that farmers had received by sending mobile phone reminders to a randomly selected group of farmers.

The implementation of the Development of Agricultural Marketing Support Services programme had the principal goal of improving smallholder farmers' incomes by reducing transaction costs for smallholder farmers in the Sikasso region of Mali through reduction in post-harvest crop losses and the sale of crops through aggregation centres (cooperatives and private companies). The programme had three main components, with an add-on (fourth) component introduced and funded by ISSER. We highlight the various activities implemented under each component below.

6.1.1 Strengthening cooperatives' organisational, technical and institutional capacities to provide production, post-harvest and marketing services to smallholder farmers

Activities implemented for this component of the programme targeted cooperatives and private aggregators operating in the intervention region. Overall, 50 cooperatives took part in this component of the programme. The main activities undertaken included:

- profiling of FBOs

- training leaders of FBOs on six modules, which were:
  - cooperative management
  - strategies for input supply
  - contract agreement and marketing
  - post-harvest management and cereal storage
  - funding strategies
  - basic accounting
- training of farmers' trainers and producers on three modules, which were:
  - cooperative principles
  - contract agreement and marketing
  - post-harvest management and cereal storage
- business plans funding by the matching grant
- exchange visits between stakeholders.

All cooperative farmers selected for the intervention received training through the training of trainers approach. This means that farmer leaders and extension agents were trained, and these individuals then trained farmers at the cooperative level. The training lasted for two days per module. In all, over 7,000 farmers from the selected cooperatives received training over the period of the intervention. The total matching grants advanced to cooperatives over the period amounted to FCFA (Franc Communauté Financière Africaine) 35 million (about US$60,209) in the form of equipment and institutional strengthening. According to the programme implementation report by AMEDD, the total volume of 2,420 tonnes of cereals sold through aggregation centres was valued at FCFA 235 million (US$404,407).[1] In addition, the reported total volume of cereals sold under contracts was 1,166 tonnes.

Implementation of this component also involved a field trip to Burkina Faso involving 23 people. This was for participants to acquire practical experience with the cereal storage system, and to assess the level of adhesion and satisfaction of stakeholders, as well as the level of engagement in the process by the Burkinabe authorities, in order to make necessary recommendations to the Malian authorities. During the trip, some cooperatives and private aggregators participated in a knowledge-sharing session with local farmer organisations, micro-finance institutions and local agricultural chambers.

6.1.2 Strengthening the technical and business capacities of private operators to provide production, post-harvest and marketing services to smallholder farmers

As there were no functional cooperatives in some of the villages where the programme was targeted, AMEDD decided to work with private aggregators in order to reach farmers in these villages. The private aggregators were chosen by AMEDD based on their capacity in terms of available infrastructure (including aggregation centre facilities) and their willingness to participate in the programme. Seven private aggregators were selected and trained on supply and stock management, business plan development, negotiation and credit management. The private aggregators worked with farmer cooperatives. Over the period of implementation, 4,200 farmers joined private

[1] We use an exchange rate of 1 USD = 581.121 (https://www.xe.com/currencyconverter/convert/?Amount=100&From=XOF&To=USD).

aggregation centres. These farmers were also trained using the same approach as the cooperative farmers on post-harvest management, contract agreement and marketing. Workshops were organised where private aggregators were linked to farmers, as well as cooperation established between the cooperatives and the private aggregators. During these workshops and training programmes, contracts were signed between farmer cooperatives and private aggregators.

6.1.3 Improving smallholder farmers' agricultural output marketing

This component of the programme involved training sessions on processing techniques and output marketing. The training programmes were also aimed at fostering partnerships between farmers and local cereal-processing women. Over the period, 46 women benefited directly from these partnerships. Trade fairs were also held in Sikasso and Koutiala as part of this component of the programme. The fairs encouraged interactions among female processors for the purpose of knowledge-sharing towards grain quality improvement. The cereal trade fairs also provided opportunities for producers, private operators and processors to make transactions. During the fair, 1.2 tonnes of cereals were sold, valued at FCFA 750,000 (approximately US$1,200).

Another component of the above programme was focused on negotiation skills. Three separate pre-harvest negotiation events were organised during the three-year intervention period. These events were geared at gathering information on the demand for cereals in order to effectively forecast demand and ensure effective output sales. Overall, 19 contracts were signed for 848 tonnes of cereal over the intervention period.

6.1.4 Mobile phone and post-harvest reminder messages

This component of the programme was an add-on intervention introduced and funded by ISSER. The add-on intervention was implemented over a period of five months (September 2016 to January 2017). In all, 808 mobile phones were procured and distributed to farmers located in a randomly selected number of treatment villages. These phones were needed for farmers to receive training reminders. The reminder messages were designed by AMEDD, ISSER and GREThA. Implementation of this component of the programme started with the setting up of a platform that enabled the sending of SMS (text) and voice messages. The platform was then integrated with mobile operators in Mali – Orange/Malitel as a local gateway for voice and SMS message dissemination. The messages were translated into Bambara and then uploaded to the platform, and subsequently sent to the farmers. There was close supervision and facilitation of the process to ensure the smooth running of the platform to deliver customised messages to the selected famers. There were also training sessions for selected staff from ISSER and partners, on how to send messages to selected farmers.

In all, 8 customised messages were sent to 704 farmers located in the 44 treatment villages over the intervention period. The messaging period was divided into three: pre-harvest, harvest and post-harvest. Note that the messages were period-specific, in the sense that they related to the activities that farmers were expected to be carrying out at the time the messages were sent (Appendix B). There were 196 messages involving 92 farmers spread across 11 villages that were not delivered for technical reasons. We therefore excluded the 92 farmers from the impact evaluation—they are not part of the 612 farmers in the 44 villages used as the treatment group. We have verified that the

excluded farmers and those included in the evaluation are identical with respect to observable characteristics (Table A2 in Appendix A), and therefore do not pose any threat to the internal validity of our impact analysis. The content of messages sent to the farmers is reported in Appendix B.

6.2 Challenges and internal validity

According to AMEDD, the programme faced two main challenges: a government ban on cross-border cereal trade (i.e. cereal release limitation) and the unwillingness of some farmers to comply with contract agreements. The AMEDD programme had promised to increase farmers' cereal output as well as improve the quality of their grains, so that they would then be able to sell to large buyers, whether within or outside Mali, with the latter presenting better prospects in terms of price. Unfortunately, for the programme, the Government of Mali refused to let cereal traders sell grains in other countries. The second issue relating to contract non-adherence came about because prices were higher in the open market at the time when farmers were expected to sell cereals to aggregators, leading some farmers to side-sell.

As the roll-out of the add-on mobile phone reminders was largely under our control, the impact of which we seek to evaluate, we note very little, if any, threats to the internal validity of the study. As Table A2 in Appendix A shows, there is no reason to believe that the few households that did not receive the message are symmetrically different from those that did.

The only threat to the internal validity of the study relates to the training received. Suppose that the quality and/or quantity of training received differed between the control and treatment groups, then we could not claim to be measuring the effect of the add-on mobile phone reminders. However, because the randomisation took place after the training, this does not pose a valid threat. If the training was not effective, it should affect both groups similarly.

7. Impact on key outcomes

7.1 Estimation approach

The successful implementation of the randomisation allows us to use a simple strategy for evaluating the impact of mobile phone reminders on pre- and post-harvest activity and aggregation services on key outcomes for smallholder farmers, y_k. For each outcome, we estimate three regressions:

$$y_{it,k} = a_k + b_{1,k}Time + b_{2,k}Treat_i + d_k(Time \times Treat_i) + u_i + e_{it,k}$$

Eqn 1

$$y_{it,k} = a_k + b_{1,k}Time + b_{2,k}Treat_i + d_k(Time \times Treat_i) + g\sum_{j=1}^{3-1} Region_j + u_i + e_{it,k}$$

Eqn 2

$$y_{it,k} = a_k + b_{1,k}Time + b_{2,k}Treat_i + d_k(Time \times Treat_i) + g\sum_{j=1}^{3-1} Region_j + x_{it,k}h_k + u_i + e_{it,k}$$

Eqn 3

where *i*, *t*, and *k* represent household, time, and outcome of interest, respectively. *Time* is the time dummy, which equals 1 for endline and 0 for baseline. *Treat* is the treatment variable, which equals 1 if the household is in the treatment group and 0 if the household is in the control group. The impact indicator is the interaction between *Time* and *Treat*, with the average treatment effect (ATE) being δ, *Region*, two of three cercle dummies, and *x* is a set of other controls (household characteristics, namely: age, household composition and literacy rate), scale of production, type of aggregator, and remoteness (measured by distance to the regional capital); *u* is the unobserved household-specific effect, and *e* is the random error term. Eqn 1 is the base model (without any covariates); Eqn 2 adds on subregion (i.e. cercle) dummies; and Eqn 3 is the full model where we control for the full set of covariates.

Our outcome variables, y_k, are one of three kinds: binary (0/1), fractions ($0 \leq y \leq 1$), corner solution outcomes with a mass at zero, and roughly continuous outcomes. Where the outcome is binary or roughly continuous, we use the linear random effects estimator, which yields a panel data linear probability model in cases where the outcome is binary. The drawbacks of the linear probability model specification are benign in this case because our interest is in the estimate of ATE (Wooldridge 2002 p.445). The added advantage of the linear probability model in this case, apart from the ease in obtaining the ATE, is that it allows us to model unobserved heterogeneity using the correlated random effects approach (Wooldridge 2010). For the fractional and corner solution outcomes, we apply the fractional probit and random effect Tobit estimators. For the nonlinear models, we use the 'contrast' capability of the Stata statistical software package to obtain the correct ATE because in nonlinear models with interactions the coefficient on the interaction term may not represent the correct marginal effect in a similar way as the case is in a linear regression model (Ai and Norton 2003; Norton et al. 2004).

7.2 Descriptive and balance test

7.2.1 Sample characteristics

Given the identical number of households sampled per village across the three subregions at baseline, and the fact that nearly all households were successfully re-interviewed at endline, the proportion of households in the subregions in the sample is identical to those shown in Table 2. Yorosso represented the largest proportion (499 households or nearly 40% of the sample), followed by Koutiala (414 households representing 31% of the sample), and then Sikasso (373 households or 29% of the sample). The ex-ante and ex-post treatment groups were identical: 48 per cent for the treatment group (T1) and 52 per cent for control (T0) at both baseline and endline.

7.2.2 Balance test

The difference-in-difference (DID) estimation technique is employed for evaluating the impact of the mobile phone reminders intervention (see section 7.1 for details). This approach is based on a number of assumptions, which must be valid in order to obtain an appropriate counterfactual for estimating causal effect. With the successful random assignment of villages to control (T0) and treatment (T1) groups, and in the absence of any observable contamination issues, we would expect farmers in the control and treatment villages to be similar on observable characteristics prior to the intervention. We verify this assumption by undertaking statistical tests for differences between the

treatment and control group at baseline on all key indicators. This is done by simply regressing each indicator, y_k, on the treatment dummy (*Treat*). The general form of the regression for this test can be written as:

$$y_{i,k} = a + r\,Treat + u_i$$

Eqn 4

Where *Treat* = 1 if household *i* is assigned to the treatment group (T1) and 0 if in the control group (T0). The balance test is the test of the null hypothesis that $r = 0$. An indicator is balanced at baseline if we fail to reject the null hypothesis at the 5 per cent level. The balance test results are in Table 3. As one could expect from a successful randomisation exercise, all our indicators are balanced because in each case we find insufficient evidence to reject the null hypothesis that $r = 0$ at the 5 per cent level. We present a more detailed discussion on each of the indicators in section 7.3.

Table 3: Balance test results for indicators of interest

	Overall		T(0)		T(1)		T(1) − T(0)
Indicators	Mean	SD	Mean	SD	Mean	SD	*p*-value
Time of harvest (week)	41.3	4.8	41.5	4.4	41.0	5.3	0.192
Cost of harvesting (US$)	52.0	71.7	50.5	69.8	53.9	74.2	0.657
Adoption of improved storage methods	0.38	0.48	0.36	0.48	0.39	0.49	0.320
Selling grain through aggregation centres	0.12	0.33	0.11	0.32	0.14	0.35	0.464
Pre-harvest grain loss incidence	0.18	0.38	0.18	0.39	0.17	0.38	0.664
Post-harvest grain loss incidence	0.07	0.26	0.07	0.25	0.08	0.27	0.549
Volume of grains sold (kg)	683	1351	626	1187	759	1542	0.344
Food crop income (US$)	552	763	539	775	569	747	0.779
Food shortage experiences	0.14	0.35	0.14	0.35	0.14	0.35	0.814
Female farmer	0.28	0.45	0.26	0.44	0.31	0.46	0.233
Age of household head	54.1	13.4	54.1	13.3	54.2	13.4	0.915
Household size	18.4	10.4	18.6	10.4	18.3	10.4	0.690
Number of children	9.27	6.02	9.32	6.10	9.20	5.91	0.797
Head is literate	0.10	0.31	0.10	0.30	0.11	0.31	0.595
Total cultivated area (ha)	14.7	10.1	15.0	10.0	14.4	10.3	0.526
Grain area share	0.61	0.17	0.61	0.16	0.61	0.18	0.947
Incidence of weather-related covariate shocks	0.13	0.33	0.14	0.34	0.12	0.32	0.386

Note: Overall N = 1,434; T(0) N =821; T(1) N = 613. The *p*-values are cluster robust.
Source: ISSER/GREThA field data 2015 and 2016

Table 3 also contains some information on important characteristics of the sample. Although less than 1 per cent of household heads in the sample are female, approximately 30 per cent of the farmers involved in the AMEDD programme are female. This proportion is balanced between the treatment and control groups. The mean age of household heads is 54 years and the average household contains more than 18 members. Other surveys in Mali also report large household sizes (Beaman and Dillon 2012; Guirkinger et al. 2015). The literacy rate among household heads in the sample is very low – only about 10 per cent of heads are literate in French. The mean cultivated area in the overall sample is greater than 14 hectares and approximately 61 per cent of this area is devoted to the grains of interest to the intervention.

There is yet another assumption that must be satisfied for impact estimates using DID to be valid, which is the parallel trend assumption. Essentially, for our counterfactual to be valid so as not to compromise the internal validity of our DID estimates, we must be convinced that in the absence of the mobile phone training reminders, the difference in observed outcomes between the treatment and control groups is constant over time. In other words, we need to ask the question: would the treated farmers have experienced the same outcomes as the control group farmers if they did not receive the mobile phone reminders? Does the mean change in grain losses and food security, for example, among the control group represent a valid counterfactual change in the treatment group if we had not distributed mobile phones and sent training reminders? Typically, this assumption is evaluated graphically using more than one pre-intervention observation on the outcome variable(s) of interest. With only one pre-intervention data point, however, we are unable to provide such evidence based on our data.

However, given the manner of our randomisation, we do not have any reason to believe that, without the mobile phones and reminders, the mean outcomes of interest for the treatment and control groups would have followed dissimilar paths over time. One of the ways the parallel trend assumption could be violated is if pre-treatment characteristics that are correlated with changes in our outcomes of interest are unbalanced between the treatment and control groups (Abadie 2005). Therefore, apart from the outcomes of primary interest, we have verified that variables associated with the outcomes are also balanced between treatment and control groups. Take the occurrence of weather-related shocks, for example. We expected such shocks to be correlated with crop losses, food crop incomes and food security. We find, however, that such covariate shocks are balanced between the control and treatment groups. Nonetheless, the unavailability of pre-baseline data limits a more thorough data-driven evaluation of the parallel trend assumption, and this must be recognised when interpreting our impact results.

7.3 Impact results

The AMEDD theory of change posits that providing training to farmers on pre- and post-harvest grain handling and quality management will reduce crop losses as well as improve grain quality, allowing farmers to access better markets. The content of the actual training covered pre- and post-harvest activities. We therefore expected reminders about such activities to have an impact at three levels. The first is an impact on behaviour, which may be observed through indicators such as harvesting time, harvesting cost, demand for post-harvest related services, increased likelihood of grain storage, and the adoption of improved storage methods. The second level of impact is on crop output and marketing, and is captured using indicators such as pre- and post-harvest grain losses, output commercialisation, selling through aggregation centres, and mean price received for grains. The impact on price is expected to arise due to the expected improvement in grain quality. The third level of impact indicators concerns the overarching programme goals: smallholder farmers' incomes and food security. From the programme's perspective, the main research question is: what impact does reminding smallholder farmers about training on pre- and post-harvest handling and quality management have on the levels of grain losses, food crop incomes and food security?

7.3.1 Impact of reminders on change in behaviour

The first level of the programme's theory of change relates to changes in behaviour following the receipt of the mobile phone reminders. The study is especially interested in behaviour changes related to timely harvesting and associated investments, and storage practices and facilities, all of which aim at reducing losses (both in the field and after harvesting), and improving the quality of the grains taken to market.

Impact of reminders on harvesting time and cost

The first variable through which behavioural change could be detected is harvesting time and investment in timely harvesting in order to minimise losses in the field and preserve the quality of grains. Farmers in the treatment group received reminders about when to harvest their grains. We expected such messages to have an impact on harvesting practices. We expected to see this change through differences in harvesting time between the treatment and control groups. We also expected harvesting costs to differ if timely and appropriate harvesting practices attract either an increase or a reduction in cost.

The DID regression results (Table 4) show that treated farmers harvested their grains about two weeks earlier, on average, than the control group farmers. Figure A1 in Appendix A provides graphical evidence, which shows that although there was no significant difference in mean time of harvesting at baseline (the error bars on the graph in the left panel overlap[2]), the right panel shows that the reminders made an impact.

Table 4: Impact of training reminders on harvesting time and costs

Variables	Harvesting time			Harvesting cost		
	Eqn1	Eqn2	Eqn3	Eqn1	Eqn2	Eqn3
Treatment	–0.555	–0.225	–0.191	–1.878	–2.497	–3.540
	(0.423)	(0.386)	(0.382)	(5.252)	(5.132)	(4.963)
Time	0.271	0.271	0.241	–5.280	–5.168	–4.528
	(0.208)	(0.208)	(0.209)	(3.424)	(3.434)	(3.429)
Treatment x Time	–1.964***	–1.964***	–1.976***	–4.118	–4.179	–3.659
	(0.365)	(0.365)	(0.368)	(7.024)	(7.017)	(6.968)
Cercle (ref. is Koutiala):						
Sikasso		–1.497***	–1.433***		–7.729	–6.976
		(0.406)	(0.370)		(5.660)	(5.312)
Yorosso		0.460**	0.421		–10.314	–8.228
		(0.194)	(0.248)		(5.840)	(6.657)
Control group mean		41.6			46.7	
Observations	2,868	2,868	2,868	2,868	2,868	2,868

Note: Cluster robust standard errors are in parenthesis. *** and ** show statistical significance at the 1 per cent and 5 per cent levels, respectively.
Source: ISSER/GREThA field data 2015 and 2016

Although we need more information to be able to determine the ideal harvesting time from our data, the finding that mean harvesting time differs between the treatment and control groups after the reminders is revealing by itself. We find, however, that the impact on difference in harvesting time did not translate to a significant difference in

[2] Error bars, referring to the confidence intervals, are graphical representations of the variability of data and used on graphs to indicate the error or uncertainty in a reported measurement. If the error bars overlap, then we are certain that there is no impact at the given significant level.

harvesting cost (Table 4 and Figure A2 in Appendix A). In general, this suggests that cost is not as much of a constraint to timely harvesting as reinforcing farmer knowledge about when to harvest. This would be a plausible argument, particularly if we find that the difference in the timing of harvesting translates to a significant impact on pre-harvest loss reduction for the treatment group compared with the control group.

Impact of reminders on the adoption of improved storage methods

How grains are handled post-harvest is an important determinant of the overall quality and value subsequently (Compton et al. 1998; Iguaz et al. 2006). Crop storage is crucial in the agriculture value chain and farmers' capacity to store crops may result in higher crop value, especially in areas that experience wide seasonal price volatility, as is common in SSA. Having received training on pre- and post-harvest grain handling and storage, we expected the mobile phone reminders prompting farmers to apply the knowledge acquired to encourage the use of improved storage methods. From the programme's perspective, this is important for the key outcome indicators of grain losses and grain quality.

Our data show that nearly all households who store grains do so using local silos. Further, less than 1 per cent of all households reported storing grains at aggregation centres. Therefore, to measure the impact of the reminders on the adoption of improved storage methods, we constructed an indicator that takes the value 1 for those who store in recommended bags with chemical treatment and zero otherwise. Our hypothesis was that the reminders (particularly reminder 8) would have significant positive impact on improved storage behaviour. The regression results (Table 5) provide the test of the above hypothesis. The null hypothesis that the reminders had no impact on change in adoption of improved storage methods is rejected at the 5 per cent level. The estimated difference in the probability of adoption is approximately 11 percentage points higher for the treatment group than it is for the control group. Graphical evidence of impact can be found in Figure A3 in Appendix A, which shows that the adoption of improved grain storage methods was identical at baseline for the control and treatment groups (left panel), but the reminders had a positive impact, as the right panel of the graph shows.

Table 5: Impact of training reminders on improved storage method adoption

VARIABLES	Eqn1	Eqn2	Eqn3
Treatment	0.033	0.007	0.001
	(0.033)	(0.033)	(0.032)
Time	0.017	0.017	0.019
	(0.031)	(0.031)	(0.031)
Treatment x Time	0.110**	0.110**	0.111**
	(0.053)	(0.053)	(0.052)
Cercle (ref. is Koutiala):			
Sikasso		0.031	0.018
		(0.036)	(0.036)
Yorosso		–0.118***	–0.085**
		(0.034)	(0.036)
Control group mean		0.370	
Observations	2,868	2,868	2,868

Note: Cluster robust standard errors are in parenthesis. *** and ** show statistical significance at the 1 per cent and 5 per cent levels, respectively.
Source: ISSER/GREThA field data 2015 and 2016

Impact of reminders on choice of marketplace

Next, we examine the impact of the reminders on choice of marketplace. One of the core behavioural changes targeted by the AMEDD programme is for farmers to sell grains in bulk through aggregation centres. The rationale is as follows. Smallholder farmers tend to sell limited quantities of low-quality grains directly from the farm gate, often to small-scale traders whose prices may be lower than those available in other markets, partly due to transportation costs. In addition, due to post-harvest storage challenges, farmers in remote locations may also sell their crops at very low prices in small-scale local marketplaces, especially at times when prices are low because of excess supply. Therefore, we expected the reminders on crop aggregation (Message 4 in Appendix B) to prompt smallholders to sell to cooperatives and private aggregators. This is based on the premise that these buyers indeed offer better prices. We note that the choice of marketplace is conditioned by a number of other factors: output volumes, distance to markets, wealth status of the farmer, FBO membership and market information, among other things (Fafchamps and Hill 2005; Muamba 2011; Zanello et al. 2014). However, the AMEDD programme tried to address some of these.

In the pooled sample, only about 13% of farmers reported selling grains through aggregation centres (12.5% at baseline and 12.7% at endline). Therefore, we used a binary response variable to test the hypothesis that the reminders increase the probability of sale through aggregation centres for the treatment group over and above that for the control group.

The DID regression results (Table 6) show that the reminders had no significant impact on grain sales through aggregation centres. Information from our process monitoring and focus group discussions suggest that the aggregation centre mean price was generally lower than prices in the open market. Indeed, from our data we find that households who sold grains through aggregation centres received US$17 less per tonne of grain sold compared with those who sold elsewhere (US$190 versus US$207 per tonne). Figure A4 in Appendix A provides graphical evidence, which supports the results in Table 6: the share of farmers selling grains through aggregation centres was balanced at baseline (left panel), and there is no visible sign of impact after the mobile phone reminders intervention (right panel).

Table 6: Impact of training reminders on selling grains through aggregation centres

VARIABLES	Eqn1	Eqn2	Eqn3
Treatment	0.027	0.028	0.033
	(0.037)	(0.036)	(0.036)
Time	0.006	0.006	0.004
	(0.025)	(0.025)	(0.025)
Treatment x Time	–0.009	–0.009	–0.009
	(0.041)	(0.041)	(0.041)
Cercle (ref. is Koutiala):			
Sikasso		–0.003	0.002
		(0.032)	(0.031)
Yorosso		0.001	–0.017
		(0.026)	(0.026)
Control group mean		0.116	
Observations	2,868	2,868	2,868

Note: Cluster robust standard errors are in parenthesis.
Source: ISSER/GREThA field data 2015 and 2016

7.3.2 Impact of reminders on key programme outcome indicators

Here, we examine the impact of the mobile phone reminders intervention on some of the core outcomes of the AMEDD programme: crop losses and commercialisation.

Impact of reminders on pre- and post-harvest grain losses

One of the main goals of the AGRA-funded AMEDD programme is to improve grain quality. This objective can be achieved through the adoption of appropriate pre- and post-harvest grain management practices. Here, we assess the impact of the mobile phone reminders intervention on pre- and post-harvest grain losses. We use binary indicators for measuring these impacts because of the very low incidence of post-harvest grain losses (7.2% and 10.7% at baseline and endline, respectively).

First, we observe a general rise in both pre- and post-harvest losses between baseline and endline. Pre-harvest loss incidence increased from 17.7 per cent at baseline to 40.9 per cent at endline. This rise has been attributed to weather-related factors, particularly rainfall, according to farmers. This is not surprising because the literature (De Bruijn et al. 2005; Generoso 2015) suggests that climate variability, especially the alternation of good and bad weather from one year to the next is common in Mali and has detrimental consequences for crop production outcomes, in particular because of the largely rainfed nature of production systems. Therefore, while not all losses are under the control of the farmer, we expected the reminders intervention to reduce the rate of crop loss for the treatment group compared with the control group.

Table 7 provides the DID regression results, showing that the mobile phone reminders reduced the incidence of pre-harvest losses. The reminders are estimated to have reduced pre-harvest losses by approximately 14 percentage points. This is a large impact magnitude, compared with the control group mean loss of about 33 per cent. Further evidence is provided in Figure A5 in Appendix A, which shows that whereas an identical share of farmers in the treatment and control groups reported pre-harvest grain losses at baseline (left panel), significantly fewer farmers in the treatment group reported any pre-harvest losses at endline (right panel).

Table 7: Impact of training reminders on crop losses

VARIABLES	Pre-harvest losses			Post-harvest losses		
	Eqn1	Eqn2	Eqn3	Eqn1	Eqn2	Eqn3
Treatment	–0.013	0.024	0.023	0.008	0.015	0.013
	(0.030)	(0.029)	(0.028)	(0.014)	(0.014)	(0.014)
Time	0.292***	0.292***	0.293***	0.048***	0.048***	0.047***
	(0.030)	(0.030)	(0.030)	(0.015)	(0.015)	(0.015)
Treatment x Time	–0.142***	–0.142***	–0.142***	–0.030	–0.030	–0.029
	(0.044)	(0.044)	(0.044)	(0.022)	(0.023)	(0.023)
Cercle (ref. is Koutiala):						
Sikasso		–0.063***	–0.049**		–0.012	–0.014
		(0.023)	(0.023)		(0.013)	(0.013)
Yorosso		0.149***	0.148***		0.027**	0.023
		(0.025)	(0.026)		(0.013)	(0.014)
Control group mean		0.329				
Observations	2,868	2,868	2,868	2,868	2,868	2,868

Note: Cluster robust standard errors are in parenthesis. *** and ** show statistical significance at the 1 per cent and 5 per cent levels, respectively.
Source: ISSER/GREThA field data 2015 and 2016

Moving to post-harvest losses, the regression results (Table 7) show that the impact of the reminders on post-harvest losses is rather imprecisely estimated, showing no significant impact. Figure A6 in Appendix A provides graphical evidence, which is consistent with the regression results. Although this might seem surprising at first glance, this could be explained by the timing of the endline survey. It may take longer than 4–5 months to observe any impact on storage losses, which are an important component of total post-harvest losses. Also, it might be difficult to drive down significantly the already low levels of post-harvest losses reported by farmers, barring measurement error in such farmer-reported post-harvest losses.

Impact of reminders on output commercialisation

Next, we examine reminders' impact on produce commercialisation. Our hypothesis was that farmers who adhere to the reminders about harvesting, threshing and storage would have higher marketable grain surplus. Reminder 4 (Appendix B), in particular, deals with marketing and we expected that this (together with the other messages) would increase grain market participation and volumes sold. Note that cotton is the dominant cash crop in the study area and grain market participation is not high – at baseline, only about half of grain producers reported any sales. We estimated the impact of the reminders on the volume of grains sold using the Tobit estimator.

The Tobit regression results (Table 8) show that, although the treatment group mean grain sale volume is approximately 94 kilograms higher than that of the control group mean, this is imprecisely estimated, meaning that the reminders did not have a significant impact on the volume of grains sold. Figure A7 in Appendix A provides graphical evidence, which is consistent with the regression results. The left panel shows that there is no significant difference in the volume of grains marketed at baseline. The right panel shows that this outcome did not change after treatment. Again, these results could be different if the endline data were collected later than 4–5 months after the harvest, when more sales volumes may have been reported. However, we note from the focus group discussions and key informant interviews that many farmers consider the grains they produce to be more important for consumption than for income generation through sales. Cotton is seen as the main cash crop, with the grains being important for food security.

Table 8: Impact of training reminders on volume of grains sold

VARIABLES	Eqn1	Eqn2	Eqn3
Treatment	131.362	53.053	56.016
	(98.941)	(93.701)	(88.453)
Time	–243.056***	–243.140***	–243.039***
	(48.309)	(48.586)	(49.710)
Treatment x Time	69.074	90.394	94.119
	(93.543)	(92.793)	(93.170)
Cercle (ref. is Koutiala):			
Sikasso		420.997***	417.379***
		(159.796)	(146.976)
Yorosso		–75.364	–96.803
		(65.158)	(78.339)
Control group mean		542.04	
Observations	2,868	2,868	2,868

Note: Cluster robust standard errors are in parenthesis. *** and ** show statistical significance at the 1 per cent and 5 per cent levels, respectively.
Source: ISSER/GREThA field data 2015 and 2016

7.3.3 Impact of reminders on higher-level outcomes – incomes and food security

The end goal of the AMEDD programme is to increase smallholder farmers' incomes and reduce food insecurity. We therefore examine whether the reminders had any impact on these high-level indicators.

Impact of reminders on food crop income

The aim of the AMEDD programme was to raise farmers' incomes by increasing the volume and quality of grains produced and sold through aggregation centres. Given that we did not find any impact on sales volumes, no impact on incomes may accrue unless there are price differentials arising from differences in the quality of grains and the type of market through which the two groups sell their grains. The village mean grain price difference between the control and treatment villages is only US$3.97 (standard error = US$2.39), which is not statistically different from zero. In general, therefore, one would not expect the reminders intervention to have a significant impact on food crop incomes, contrary to the aim of the programme.

The estimated mean food crop income at baseline was US$552 (US$539 for the control group and US$569 for the treatment group). At endline, mean food crop income fell (by approximately 8% overall) – not surprising given the reduction in grain sales. The Tobit regression results (Table 9) show that, although the reminders increased mean food crop incomes by approximately US$77, this difference is imprecise and thus not statistically different from zero. Figure A8 in Appendix A shows graphical evidence. The left panel shows that food crop income was identical at baseline between the two groups, and the story did not change significantly at endline (right panel). This is not surprising given the reasons presented earlier. Given the time lag between treatment and endline, it is possible that even with reduced crop losses and increased smallholder market, the impact on incomes would not be immediately detected.

Table 9: Impact of training reminders on food crop income

VARIABLES	Eqn1	Eqn2	Eqn3
Treatment	51.107	–81.399	–99.678**
	(84.186)	(50.407)	(47.805)
Time	–70.935**	–66.663**	–61.543**
	(30.348)	(30.211)	(29.331)
Treatment x Time	70.328	74.661	76.580
	(62.610)	(60.420)	(58.974)
Cercle (ref. is Koutiala):			
Sikasso		688.139***	628.258***
		(87.432)	(79.535)
Yorosso		–164.957***	–84.434**
		(43.371)	(39.151)
Control group mean		497.42	
Observations	2,868	2,868	2,868

Note: Cluster robust standard errors are in parenthesis. *** and ** show statistical significance at the 1 per cent and 5 per cent levels, respectively.
Source: ISSER/GREThA field data 2015 and 2016

Impact of reminders on food (in)security

Finally, we examine the impact of the mobile phone reminders on food security. The rationale for expecting the reminders intervention to have an impact on food security is as follows. All other things being equal, timely harvesting, which the treatment aimed to

encourage, as well as proper storage, should make more food available to the household for longer periods of the year, particularly under the semi-arid conditions faced by the population in our study area, including the unimodal rainfall pattern. The impact of the reminders on pre-harvest crop losses and the adoption of improved storage methods should make more grains, the main staple foods in the study area, available to the households over a longer period and thereby reduce the incidence of hunger.

The impact on food security is evaluated using the incidence of food shortage. The baseline and endline surveys asked households about the following food insecurity experiences:

- In the last 12 months, did you or other adults (18 years and above) in your household lose weight because there was not enough money for food?
- In the last 12 months, did you or other adults (18 years and above) in your household ever have to miss meals for a whole day because there was not enough money for food?
- In the last 12 months, did you ever have to reduce the quantity or quality of your child's meals because there was not enough money for food?
- In the last 12 months, did a child ever have to skip meals because there was not enough money for food?
- In the last 12 months, was a child ever hungry but you just could not afford more food?
- In the last 12 months, did a child ever have to forego meals for a whole day because there was not enough money for food?

A household is categorised as having suffered food shortage or hunger if they responded 'yes' to any of the above questions. Overall, only 13% of households responded 'yes' to at least one of the above (14% at baseline and 11% at endline).

Table 10: Impact of training reminders on the incidence of food shortage

VARIABLES	Eqn1	Eqn2	Eqn3
Treatment	–0.006	0.012	0.014
	(0.027)	(0.025)	(0.025)
Time	0.001	0.001	–0.003
	(0.022)	(0.022)	(0.023)
Treatment x Time	–0.073***	–0.073***	–0.072**
	(0.028)	(0.028)	(0.029)
Cercle (ref. is Koutiala):			
Sikasso		–0.033	–0.030
		(0.021)	(0.020)
Yorosso		0.070***	0.038
		(0.026)	(0.027)
Control group mean		0.146	
Observations	2,868	2,868	2,868

Note: Cluster robust standard errors are in parenthesis. *** and ** show statistical significance at the 1 per cent and 5 per cent levels, respectively.
Source: ISSER/GREThA field data 2015 and 2016

The regression results (Table 10) show that the reminders had a statistically significant impact on food shortage incidence. The incidence of food shortage reduced among the treated households by approximately 7 percentage points compared with the control group; this is a large impact magnitude relative to the control group's mean food

shortage incidence. Figure A9 in Appendix A provides further support to the regression results. The incidence of food shortage is identical between the treatment and control groups at baseline. However, treated households have a significantly lower incidence of food shortage after the intervention. It seems that the reduction in crop losses and the adoption of improved storage methods makes more food available to the household for consumption and not necessarily for sale, and likely reduces the so-called 'sell low, buy high' behaviour of smallholder farmers (Stephens and Barrett 2011; Dzanku 2015; Dzanku 2017).

7.3.4 Impact heterogeneity

We examine the differential impact of the reminders by type of aggregator and sex of farmer. We focus on three key outcome indicators: crop losses, adoption of improved storage methods and food security. We do this by estimating the impact of treatment on the selected outcomes at endline by estimating the following equation:

$$y_{i,k} = a_k + p_k(Group' \ Treat_i) + g\sum_{j=1}^{3-1} Region_j + x_{i,k}h_k + e_{i,k},$$

Eqn 5

where *Group* denotes aggregator type (equals 1 if private aggregator and 0 if cooperative) or sex of farmer (equals 1 if female farmer and 0 if male farmer), *x* is a vector of control variables including the baseline outcome and household demographics. If the reminders intervention has a differential impact, then π_k should be significantly different from zero at the 5 per cent level.

Table 11 tests the presence of differential impact of treatment by aggregator type for improved grain storage method adoption, pre-harvest grain losses and hunger incidence. The results show no evidence that the reminders intervention had differential impact by aggregator type for any of the three outcomes at the 5 per cent level. Similarly, Table 12 shows no differential impact of treatment by gender of farmer for all three outcomes at the 5 per cent level.

Table 11: Impact of training reminders by aggregator type

VARIABLES	Improved storage	Pre-harvest losses	Hunger incidence
Treatment	0.030	–0.099**	–0.064**
	(0.060)	(0.039)	(0.029)
Private aggregator	–0.004	–0.022	–0.027
	(0.074)	(0.050)	(0.034)
Treatment x Private aggregator	0.160	–0.017	–0.005
	(0.093)	(0.063)	(0.041)
Cercle (ref. is Koutiala):			
Sikasso	0.063	–0.002	–0.030
	(0.055)	(0.037)	(0.023)
Yorosso	–0.125**	0.236***	0.025
	(0.061)	(0.037)	(0.031)
Observations	1,434	1,434	1,434

Note: Cluster robust standard errors are in parenthesis. *** and ** show statistical significance at the 1 per cent and 5 per cent levels, respectively.
Source: ISSER/GREThA field data 2015 and 2016

Table 12: Impact of training reminders by gender of farmer

VARIABLES	Improved storage	Pre-harvest losses	Hunger incidence
Treatment	0.071	–0.100**	–0.068***
	(0.048)	(0.039)	(0.023)
Female farmer	0.031	0.028	0.015
	(0.031)	(0.049)	(0.032)
Treatment x Female farmer	0.082	–0.022	0.009
	(0.048)	(0.072)	(0.038)
Cercle (ref. is Koutiala):			
Sikasso	0.078	–0.003	–0.030
	(0.055)	(0.038)	(0.024)
Yorosso	–0.126**	0.236***	0.025
	(0.061)	(0.037)	(0.031)
Observations	1,434	1,434	1,434

Note: Cluster robust standard errors are in parenthesis. *** and ** show statistical significance at the 1 per cent and 5 per cent levels, respectively.
Source: ISSER/GREThA field data 2015 and 2016

7.4 Summary of impact results

We have analysed the impact of mobile phone training reminders about pre-and post-harvest grain handling and management on a number of indicators summarised in Table 13. Out of the eight indicators assessed, the results show the impact of the reminders on three of them: adoption of improved methods of grain storage, pre-harvest losses and the incidence of food shortage. We conjecture that it could take longer than the 4–5 months left between intervention and endline survey, to observe an impact on other outcomes even if the intervention drives those outcomes (e.g. post-harvest losses and income). Nonetheless, the observed impact on food security is an important one.

Table 13: Summary of impact results

Indicator	Conclusion
Intermediate outcome indicators:	
Cost of harvesting	No impact
Adoption of improved storage methods	Positive impact
Sale through aggregation centres	No impact
Key outcome indicators:	
Pre-harvest grain losses	Positive impact
Post-harvest grain losses	No impact
Volume of grains sold	No impact
Programme impact indicators:	
Food crop income	No impact
Food shortage incidence	Negative impact

Source: Analysis using ISSER/GREThA field data 2015 and 2016

8. Discussion

8.1 Threats to internal validity

8.1.1 Contamination and attrition

As we noted in section 6, we are not aware of any serious contamination issue that could render the results of the analysis invalid. There is therefore no obvious threat to internal validity. Attrition is not a problem given that only two households could not be followed at endline.

8.1.2 Hawthorne and John Henry effects

In our experiment, one could argue that the Hawthorne and John Henry effects are more likely to be an issue among the treatment than control group because the geographical dispersion of the two groups makes it unlikely for the control group to know that their counterparts in other communities are being treated. The treatment and control villages (and households) do not belong to the same famer groups or cooperatives. However, the treatment group could interpret the reminders as a test of the knowledge received during training and may therefore feel under some pressure to perform. This could be a limitation to our study.

8.2 Threats to external validity

8.2.1 Heterogeneity

Our results show that, for a number of the indicators, the Yorosso cercle seems to be different from the other two, and this could be driving some of the results. Yorosso is the most remote of the three subregions and is generally poorer. Further analysis may therefore be required to gauge such possible heterogeneous impacts.

8.3 Stakeholder expectations and experiences

The presentation of our baseline and impact results generated great interest from government, farmer organisations and non-governmental organisations in Mali. Participants, including government officials from the Ministry of Agriculture, raised some concerns and provided some recommendations. Some raised questions about the focus on grains in the Sikasso region, claiming that cotton rather than grains is the most important crop in the region. The programme implementers (AMEDD) defended the choice of Sikasso, stating that the villages chosen in the region are major grain producers and that diversification is important even in a cotton-dominant area. The government officials, in particular, recommended that the programme be scaled up to other regions in southern Mali, especially Ségou and Bandiagara.

Participants also raised concerns about accuracy in the measurement of post-harvest losses from farmer recalls. They recommend that the figures produced by the survey be taken as very rough estimates and that a lot more work is required to capture accurately the exact extent of post-harvest losses.

Some participants were of the opinion that, given the intervention timelines, it is premature to talk about impact. They suggested the need for a third round of data collection in order to measure the impact more accurately.

8.4 Key lessons from this study

The ISSER team has been involved in a number of impact evaluations with varying experiences and frustrations coming mainly from non-adherence to experimental assignments by implementation agencies. This particular evaluation was similarly threatened. The threats, however, led us to be innovative. At the end, we believe the experiment we have conducted was largely successful because issues of non-compliance were reduced. For the so-called 'real time' or 'real world' experiments to be successful, it is our view that much stronger commitment has to be engendered between programme-implementing agencies and researchers; this collaboration has to be 'forced' rather than left to the discretion of the parties involved.

9. Specific findings for policy and practices

The overall goal of the programme, a component of which we have evaluated, was to increase farmers' incomes by linking them to markets and increasing their market power. Our overarching hypothesis was that a one-time face-to-face training was not enough to ensure that farmers applied what they learned – training must be reinforced through reminders. Thanks to ICT penetration across Africa, we were successful in sending farmers mobile phone reminders that enabled us to test our reinforcement hypothesis.

Our hypotheses tests were at three levels: (1) impact on behaviour changes as seen through the adoption of practices and techniques that could reduce pre- and post-harvest losses and improve grain quality; (2) direct impact on outcomes such as grain losses and grain marketing; and (3) impact on higher-level outcomes such as income and food security. At each level, we found some evidence of impact, often of reasonably high magnitude that is not only statistically significant but also practically important. The quality of evidence can be indicated as: (1) a high positive change in behaviour related to the adoption of improved grain storage methods; (2) impact on pre-harvest grain losses; and (3) finally, a strong impact on food security.

An important question, which also came up during the dissemination of the impact results at stakeholder engagement sessions in Mali, relates to the scalability of the intervention, particularly the mobile phone reminders arm. There were questions about the cost-effectiveness of this arm of the intervention. However, our calculations show that the reminders are relatively inexpensive compared with methods such as farmer field schools, for example. It cost approximately US$31 to reach a farmer with the reminders. This includes US$20 per mobile phone and SIM card, and US$11 for setting up the platform and sending the messages. The US$31 figure translates to approximately 159 kilograms of grain in the study area. While we are unable to calculate the exact quantity of grains that the reminders saved, the impact on reducing hunger is large and could well be above US$31 in monetary terms. As an alternative, farmer field schools and similar agricultural extension programmes are estimated to cost between US$42 and US$62 per famer (Quizon et al. 2001). The reminder arm of the intervention could, in fact, be undertaken at a much lower cost, because it could be implemented with a high degree of success without giving each farmer a mobile phone. In our sample, for example, 98 per cent of farmers had their own phones, which could be used for sending them reminders.

The overall takeaway from a policy perspective is that one needs to think more carefully about the approaches to boosting agricultural technology adoption in rural Africa beyond the traditionally known approaches. The high penetration of mobile phones in the region could be seen as a vehicle for proving ‘real-time’ agricultural technology advice to farmers. The cost of doing this is relatively inexpensive (compared with face-to-face training, for example).

Appendixes

Appendix A: Figures and tables

Figure A1: Harvesting time was identical between the treatment and control groups at baseline but at endline the treatment group harvested earlier on average

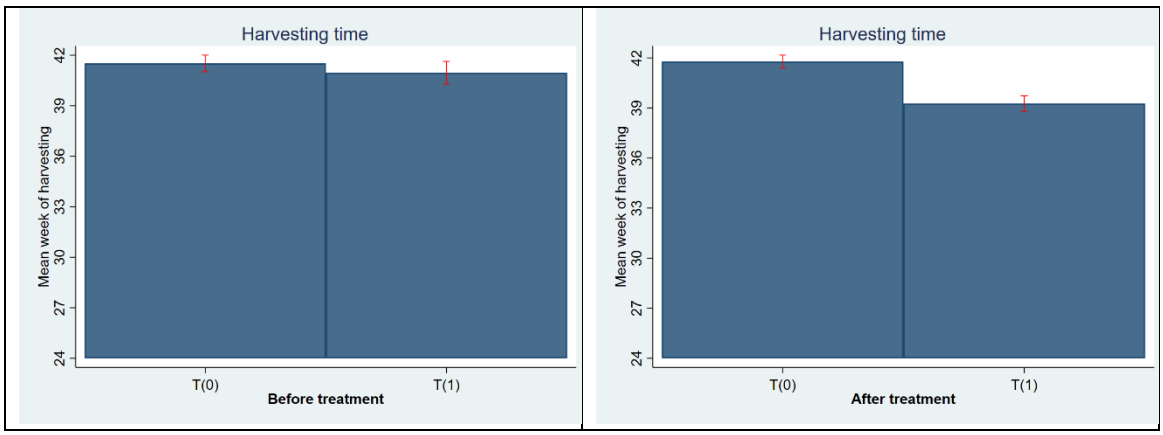


Figure A2: There was no difference in harvesting cost between the two groups at baseline and this did not change significantly after treatment

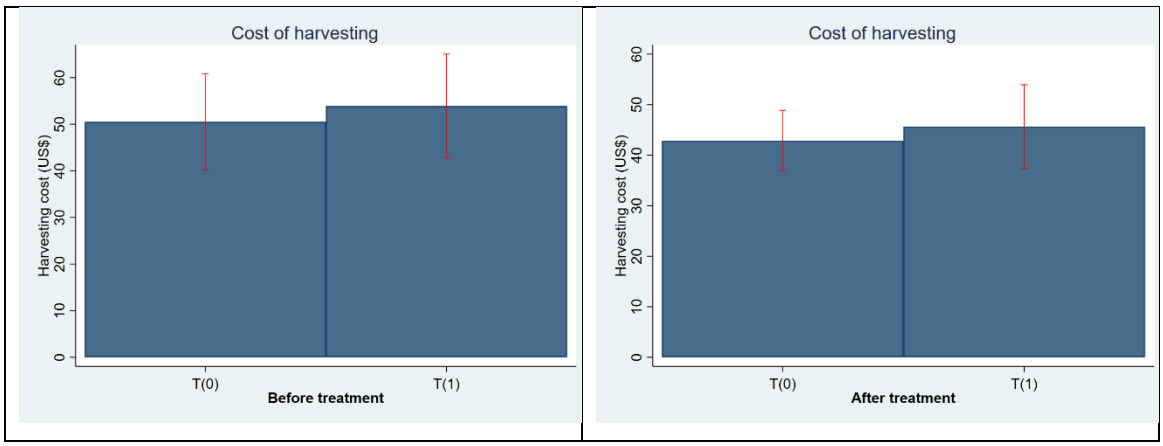


Figure A3: There was no difference in improved storage adoption between the two groups at baseline but the reminders seem to have increased adoption among the treatment group than among the control

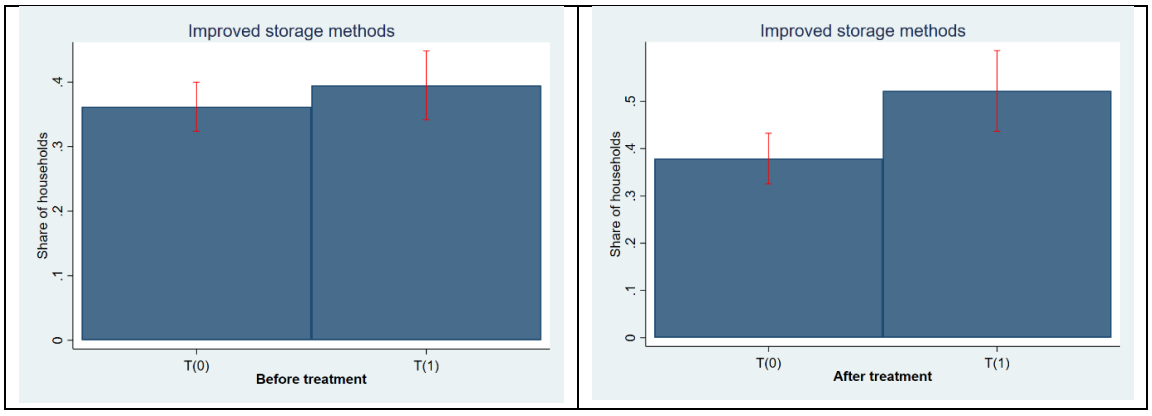


Figure A4: The share of farmers selling grains through aggregation centres was identical between the two groups at baseline and this did not change after treatment

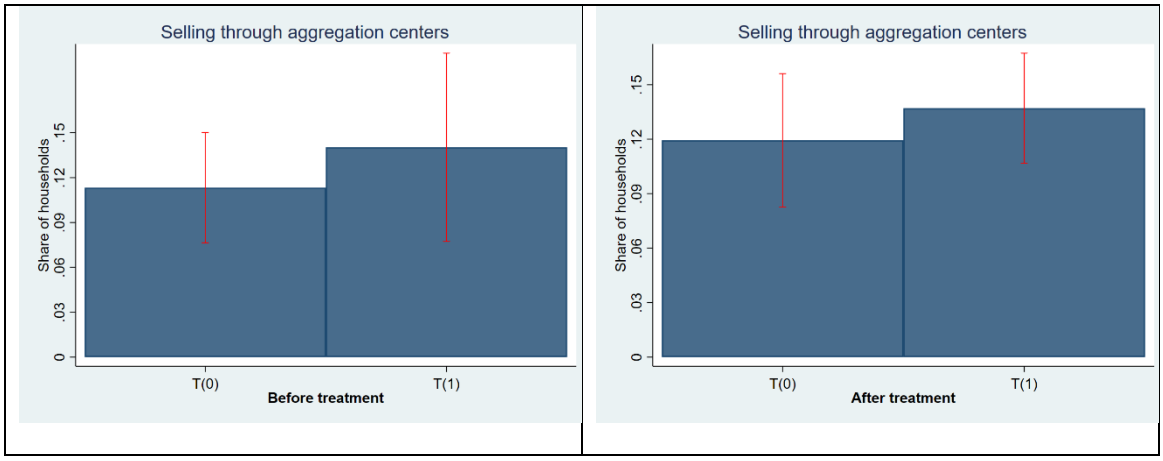


Figure A5: An identical share of control and treated farmers reported pre-harvest grain losses at baseline but at endline fewer farmers in the treatment group reported losses than in the control group

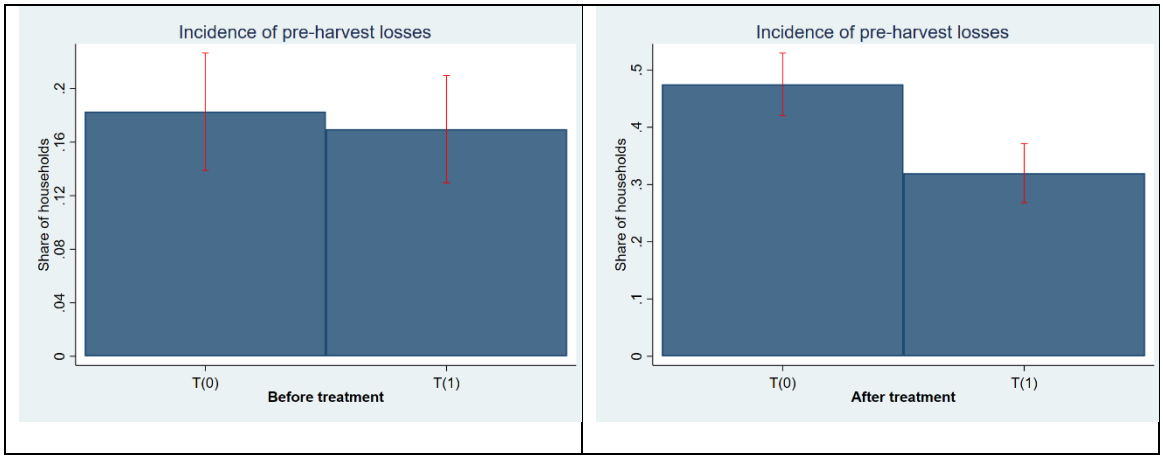


Figure A6: An identical share of control and treated farmers reported post-harvest grain losses at baseline and no difference is detectable after treatment

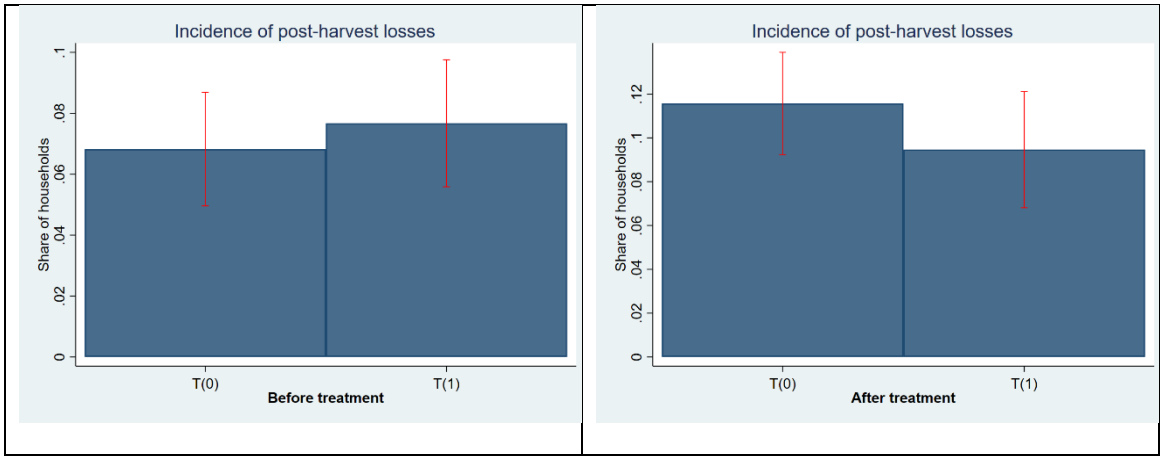


Figure A7: The volume of grains sold is identical for the control and treatment groups at baseline and this did not change significantly after treatment

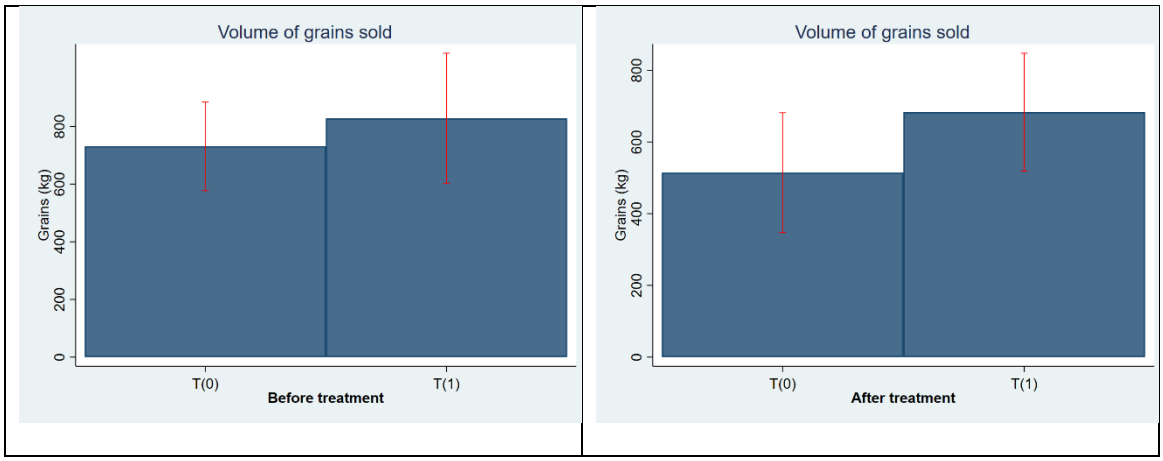


Figure A8: Food crop income is identical for the control and treatment groups at baseline and this did not change significantly after treatment

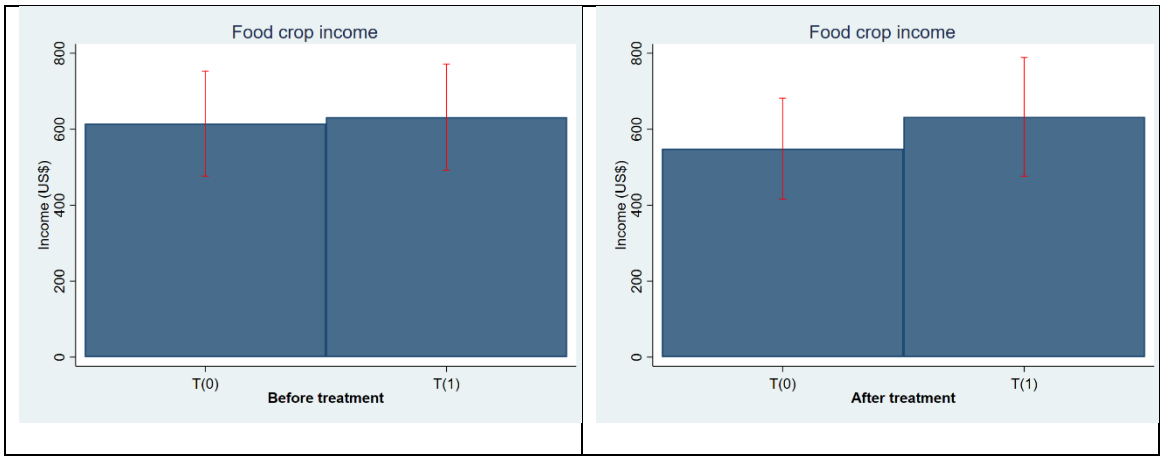


Figure A9: The incidence of hunger is identical for the control and treatment groups at baseline but reduced significantly for the treatment group compared with the control group after the intervention

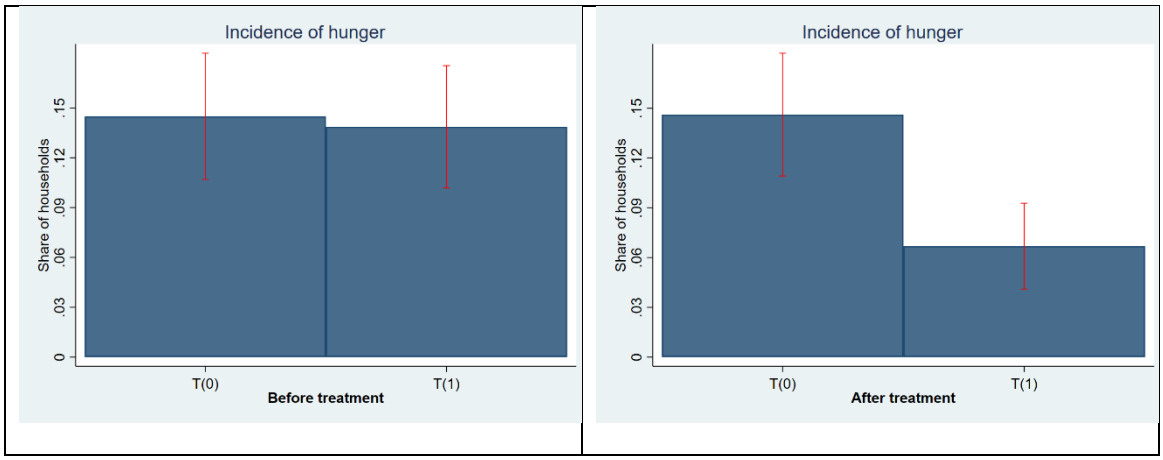


Table A1: Post-intervention intra-cluster correlation

Variables	ICC
Time of harvesting	0.138
Harvesting cost	0.220
Improved grain storage methods adoption	0.044
Selling through aggregation centres	0.210
Incidence of pre-harvest losses	0.093
Incidence of post-harvest losses	0.008
Volume of grains sold	0.171
Food crop income	0.462
Food shortage	0.085

Table A2: Probit regression estimates of the probability of mobile phone reminders terminating

Variables	Estimate
Education	–0.045
	(0.274)
Literacy	0.314
	(0.268)
Age	–0.000
	(0.003)
Income (1000s)	–0.008
	(0.021)
Distance to district	0.000
	(0.005)
Time	–0.004
	(0.008)
Cercle:	
Sikasso	0.138
	(0.182)
Yorosso	–0.129
	(0.191)
Constant	–1.844***
	(0.333)
Observations	2,962
Pseudo R-squared	0.012
Log-likelihood	–411.89

Note: Cluster robust standard errors are in parenthesis. *** and ** show statistical significance at the 1 per cent and 5 per cent levels, respectively.
Source: ISSER/GREThA field data 2015 and 2016

Appendix B: Content of mobile phone voice messages sent to the treatment group

Messages before harvest

Message 1 Bonjour, this is AMEDD and AMASSA Afrique Verte. We trained you on how to manage your grains after harvest to ensure good quality and reduce your losses. We will be sending you messages over the next few months to remind you of what you learnt during the training. Thank you, goodbye.

Message 2 Bonjour, this is AMEDD and AMASSA Afrique Verte. This message is to remind you that it is important to harvest your grains at the right time to ensure good quality grains. As you know, your grains are mature and ready for harvesting when you notice that almost all the panicle has turned yellow. Thank you, goodbye.

Message 3 Bonjour, this is AMEDD and AMASSA Afrique Verte. This message is to remind you that you need to prepare your threshing area before you bring in your grains. Use the right materials such as sickle, tarpaulins, threshers and shellers. Thank you, goodbye.

Message 4 Bonjour, this is AMEDD and AMASSA Afrique Verte. This message is to remind you that you can identify the buyers of your grains before harvest. Also, remember that you can sign contracts with your buyers before harvesting your grains. Thank you, goodbye.

Messages during harvest

Message 5 Bonjour, this is AMEDD and AMASSA Afrique Verte. This message is to remind you that to prevent dirt from polluting the grains during harvest do not cut the plant close to the ground or pull the plants from the root. Thank you, goodbye.

Message 6 Bonjour, this is AMEDD and AMASSA Afrique Verte. This message is to remind you that to minimise loss of grains, you need to use the right materials to gather the grains during harvesting. Thank you, goodbye.

Message 7 Bonjour, this is AMEDD and AMASSA Afrique Verte. We are sending you this message to remind you that if you are selling grains together with others in a group you should remind your group members to honour their contract agreements. Thank you, goodbye.

Messages after harvest

Message 8 Bonjour, this is AMEDD and AMASSA Afrique Verte. We are sending you this message to remind you to dry your grains very well before storing or threshing. Always remember to store your grains at a clean ventilated place. Use the recommended grain storage pallets and ensure that your grains are free of impurities or insects. Thank you, goodbye.

References

Abadie, A, 2005. Semiparametric difference-in-differences estimators. *The Review of Economic Studies,* 72(1), pp.1-19.

AGRA, 2014. Establishing the status of postharvest losses and storage for major staple crops in eleven African countries (Phase II). Alliance for a Green Revolution in Africa, Nairobi, Kenya. Available at: <https://agra.org/> [Accessed 11 July 2017] .

Ai, C and Norton, EC, 2003. Interaction terms in logit and probit models. *Economics Letters,* (80), pp.123-129.

Beaman, L and Dillon, A, 2012. Do household definitions matter in survey design? Results from a randomized survey experiment in Mali. *Journal of Development Economics,* 98(1), pp.124-135.

Compton, JAF, Floyd, S, Magrath, PA, Addo, S, Gbedevi, SR, Agbo, B, Bokor, G, Amekupe, S, Motey, Z, Penni, H and Kumi, S, 1998. Involving grain traders in determining the effect of post-harvest insect damage on the price of maize in African markets. *Crop Protection,* 17(6), pp.483-489.

Dawes, M, Murota, R, Jera, R, Masara, C and Sola, P, 2009. Inventory of smallholder contract farming practices in Zimbabwe. SNV Netherlands Development Organisation. Available at: <http://www.snvworld.org/> [Accessed 5 May 2014].

De Bruijn, ME, Kaag, MAA, Til, AV and van Dijk, JWM, 2005. *Sahelian pathways. Climate and society in Central and South Mali*. Leiden University, Leiden.

Dzanku, FM, 2015. Household-specific food price differentials and high-value crop production in rural Ghana. *Food Policy,* 57, pp.73-82.

Dzanku, FM, 2017. Rational but poor? An explanation for rural economic livelihood strategy. *Journal of Agricultural Economics,* doi: 10.1111/1477-9552.12245.

Fafchamps, M and Hill, RV, 2005. Selling at the farmgate or traveling to market. *American Journal of Agricultural Economics,* 87(3), pp.717-734.

FAOSTAT, 2017. Food and Agricultural Organization of the United Nations (FAO), FAO Statistical Database. Available at: <http://faostat3.fao.org/download/Q/QC/E>

Generoso, R, 2015. How do rainfall variability, food security and remittances interact? The case of rural Mali. *Ecological Economics,* 114(Supplement C), pp.188-198.

Guirkinger, C, Platteau, J-P and Goetghebuer, T, 2015. Productive inefficiency in extended agricultural households: Evidence from Mali. *Journal of Development Economics,* pp.116, 17-27.

Iguaz, A, Rodriguez, M and Virseda, P, 2006. Influence of handling and processing of rough rice on fissures and head rice yields. *Journal of Food Engineering,* 77(4), pp.803-809.

INSTAT, 2011. *4th General population census habitat and Mali (RGPH-2009): Analysis of final results.* Institut National De La Statistique, Bamako.

INSTAT, 2017. National Statistics. Institut national de la statistique. Available at: <https://www.ird.fr/les-partenariats/principaux-partenaires-scientifiques/afrique-de-l-ouest-et-centrale/mali/instat> [Accessed 5 May 2016).

Kim, JW, Ritter, FE and Koubek, RJ, 2013. An integrated theory for improved skill acquisition and retention in the three stages of learning. *Theoretical Issues in Ergonomics Science,* 14(1), pp.22-37.

Kumbhakar, SC and Bokusheva, R, 2009. Modelling farm production decisions under an expenditure constraint. *European Review of Agricultural Economics,* 36(3), pp.343-367.

Minot, N and Sawyer, B, 2016. Contract farming in developing countries: Theory, practice, and policy implications. Innovation for inclusive value-chain development: Successes and challenges. *International Food Policy Research Institute (IFPRI), Washington, DC*, pp.127-158.

Muamba, FM, 2011. Selling at the farmgate or traveling to the market: a conditional farm-level model. *The Journal of Developing Areas,* 44(2), pp.95-107.

Narayanan, S, 2012. Notional contracts: The moral economy of contract farming arrangements in India. WP-2012-020. Indira Gandhi Institute of Development Research, Mumbai, India. Available at:< http://www.igidr.ac.in/pdf/publication/WP-2012-020.pdf> [Accessed 5 May 2014].

Norton, EC, Wang, H and Ai, C, 2004. Computing interaction effects and standard errors in logit and probit models. *Stata Journal,* 4(2), pp.154-167.

Quizon, J, Feder, G and Murgai, R, 2001. Fiscal sustainability of agricultural extension: The case of the farmer field school approach. *Journal of International Agricultural and Extension Education,* 8(1), pp.13-24.

Schmidt, RA and Bjork, RA, 1992. New conceptualizations of practice: Common principles in three paradigms suggest new concepts for training. *Psychological Science,* 3(4), pp.207-217.

Stephens, EC and Barrett, CB, 2011. Incomplete credit markets and commodity marketing behaviour. *Journal of Agricultural Economics,* 62(1), pp.1-24.

Tefera, T, Kanampiu, F, De Groote, H, Hellin, J, Mugo, S, Kimenju, S, Beyene, Y, Boddupalli, PM, Shiferaw, B and Banziger, M, 2011. The metal silo: An effective grain storage technology for reducing post-harvest insect and pathogen losses in maize while improving smallholder farmers' food security in developing countries. *Crop Protection,* 30(3), pp.240-245.

VanLehn, K, 1996. Cognitive skill acquisition. *Annual Review of Psychology,* 47(1), pp.513-539.

Wooldridge, JM, 2002. *Econometric analysis of cross section and panel data*. Cambridge, MA: MIT Press.

Wooldridge, JM, 2010. Correlated random effects models with unbalanced panels. Manuscript. Available at: <http://econ.msu.edu/faculty/wooldridge/docs/> [Accessed 5 March 2012].

World Bank, 2018. World Development Indicators. World Bank. Available at: <https://data.worldbank.org/products/wdi> [Accessed 5 May 2018].

Zanello, G, Srinivasan, CS and Shankar, B, 2014. Transaction costs, information technologies, and the choice of marketplace among farmers in Northern Ghana. *The Journal of Development Studies,* 50(9), pp.1226-1239.

Other publications in the 3ie Impact Evaluation Report Series

The following reports are available from http://www.3ieimpact.org/en/publications/3ie-impact-evaluation-reports/3ie-impact-evaluations/

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.

Mali is a landlocked, low-income and food-deficit country in the African Sahel. Farmers face adverse weather conditions and poor access to agricultural inputs, knowledge of improved grain management practices, credit facilities and output markets. Osei and colleagues assessed the impact of mobile phone voice reminders for a pre- and post-harvest grain management training on farmer behaviour and household income. The reminders had a significant impact on the timing of the grain harvest and the adoption of improved grain storage methods. While the incidence of pre-harvest grain losses lowered significantly, there was no impact on post-harvest grain losses. The reminders reduced the incidence of food shortage in households, but had no impact on the likelihood of selling through aggregation centres or on food crop incomes.

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