Reinforcing agro dealer networks in Niger: an impact evaluation study

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Grantee Final Report

Accepted by 3ie: July 2017

International Initiative for Impact Evaluation

Note to readers

This impact evaluation has been submitted in partial fulfilment of the requirements of grant TW4.1015 awarded under Thematic Window 4. 3ie is making this final report version available to the public as it was received from the authors. No further copy-editing or formatting has been done. All content is the sole responsibility of the authors and does not represent the opinions of 3ie, its donors or its board of commissioners. Any errors and omissions are the sole responsibility of the authors. All affiliations of the authors listed in the title page are those that were in effect at the time the report was accepted. Any comments or queries should be directed to the corresponding author, Robert Darko Osei at rdosei@yahoo.co.uk

Suggested citation: Osei, R, Osei-Akoto, I, Asante, FA, Adam, M, Fenny, A, Adu, P and Hodey, L, 2017, *Reinforcing agro dealer networks in Niger: an impact evaluation study, 3ie Grantee Final Report.* New Delhi: International Initiative for Impact Evaluation (3ie)

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.

Acknowledgement

We wish to acknowledge 3ie for funding and technical review and support throughout this study. We also wish to thank AGRA monitoring and evaluation office for the continued support and readiness to answer questions whenever we approached them. We will also wish to thank the implementing partners CEB who have been very tolerant throughout the study period. Finally we wish to thank various participants for their invaluable comments during our stakeholder meetings and other engagements. All views expressed in this study are those of the authors only.

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Acronyms and Abbreviations

ADOC	Appui au Développement des Organisations Communautaires
ADPHYTO	Association des Distributeurs des Produits Phytosanitaires du Niger
AGRA	Alliance for a Green Revolution in Africa
CAADP	Comprehensive Africa Agriculture Development Programme
CEB	Contribution à L'Education de Base
CEDEAO	Communauté Economique des Etats de l'Afrique de l'Ouest
ECOWAS/CEDEAO	Economic Community of West African States/Communauté Economique des Etats de l'Afrique de l'Ouest
FAO	Food and Agriculture Organisation
FBO	Farmer-Based Organisations
FGD	Focus Group Discussions
GDP	Gross Domestic Product
HHDS	Household Dietary Diversity Score
IFAD	International Fund for Agricultural Development
INRAN	Institut National de la Recherche Agronomique du Niger
ISSER	Institute of Statistical, Social and Economic Research
ITT	Intention to Treat
IV	Instrumental Variables
MiDA	Millennium Development Authority
RCT	Randomised Control Trial
SIMA	Système d'Information sur les Marchés Agricoles
SWMT	Soil and Water Management Technologies
TOC	Theory of Change
USAID	United States Agency for International Aid
USD	United States Dollars

Executive Summary

Agricultural production in Niger has been plagued with low productivity and, as such, low incomes for the majority of the country's small-scale farmers. This is largely due to poor soil quality and arid climate conditions which result in less than satisfactory yields and high crop losses per hectare. *Contribution à L'Education de Base* (CEB) with the support of the Alliance for a Green Revolution in Africa (AGRA) maintain that input-use by farmers is a crucial part of the solution to these problems. However, the rate of adoption remains low among farmers in Niger. One way in which they hoped to deal with this challenge was through a programme that sought to empower agro-dealers, who are a key part of the agriculture value chain. The objective of the program was to train agro-dealers in three regions in Niger namely, Maradi, Tahoua and Zinder, to facilitate farmers' access to inputs and encourage adoption through provision of extension services, especially through practical demonstrations.

The Institute of Statistical Social and Economic Research (ISSER), was contracted to evaluate the proposed agro-dealer training program over a two-year period. This study therefore sought to determine whether strengthening agro-dealer networks increases farmer productivity in the study regions. More specifically, the study evaluates the impact of agro-dealer training in input use and handling, and crucial business practices, on the behaviours of the small-scale farmers that they serve.

The evaluation looks at the performance of two treatment groups, who received either training only or training plus demonstration, randomly assigned to agro-dealers at baseline. Though the design of the study followed a randomized phased-in approach, non-adherence to the random assignments during the programme implementation made it necessary to employ an IV approach in estimating the impact. In the first stage, the ex-post treatments are instrumented with the ex-ante treatment assignments and other key characteristics of the sampled agro-dealers that we anticipate will affect the likelihood of being treated. The second stage looks at the impact of the treatment on two sets of indicators; one representing input adoption and use, and the other, farmer outcomes which results from input use.

The main findings of the study are summarized as follows:

- We observe a negative impact of training alone on improved seed use, as measured by the likelihood of farmers adopting the input.
- Following training plus demonstration plots, we observe increased adoption of improved seed, showing the added value of the demonstration component in the intervention, in encouraging seed use.
- There was no significant impact on farmer production outcomes, namely crop yields and pre-harvest crop losses over the period.

The study concludes by proffering some suggestions as to why the programme could not achieve the expected outcomes. First, it is noted, based on discussions with stakeholders in a workshop, that credit was an important missing link as to why the take-up was not as anticipated. Indeed, even though credit was originally part of the study design, the late start of that component meant that it had to be dropped as a treatment arm in the study. The stakeholders essentially argued that improved access to credit would have allowed for greater impact.

1 Introduction

In most sub-Saharan Africa (SSA) countries, there is limited use of agricultural inputs by smallholder farmers. The problem is particularly acute in Niger, where input supply systems are largely inefficient. Good quality inputs are neither available at the right time nor affordable for smallholder farmers to assure agricultural intensification through the use of inputs. For instance, in Niger, only about 12% of the agricultural land area is cultivated using improved seeds. Also fertilizer use remains low at about 1.1kg per hectare of arable land compared to the already low West African average of about 16kg per hectare of arable land (World Bank 2016). Consequently, the only way by which the majority of farmers can have increased crop production is by extending cultivation area towards marginal lands. There are many factors that have accounted for the particularly low usage of inputs in Niger. One such factor is the absence of input distributors with a high degree of professionalism, particularly in the rural areas. Secondly, there is limited access to credit and information on input markets. Finally, farmer organizations are generally weak, and are therefore unable to mobilize and overcome some of the bottlenecks that farmers face.

There has always been an interest in agricultural inputs, their adoption and their impact on production, especially in sub-Saharan Africa. This is because, agricultural growth is seen as a fundamental pre-requisite for widespread poverty reduction, and there is a strong connection between poverty alleviation and agricultural expansion (Dorward, Kydd, Morrison, & Urey , 2004). Farming in SSA is largely by smallholder farmers who mainly do subsistence farming. A key feature of smallholder agriculture is a heavy reliance on rainfall and limited use of key inputs such as improved seeds and chemicals with the result that yields are generally low. It is for this reason that some argue that giving more attention to subsistence farming will be critical for productivity gains, poverty reduction and food security (de Janvry and Sadoulet, 2012). Green revolution requires increased use of a number of inputs, namely improved seed varieties, pesticides and fertilizers to restore depleted nutrients, improve soil quality, reduction in crop losses and consequently, an increase in overall yield. It is argued that Ethiopia's success between 1995 to 1997 followed the intensive adoption of these inputs (Quinones, Borlaug, & Dowswell, 1997).

Input use remains lowest in SSA even though there is empirical evidence of the benefits of its use. This reaffirms the argument that, many factors account for the low level of input adoption and use. It is for this reason that some have argued that factors affecting adoption be studied a bit more carefully as they can be very complex (Feder, Just, & Zilberman, 1985). The literature also points to the fact that programs that target farmers directly have had some impact on their incomes. For instance, farmer training in farm management and technologies have recorded significant increases in farm income and profits for treated groups (Kilpatrick, 1996 and Mugisha & Owens, 2008). Very few studies however, have looked at the impact of using agro-dealers as a vehicle for promoting input adoption among small-scale farmers. It is observed that agro-dealers are typically concentrated in specific areas and are not widespread. Therefore, the proliferation of agro-dealers is thought to be a means of spreading technology through market channels (Odame & Muange, 2011). An assessment of initiatives by the Rockefeller Foundation, USAID and IFAD in Zimbabwe, Malawi, Mozambique and Uganda suggest that agro-dealer programs can effectively link input suppliers to rural markets. As rural markets expand, farmers' input search costs and prices should decline (Kellya, Adesinab, & Gordon, 2003). For our purposes, we observe that there are no key studies that have evaluated programs geared towards improving agro-dealer efficiency as a way of impacting on input use and consequently yields.

In order to address some of the constraints that relate to farmers' access to inputs, *Contribution à L'Education de Base* (CEB) with the support of the Alliance for a Green Revolution in Africa (AGRA) implemented a project that sought to "reinforce agro-dealers' networks in Niger". This intervention had the overall goal of improving smallholder farmers' access to, and the adoption of, agricultural inputs. The expected outcome of the intervention was for an improvement in the supply of agricultural inputs such as fertilizers, seeds, and pesticides. It was expected that improved access will subsequently lead to an increase in the use of the inputs by farmers. There is little doubt, that this is an important part of the agriculture value chain. Therefore, knowledge on whether the strengthening of the agro-dealer networks, with a view to improving knowledge of and access to inputs, will impact farmer decisions and outcomes is important for policy making. This report is based on a study that undertakes an impact assessment of this CEB intervention in Niger. The key question that is addressed in this study is whether strengthening agro-dealers' capacity to supply agricultural inputs will improve smallholder farmers' access to, and use of, agricultural inputs.

In this study, we analyze the impact of the CEB training program on two sets of small-scale farmers residing in villages served by agro-dealers who either received training only or training with a demonstration plot. Based on a stipulated theory of change, we compare the changes in key impact and outcome indicators experienced by the groups to that of farmers contained in a control group, who were served by agro-dealers who received neither treatment at the time of the study. The study aims to answer the following research questions:

- Will the training of agro-dealers improve smallholder farmers' adoption and use of agricultural inputs?
- Will the training of agro-dealers impact positively on smallholder farmers yields and reduce pre-harvest losses from farm crops?
- Will the establishment of demonstration plots, in addition to the training of the agro-dealers, further boost adoption and use of inputs by smallholder farmers?

Given a high level of non-adherence of the programme implementation to the initial treatment assignments, we employed an Instrumental Variable estimation approach which instruments actual treatment with initial treatment assignments.

This report is structured as follows. Following this introductory section is a description of the program intervention, the underlying theory of change and the research hypotheses. Section *3* presents the context of the study with the timelines following in Section 4. We then present the evaluation design, methods and implementation in Section 5. The programme design, methods and implementation follows in Section 6. In Section 7 we present the impact results. We then follow with a general discussion of the threats to internal and external validity and the key lessons in Section 8. In Section 9 we outline the specific findings for policy and future studies.

2 Intervention, theory of change and research hypothesis

2.1 Programme intervention

Farm yields in Niger are low as a result of desertification, erosion and over utilization of poor soils. The lack of an effective distribution network and shortage of input supply further hinders farmers' access to agricultural inputs such as fertilizer and improved seeds. This in turn aggravates the problem of the poor soils. The programme evaluated in this study is therefore premised on the argument that agro-dealers can be successfully used as trusted channels for delivering agriculture information to small-scale farmers. Additionally, they have the benefit of local knowledge and can therefore provide not only advice, but also the necessary inputs and, in some cases, act as conduits to output markets.

With funding from AGRA, CEB, in collaboration with about 15 other institutions, implemented a programme titled "Reinforcing Agro-dealers' Network in Niger". The intervention aimed to improve smallholder farmers' access to, and the adoption of agricultural inputs in the Maradi, Zinder and Tahoua regions of Niger. More specifically the objectives of this AGRA sponsored programme were as follows;

- to strengthen agro-dealers' capacity to supply agricultural inputs to smallholder farmers
- to increase agro-dealers' access to commercial credit through linkages with financial institutions
- to increase smallholder farmers' awareness of improved seeds, fertilizers and other technologies

The project intervention aimed to train agro-dealers to improve upon their agricultural input supply practices, particularly that related to ordering and distribution of inputs. It also sought to put in place an effective agro-dealer network by strengthening the capacity of agro dealers through training and certification alongside other business support.

The training was offered in technical competence and business skills development. Technical training dealt with building the knowledge base and awareness of products on offer to farmers, so that they themselves would become knowledge experts to serve their farmer clients. The project planned to build on the Association des Distributeurs des Produits Phytosanitaires du Niger (ADPHYTO) platform - an existing agro dealers association - to carry out some proposed set of activities. These activities included the following:

- Training agro-dealers to improve upon input ordering and distribution;
- Training agro-dealers on product knowledge, usage, marketing, and management of credit and stock;
- Facilitate business relations between agro dealers and other private sector actors;
- Bridging the huge gap between agro-dealers and commercial banks and micro-finance institutions for access to credit;
- Facilitate the development of business plans by agro-dealers to enable them obtain credit;

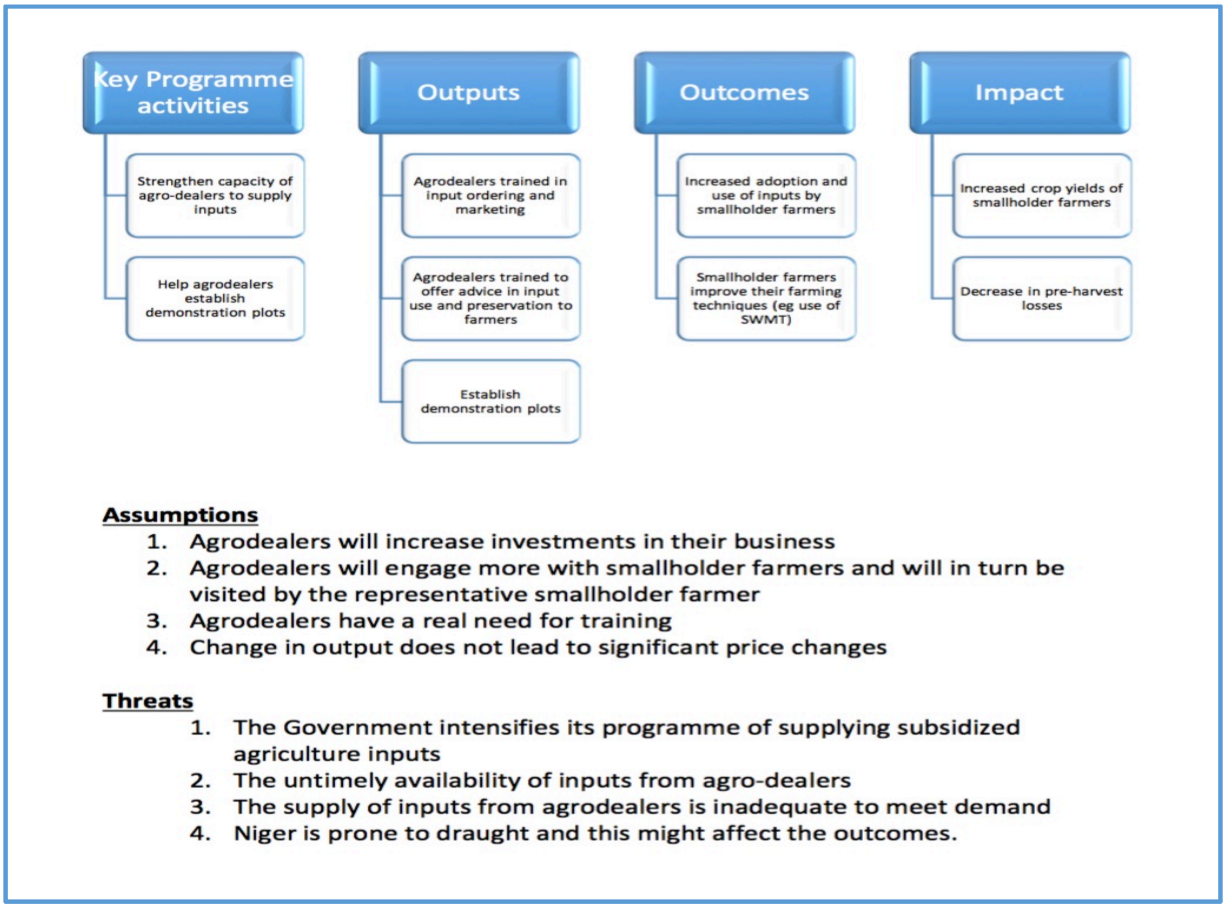
- Training of extension agents and agro-dealers to advise farmers on best agricultural practices; and

- Establish demonstration plots to compare technologies in order to create awareness and demand for inputs.

2.1.1 Theory of Change

The implicit theory of change of this programme was based on the fact that strengthening the institutional capacity of the agro-dealer organizations, by improving their accountability and ownership structure, will lead to well-aggregated and structured agro-dealers. This will in turn improve the supply of inputs, and also help in transferring knowledge on the use of these inputs to farmers.

Figure 2-1 Theory of Change: Niger Agro-Dealer Reinforcement Programme



Note: Authors representation based on programme document and discussions with implementers.

In addition to training, the programme was to help the agro-dealers establish demonstration plots to help drive home the messages inherent in the knowledge sharing component of the programme. Three main outputs of the programme were anticipated; agro-dealers were to be trained in input ordering and marketing (increased supply of inputs); agro-dealers were to be trained to offer advice in input use and preservation to farmers (increased knowledge on use of inputs); and agro dealers were to be supported to establish demonstration plots. The outputs were to lead to two broad outcomes: an increased adoption and use of appropriate inputs by the smallholder farmers; and the improvement in farming practices of the smallholder farmer. Two main impacts were anticipated under this programme namely, increased crop yields of smallholder farmers; and a decrease in pre-harvest losses (Figure 2-1).

2.1.2 Research Hypotheses

In line with the study design and the theory of change as discussed above, this study sought to test three broad hypotheses:

H1: Training of agro-dealers will improve smallholder farmers' adaption and use of agricultural inputs. (Comparing the Training only group with the Control group for input use)

H2: Training of agro-dealers will impact positively on smallholder farmers yields and reduce losses from farm crops. (Comparing the Training only group with the Control group for programme goals)

H3: The use of demonstration plots in addition to the training of the agro-dealers will further boost adoption and use of inputs by smallholder farmers. (Comparing the Training only group with the Training and demonstration group for both outcomes and programme goals)

These constitute the main hypotheses of the study. We however also test auxiliary hypotheses which are essentially variants of *H1* and *H2* but using the training plus demonstration plots as our treatment.

3 Context

3.1.1 Country background

Niger occupies a total land surface area of 1,267,000 km2 of which three-quarters is arid. The population, which is estimated at about 19 million, is concentrated in a narrow strip in the south. The main activities of the majority of households in Niger are farming and herding. More than 50% of Niger's population belong to the Hausa tribe, with the rest belonging to nomadic or semi-nomadic tribes such as Fulani, Kanuri, Arabs, Toubou, and Tuareg. Niger's potential arable land is estimated around 14.5 million hectares of which only 270,000 hectares can be irrigated. Of this potential, agricultural land constitutes only about 67% of the total land area. Niger's economy grew by 7.1% in 2014 from a growth rate of 4.1% in 2013. This growth was driven mainly by agriculture, which enjoyed favourable weather, and also by the construction, and the transport and communications sectors. Agriculture contributes about 36% of GDP and is the source of income for 85% of the population (World Bank, 2013). The country faces a recurring food crisis which has been attributed to low agricultural yields, which in turn is a result of an inefficient agricultural input supply system. Other factors that contribute to the low yields in the country include poor soils, erratic rainfalls, recurrent draughts and a lack of water and soil management technologies.

To consolidate its economic gains and address the perennial food security issues, several interventions have been implemented to improve farmers' access to agricultural inputs. However, the development and application of new technologies to boost yields depend on the ability to make the needed investments on one hand (tackling the supply side constraint), and the willingness of farmers to adopt the provided technologies (the demand side constraint). Furthermore, the effectiveness of technology adoption, in turn, depends on land characteristics, such as soil quality and access to water, as well as other factors such as security of tenure of a farmer's land, income and wealth of farmer, and access to credit.

3.1.2 Background of the study area

The proposed project, which forms the basis of this evaluation, was planned to cover the east side of Niger Republic because a similar project was ongoing on the west side of the country by another consortium led by a non-governmental organization called Appui au Développement des Organisations Communautaires (ADOC). The programme document also mentions that the regions were selected strategically to complement another AGRA programme that was being implemented for agro-dealer development in Niger (CEB, 2013).

In the three regions chosen, the main activities are agricultural and livestock breeding. Agriculture in these regions focuses on rain-fed crops with a dominance of millet inter-cropped with cowpea. In addition to crops, most of the farmers keep livestock. These three regions fall within two ecological zones – the Sudan Savanna and the Sahel. The Sudanian Savanna is a broad belt of tropical savanna that runs east and west across the African continent, from the Atlantic Ocean, in the west, to Ethiopian Highlands, in the east. It is characterized by the coexistence of trees and grasses and the cultivation of sorghum, maize, millet or other crops. The annual rainfall is as high as 1,000 mm in the southern portion, but declines as one moves northward, with only 600 mm found on the border with the Sahelian Savanna eco-region. Rainfall is highly seasonal with the dry season lasting for several months. As a result, some farmers rely on an irrigation cropping system, albeit a very small proportion. The Sahel ecological zone is a semi-arid region of western and north-central Africa extending from Senegal eastward to Sudan. It forms a transitional zone between the arid Sahara (desert) to the north and the belt of humid savannas to the south. The Sahel has natural pasture, with low-growing grass and tall, herbaceous perennials which provides forage for the region's livestock (camel, pack ox, grazing cattle and sheep). Annual rainfall varies from around 100 mm to 200 mm, in the north of the Sahel, to around 600 mm in the south of the Sahel (Van Duivenbooden, Abdoussalam, & Mohamed, 2002).

3.1.3 Maradi

The Region of Maradi is one of seven regions of Niger. Maradi is located in the south-central part of Niger, east of the Region of Tahoua, west of Zinder, and north of Nigeria's city of Kano. It covers an area of 41,796 km², which is about 3% of the national territory. Maradi is the major transport route for trade and agricultural hub of Niger's south central Hausa region. It lies on the major east—west paved highway which crosses from Niamey in the west to Diffa in the far east. Maradi has long been a merchant city, on the route north from Kano, Nigeria. Its population in 2011 was estimated at 3,021,169 (Ministry of Agriculture, 2013)

Figure 3-1 Map of Niger showing the 3 study regions

Source: http://www.nationsonline.org/oneworld/map/niger-administrative-ma

3.1.4 Zinder

Zinder covers an area of 155,778 km2 and has a population estimate of 2,824,468 in 2010. It is situated 861 km east of the capital Niamey and 240 km north of the Nigerian city of Kano. It is bordered to the north by the Agadez region and south by the Federal Republic of Nigeria, to the east by the Diffa region and to the west by the Maradi region (Figure 3-1).

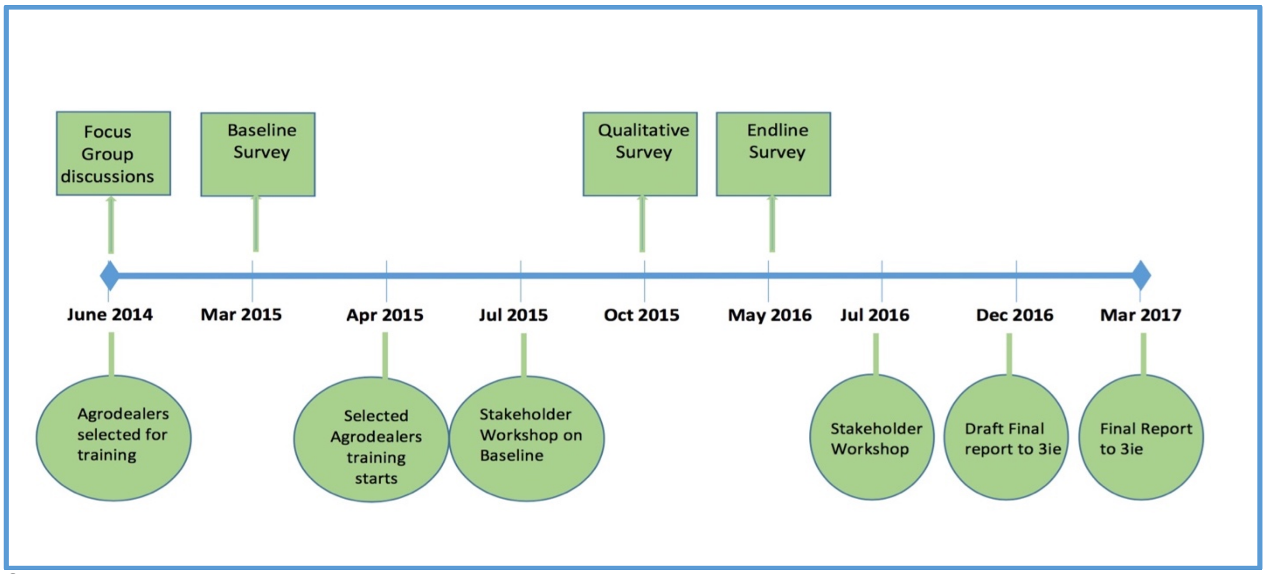
3.1.5 Tahoua

Tahoua is the last of the three regions being covered by the programme being studied and has its capital as the 'Commune of Tahoua'. It is bordered in the north east by Agadez, south west by Dosso, West by Tillabéri and Maradi in the south east. Its population estimate as of 2010 was 2,658,099. It covers an area of 113,371 square kilometers or 8.95% of national territory.

4 Timelines

The activity timeline for the study is shown in Figure 4-1. In this diagram, we show the main study activity milestones and note that the study started with the randomization of the agro-dealers into the different arms. This was done by the researchers (PIs of this study) together with the programme implementers, so that we had their agreement from the beginning of the study about the need to keep to this random assignment. The random assignment was preceded by a focus group discussion with some of the agro-dealers as well as opinion leaders in some of the communities to explain the essence of the study design. Following the random assignment of the agro-dealers into the different treatment arms, we undertook a baseline survey in March 2015. The training for the agro-dealers by the programme implementers then started in April 2015. We organized a stakeholder workshop in July 2015, to discuss the baseline results, after which the research team undertook a qualitative survey between October - November 2015. This was to interrogate the results from the baseline and subsequently refine the quantitative instrument for the endline. The endline survey was undertaken from May – June 2016, after which the preliminary results were discussed at a stakeholder workshop in July 2016. The draft final report was submitted in December 2016 to 3ie.

Figure 4-1 Activity Timeline for Study



Source: Authors own construct

5 Evaluation: Design, methods and implementation

5.1 Evaluation Design (including randomisation)

5.1.1 Design

The study was designed as a randomized phase-in approach where agro-dealers were randomized into early and late treatment. In particular, our approach involved two main steps. First we randomized the agro-dealers into three experimental arms within each region (stratum). For each of the treatment arms we selected a minimum of forty (40) agro-dealers. At the second stage we selected 12 farmers from each community served by the agro-dealers. We took steps to ensure that for each community that we selected farmers from, the community was served by only one of the agro-dealers in the list.

These three treatment arms included the following:

T(0) – Pure control

T(1) – Selected Agro dealers were to get only training

T(2) – Selected Agro dealers were to get training and also they were helped to set up a demonstration plot

For agro-dealers in the T(0) group, they were supposed to get neither the training nor the demonstration plots in the first year. For the agro-dealers in T(1) and T(2) they were supposed to get training only or training and demonstration plot respectively in year 1.

At a second stage we sampled 12 farmers from the respective communities in which each of the selected 40-plus agro-dealers operate. Our understanding from the CEB project document at the start of the study was that actual application of the treatment will start in year 2. Consequently, we undertook a comprehensive baseline survey before the start of the treatment to the agro-dealers who were part of the study. One year after the baseline, and after the programme implementers reported they had 'treated' the respective agro-dealers, we conducted a comprehensive endline survey.

The study utilized both qualitative and quantitative research methods. We employed the qualitative approach to enhance our understanding of the peculiar context of the impact evaluation. This was used to address questions relating to why farmers were not adopting fertilizers, improved seeds and/or other agricultural inputs; what farmers thought could explain low yields despite the adoption (or an increased adoption rate) of some agricultural inputs. The quantitative survey instruments for the endline survey benefited from the qualitative component of the impact evaluation.

In terms of the integration and sequencing of qualitative and quantitative methods in the study, there was one round of focus group discussions (FGD) and two validation workshops. The FGDs were undertaken after the baseline and before the endline survey to help better understand the baseline results and fine-tune the instrument for the endline. A total of six FGDs for farmers in the 3 regions and one for Agro-input dealers were undertaken. In other words, for each region there were two FGDs – one for men and one for women – and another for agro-dealers.

5.1.2 Randomisation

The randomization essentially followed the stages of the design. At the first stage we obtained a list of 144 agro-dealers from the implementer. For each region (and using this as a stratifying variable) therefore we randomly assigned each of the agro-dealer to one of the three arms – T(0), T(1) and T(2). The distribution of the agro-dealers by region is given in Table A 40. We note here that, generally, the distribution by the treatment arm was about a third each ex post. Across the regions, the distribution was essentially consistent with what the implementer made available for the study – about 39% in Maradi, 19% in Tahoua, and 42% in Zinder. The random assignment was done together with the implementer using Stata software.

At the second stage we listed households in 142 villages in the three regions. Having obtained the listing data, we randomly selected 12 households (plus 3 as replacement) from each of the villages that had been listed. In total, therefore, the study planned to interview 1704 farming households in the 142 villages.

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 about key parameters. In particular, we noted that different assumptions about these parameters give different power and therefore has implications for the sample size for any study. Our power analysis was therefore based on the following assumptions:

- The significance level of tests was 5%
- The intra-cluster correlation coefficient of between 10-15%.
- The number of clusters per treatment arm (number of agro-input dealers in each treatment arm) was 40
- The effect size varying from 10% to 30%. More specifically we looked at scenarios that included effect sizes of 10%, 15%, 25% and 30%.
- The cluster size varied between 10 and 14.

Our results based on these assumptions are shown in Table A 41.We note that based on an intra-cluster assumption of 15%, there was just one scenario for the set we have that gave reasonable power. That is when the minimum detectable effect size is 30%. Obviously if this is higher as suggested by the programme, then based on these assumptions a sample size of about 1680 should be fine.

With an intra cluster assumption of 10%, there were possibly two scenarios for which the study was to have reasonable power. That is when the minimum detectable effect size is at 25%. It must be mentioned that even here the power was a little below the 80% that is usually recommended. We did not find any data for Niger that we could use as the basis for estimating the intra-cluster correlation coefficient. However, data on farmers in farmer-based organizations in Ghana, gave estimates of the intra-cluster correlation coefficient at about 0.15. Additionally, the CEB programme document put the ex-ante effect size of the project at about 50%. We therefore proceeded on the basis of these assumptions and suggested a sample size of about 1680 as ideal for the study – i.e. a minimum of 40 clusters per arm with a cluster size of about 14.

5.3 Survey Methodology

5.3.1 Sampling

The sampling for the quantitative study followed the study design and was therefore centered around the agro-dealers. Using the agro-dealer list obtained from the programme implementers, the researchers targeted the communities that the agro-dealers had given as their base of operation. The agro-dealer data obtained from the implementers was stratified by region. The regions therefore formed the stratifying variable used for the sampling. After selecting the agro-dealers (and therefore the villages) we then undertook a listing of households in the communities. The list of villages and the number of households in the respective villages is attached in the appendix. After capturing the data in Stata, we randomly selected 12 farming households from each community. In each household, the household instrument was administered to the household head, who was usually the farmer.

5.3.2 Data Collection

Two main sets of data were collected for this study – quantitative and qualitative data. For the quantitative data it was collected over two waves – a baseline in March 2015 and a follow-up in May 2016 – one year after.

The survey instrument used focused on the farming activity of farmers in the communities in which the agro-dealers operate. Although some household information on the farmers were included in the instrument, the emphasis was on information relating to agricultural production, harvesting and marketing. Particular attention was paid to getting information on farmer crop yields and crop losses; two key impact indicators. The baseline data collection was undertaken in March 2015 whilst that for the endline was in May 2016. The period for the survey was chosen so that it preceded the start of the raining season when farmers are busiest. Even though the endline delayed a bit, that data was still with reference to the last farming season and so it was not problematic.

The actual surveys were led by researchers from INRAN but with supervision and guidance from 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 the administering of the questionnaire to selected farmers in a community outside those that were used for the actual survey. Following the pre-tests, the team organized a debriefing session in which they discussed any concerns or challenges that had come up during the pre-tests. The actual survey started almost immediately after the training. Each of the supervisors was assigned one of the regions and each region was assigned a number of enumerators. The supervisors inspected the filled questionnaires and made sure corrections were made when mistakes were detected. The supervisors also interviewed selected agro dealers in the communities. The ISSER team visited the enumerators in the field during each round of the survey.

6 Programme: Design, methods and implementation

6.1 Programme

The programme for which this study is being undertaken was funded by AGRA and implemented by CEB. It is noted that in Niger only 12% of the cultivated area is planted with improved seeds. Also fertilizer use is less than 10kg per hectare compared to the ECOWAS/CEDEAO average of about 50kg per hectare. The programme is therefore premised on the fact that agricultural inputs is critical for any increase in agriculture yields in Niger. The programme notes that smallholder farmers have a problem with accessing inputs due to the high costs, and low quality of inputs. This in turn is a function of the dysfunctional distribution system and limited access of the agricultural sector to credit.

The overall goal of the programme therefore was to improve food security and incomes of smallholder farmers through increasing their accessibility to agricultural inputs such as seeds, fertilizers and pesticides. More specifically, the project had three objectives, namely:

- To strengthen the capacity of agro-dealers to supply agricultural inputs to smallholder farmers;
- To increase access of agro-dealers to commercial credit through linkages with financial institutions;
- To increase awareness on improved seeds, fertilizers and other technologies by smallholder farmers.

The main activities of the programme included the following:

- Identifying and preparing a directory of agro dealers in Maradi, Zinder and Tahoua using GPS
- Training agro dealers to improve their competencies in terms of inputs (seed, fertilizers and pesticides) demand and its distribution. In particular, agro-dealers were to be trained on the following:
    - Product knowledge
    - Instruction of use and period of application
    - Product marketing
    - Output marketing
    - Training on the management of credit and stock.
    - Training agro-dealers on technique of lobbying
- Strengthening agro-dealer associations and building their capacity for service delivery to their members
- Facilitating the collaboration between agro-dealers’ network and SIMA (information system on agricultural products and inputs market), and financial institutions.
- Training both extension agents and agro-dealers to advice farmers in the areas of best agricultural practices (fertilizer, seed and pesticides use and application).

- Establishing demonstration plots to compare technologies in order to create awareness and demand for input
- Organizing field days

6.2 Programme Implementation

The main thrust of this project was to put in place an effective agro-dealer network by strengthening the capacity of agro-dealers through training and certification alongside other business support. Training was offered in technical competence and business skills development. Technical training dealt with building the knowledge base and awareness of products on offer to agro-dealers so that they in turn become knowledge experts to serve their farmer clients. We discuss in this section what the different arms of the training actually entailed.

6.2.1 Directory of agro-dealers

A directory of agro-dealers was developed using GPS locations prior to the training activities. Training activities took the form of 2-day training workshops on three different topics which we discuss below.

6.2.1.1 Establishment of Demonstration Plots by Agro-dealers

This session explained the importance of demonstration plots as a means of sharing knowledge with their customers. The objective of the training was to direct agro-dealers on the way demonstration plots are constructed and used as tools for technology transfer, as well as the proper location for these plots. Sessions were held in all three regions. A total of 136 agro-dealers attended the training sessions - which was about 91% of the targeted number.

Plot demonstrations (PD) were established by agro-dealers with the collaborating extension agents as part of the training. Agro-dealers were to use these demonstration plots to show farmers the superiority of the proposed technologies (fertilizer, seed and pesticides use and application) compared to their traditional farm practices.

As part of this activity, the established demonstration plots compared two improved seeds against a local variety. To reach the objective of technology demonstrations, field days were also organized where farmers were invited to exchange ideas with other farmers to create awareness and improve farmer demand for inputs. At the end of the project, a total of 75 plots, ran by agro-dealers and extension officers, had been established – Maradi 24, Tahoua 24 and Zinder 27.

6.2.1.2 Good agricultural practices relating to soil fertility management (ISFM)

A total of 125 agro-dealers were trained at workshops in all three regions. The aim of the workshops was to sensitize farmers on basic soil science, and the principles of soil and crop nutritional needs. This was to help equip agro-dealers with the ability to act as advisory agents for farmers. They were introduced to different integrated soil fertility management (ISFM) techniques that could be shared with farmers to complement appropriate input use. Agro-dealers were instructed on product use and application, specifically for fertilizer, pesticides and seeds, based on the different nutrient needs of the different levels of soil quality.

6.2.1.3 Access to credit and input shop management

Under this area, agro-dealers were coached on the sources and means of obtaining credit for business operations. This included spelling out the necessary conditions for obtaining credit from financial institutions, opening bank accounts, and the documentation needed to open an account.

Special focus was placed on acquiring credit from seed companies, with the aim of encouraging seed production and increased access by farmers. Additionally, agro-dealers were given business training especially with regard to record-keeping, pricing, advertising and sales.

6.3 Challenges encountered

There were initial challenges with the implementation of the programme in the first year which led to a 3-month delay of the activities planned, mainly due to insufficient funds. In addition, the creation of agro-dealers' associations in the respective regions required more effort and time since some agro-dealers were reluctant to join initially. The implementers therefore had to spend more time than anticipated to convince agro-dealers about the advantages of being part of a formal association.

Another key challenge was that related to improving credit access for the agro-dealers. This was one that the programme was not able to make much inroads, at least initially. The implementers assert that two main factors accounted for this. First, they argue that the financial institutions seemed to still require some guarantee from the agro-dealers, and many of them did not have this. The second challenge had to do with the agro-dealers themselves. They were not really forthcoming with accessing credit from the financial institutions. One of the reason was cultural and/or religious, with some agro-dealers arguing that they were uncomfortable with 'owing money'.

Even though the implementer eventually trained in excess of the targeted number of 450 agro-dealers by the end of the project, it resulted in a high degree of non-adherance to the originally randomly assigned treatments. Part of the problem, we inferred from discussions with the implementer, was that at some point they realized that following the randomization protocol was slowing their progress and so they 'sometime sacrificed the random assignments for speed' so they could meet their targets. In terms of the programme implementation we note that generally the programme was on target with respect to its goal. Indeed for most of the key indicators, they did exceed the target as shown in Table A 42

6.3.1 Threats to Internal Validity:

We note from Table 1 that internal validity of the study was compromised. We compiled this data by asking the implementer to classify the agro-dealers in our study by their treatment status as at May 2016. We then matched that information with our original assignment information to obtain the results shown in this table. We note from the table that about 13% of the agro-dealers (and by extension farmer households) were contaminated. Additionally, we have about 29% that were not treated even though there were assigned treatment ex ante. This means that only about 58% of the sample was not contaminated (compliers). This clearly has serious implications for internal validity in an experimental design.

Table 1 Intended treatment versus actual treatment by region

	Planned			Degree of Contamination			
Region	Control	Training Only	Training with Demonstration	Not contaminated	Contaminated*	Not treated as at time of interview.**	Total
Maradi	19	18	19	30	6	20	56
Tahoua	9	9	10	19	6	3	28
Zinder	20	20	20	34	7	19	60
Total	48	47	49	83	19	42	144
Percent	33%	33%	34%	58%	13%	29%	

Notes: * these were either not supposed to be treated or they were assigned to one treatment but given some other treatment – from T(0) to either T(1) or T(2) or from T(1) to T(2) or T(2) to T(1). ** These were those that were assigned to T(1) or T(2) but had not been treated.
Source: Authors' computation

This was a very worrying development for this study. Clearly the implementer had not followed strictly the assignments as agreed. We therefore used the 2SLS instrumental variables (IV) approach to estimate the impact. This approach involves using the ex-ante treatment assignment as an instrument for the ex-post assignment for each household. We included other agro-dealer characteristics, to account for the non-adherence. We discuss this method in a bit more detail in Section 7.

7 Impact on Key Outcomes

7.1 Estimation Approach

We noted from Section 6 that, there was a high degree of non-adherence to the originally assigned treatments during programme implementation. This high degree of contamination meant that the benefits of randomization was lost and the intention to treat estimates were going to be biased (Sussman & Hayward, 2010). Therefore, we used an instrumental variables (IV) approach to provide estimates of the programme impact. Indeed, this forms the basis of the results that we discuss in this study. For the IV approach we use the ex-ante treatment assignment as an instrument for the ex post treatment (Glennerster & Takavarasha, 2013). The instrumental variable approach is a well documented one and involves using a 2SLS method, to get the estimands for the impact of the programme (Angrist & Pischke, 2008). Essentially, the approach entails estimating at the first stage the probability that a farmer actually got the treatment given that they were assigned the treatment in the first place. This is estimated as;

$$D_i^{post} = \alpha + \vartheta_1 D_i^{ante} + \omega_i \quad (7.1)$$

Where,

- D_i^{post} is our ex-post treatment variable with the value of 0 if control and 1 if training was received,
- D_i^{ante} is our ex-ante treatment variable with the value of 0 if control and 1 if training was assigned,
- ϑ_1 is the co-efficient measuring the effect of the ex-ante assignment on the likelihood of being treated ex-post
- ω_i is the random error term

At the second stage we estimate a model of the outcome variable of interest, using the predicted ex post treatment variable as a regressor, as in;

$$y_i = \alpha + \gamma_1 \widehat{D}_i^{post} + \mu_i \quad (7.2)$$

Where,

- y_i is the indicator of interest, i.e. impact and outcome variables,
- $\widehat{D}_i^{post}$ is the fitted values of the ex-post treatment following the first stage,
- γ_1 is the co-efficient measuring impact of the ex-post treatment on the indicator of interest.
- μ_i is the random error term

In the estimation of Equation 7.1 we included some characteristics of the agro-dealers as instruments. Essentially, we did this in the knowledge that these variables are not correlated with the outcome variables (y_i) of interest but may explain the ex post treatment assignment. In practice, and using Stata 14, we in effect estimate equations (7.1) and (7.2) simultaneously (See Angrist & Pischke, 2008 pp. 189).

The estimation of the hypotheses 1 and 2 (as per Section 2) are essentially a test for the γ_1 coefficient in Equation 7.1 for the variables of interest shown in Table A 43 and Table A 44. In the case of hypotheses 1 and 2, our $D_{i,1}$ is the training only treatment dummy.

For hypothesis 3, we estimate a generalized form of Equation 7.2 which allows both treatment arms to be estimated in the same equation. We therefore estimate the equation:

$$y_{itd} = \alpha + \beta_1 D_{i1} + \delta_1 D_{i2} + \mu_{id} + \varepsilon_{itd} \quad (7.3)$$

Where,

- y_{itd} is the indicator of interest, i.e. impact and outcome variables,
- D_{i1} is the ex-post treatment dummy variable for training only,

- D_{i2} is the ex-post treatment dummy variable for training with demonstration plot,
- β_1 is the co-efficient measuring impact of the ex-post treatment (training only) on the indicator of interest,
- δ_1 is the co-efficient measuring impact of the ex-post treatment (training with demonstration plot) on the indicator of interest
- μ_{id} and ε_{itd} are the unobserved individual effect and the random terms, respectively

In this equation both treatment terms (D_1 and D_2) are present and based on our parameter estimates from Equation 7.3, we can therefore test hypothesis 3 as a one-tailed test of $\delta_1 > \beta_1$.

Given that we randomized at the agro-dealer level, but our analysis was to be done for individual level outcomes, we needed to correct for this using clustered standard errors (Glennerster & Takavarasha, 2013).

In the case of the dichotomous dependent variables of interest, namely seed use, chemical use, fertilizer use and SWMT application, the IV specification is estimated using the conditional mixed process model (cmp), a Stata program developed by David Roodman (2011) which employs multiple equations, including that which we used to mimic the two stage method of the IV. This is done to allow for a combined IV and ordered probit combination which does not exist as one regression model in Stata. The *cmp* is suitable in this case as it offers more flexibility in model construction. For example, one can regress a continuous variable on two endogenous variables, one binary and the other sometimes left-censored, instrumenting each with additional variables, a crucial feature for this analysis (Roodman 2011).

In general, the *cmp* specification is designed to combine the two stages; one, an ordered probit regression of the indicator of interest on the ex-post treatment and other key independent variables. The second stage is a probit regression of the ex-post treatment variable on the ex-ante treatment and other covariates relating to the agro-dealers. Even though the *cmp* programme is structured to behave like the IV model, its drawback is that it does not allow for tests for over-identifying restrictions (the Sargan and Hansen statistics), which are typically reported in the traditional IV regressions. As such, the Hansen p-value is reported for all IV equations, except for instances in which the *cmp* was employed for the estimation.

The variables used in our estimations and their definitions are shown in Table A 43 and Table A 44.

7.2 Descriptive and Balance Test

7.2.1 Sample Characteristics

The farm households studied were sampled from the three regions Maradi, Tahoua and Zinder. Table A 1 shows the share of households sampled by region at baseline, with Zinder having the largest share and Tahoua, the smallest. Maradi represented 39.6% of the 1511 households sampled, with 14.4% from Tahoua and the remaining 36.1% from Zinder. Across the ex-ante treatment arms we find that the households were distributed among the groups as follows; 31.4% for the Training (T1), 39.4% for the Training and Demonstration Plot (T2) and 29.2% for the Control group (T0). The actual (ex post) treatment assignments differed markedly from the ex-ante assignment with a distribution showing 61.5% for the Control Group, 29.3% for the Training Only treatment and 9.2% for the Training and Demonstration Plot treatment (Table A 1).

The demographics show an average household size of 10 members. Almost all the household heads were male with an average age of 50 years. These households are largely uneducated with only 23.1% indicating that they had ever attended school. Generally we do not find major differences in the demographics across the different treatment arms (Table A 1).

7.2.2 Balance Test

This study was designed based on a random assignment of agro-dealers to one of the three treatment arms; T0 (Control), T1 (Training Only) and T2 (Training plus Demonstration Plot). Unfortunately, there was a high degree of non-compliance so that the ex post assignment ended up being different from the ex-ante. Given that the objective of the study was to test the actual impact of the programme, we undertook statistical tests for differences between the treatments (T1 and T2) and the control (T0) for both the ex-ante as well as ex post assignments at baseline. Our results are shown in Table A 1.

The balance tests were undertaken by regressing the individual indicators on the respective treatment dummy. In effect we run a regression such as:

$$Y_i = \alpha + \rho_1 D1 + \varepsilon_i \quad (7.4)$$
$$Y_i = \alpha + \rho_2 D2 + \varepsilon_i \quad (7.5)$$
$$Y_i = \alpha + \rho_3 D3 + \varepsilon_i \quad (7.6)$$

Where,
D1= 1 if in group T1 and 0 if in control group
D2= 1 if in group T2 and 0 if in control group,
D3= 1 if in group T2 and 0 if in group T1,

The balance tests therefore entailed testing the respectively the hypotheses

H^1_0: ρ_1=0 ; against
H^1_1: $\rho_1 \neq 0$,

H^2_0: ρ_2 =0 ; against
H^2_1: $\rho_2 \neq 0$,

H^2_0: ρ_3 =0 ; against
H^2_1: $\rho_3 \neq 0$.

The indicators which formed the basis of these tests are categorized under one of three sets: Outcome indicators, impact indicators and other household characteristics. The outcome and impact indicators are directly from the theory of change, indicating input adoption and subsequently its effect on farm outputs. We additionally tested for some of the key individual characteristics to provide a guide as to whether we needed to partition the effects of these variables if we found them to be significant. We discuss both the ex-post as well as the ex-ante balance test results for our indicators as follows (see Table A 1 for balance test results).

7.2.2.1 Outcome Indicators

The outcome indicators are those that capture the behaviour of the households (input adoption as per the theory of change) following the intervention. The indicators that we discuss include improved seed use; the value of the improved seed used in U.S dollars (USD); the quantity of the improved seed used in kilograms; the share of households using chemicals on their plots; the value of the chemicals used in USD; the share of households using fertilizer; the value of the fertilizer used in USD; the quantity of chemicals and fertilizer used and the share of households practicing soil and water management techniques (SWMT). The balance tests show that at 5% there are significant differences in the value of chemical used and also the value of fertilizer used for the training only (T1) versus the control (T0) households (this result is true for both the ex-ante as well as ex post assignments).

In Appendix 1, we present both first and second stage IV estimations, including the p-values of the Hansen test for over-identification of the instrumental variables. The Hansen tests indicate that, for our robust IV regressions, we are unable to reject the null hypothesis that the set of instrumental variables are appropriate for our estimations.

7.2.2.2 Impact Indicators

The impact indicators refer to indicators such as crop production, crop yields, and pre-harvest crop losses. The results show that at 5% we do not find any significant differences in these indicators for the treatments and control. Here also the results are true for both the ex-ante as well as ex post assignments (Table A 1).

7.3 Impact Results

In this section the results are presented generally in line with the theory of change as discussed in Section 2. As already mention our estimation technique takes into account the high degree of non-compliance with respect to the ex-ante treatment assignment. We discuss our results along the three broad research hypotheses outlined in Chapter 2.

7.3.1 Hypothesis 1: Training only outcomes (T1 vs T0)

Our Hypothesis 1 relates to the fact that training agro-dealers will lead to increased adoption of agricultural inputs, namely improved seeds, chemicals and fertilizer usage. This hypothesis hinges on the part of the theory of change which argues that farmers will buy and use more inputs needed for improved crop production. Note here that hypothesis 1 relates to a comparison of T(1) against T(0).

In Appendix 1, we present both first and second stage results of the IV estimation. We observe that for all indicators, the likelihood of receiving the training only treatment ex-post was significantly determined by ex-ante assignment to the training only group, while the likelihood of receiving training with the demonstration plot was positively and significantly impacted by an agro-dealer's access to credit and membership in an agro-dealers' association.

7.3.1.1 Improved Seed Use

The impact on improved seed use is examined using three different indicators: proportion of uptake of improved varieties, the quantity, and the expenditure of improved seed use. Seed use or uptake is defined in this case as the likelihood of a household using improved seeds for planting, in at least one crop type. The farmers indicate the type of seed variety used, local or improved, for each crop planted in the previous planting season.

In our sample, at baseline, about 24.2% of all households used improved seeds (20.1% for the T1 group, and 25.9% for the control group) and spent about US$ 2.92 per household on the inputs (Table A 1). We note from our IV results that there was a decline in probability of using improved seeds at 10% level of significance. This result is at first counter intuitive to our theory of change as we expected the programme to impact positively on seed use. One explanation proffered by one of the agro-dealers was that there was a severe drought in the year and that might have affected crop output and therefore discouraged farmers from its continued use as it was riskier using seeds the farmers had little experience with. The challenge though with this explanation is that it still does not explain why farmers in communities where agrodealers were trained experienced a decline in improved seed use whilst those in the control communities did not. Ideally a qualitative study on some of these issues could have helped unearth some of the reasons for this result.

In Table A 5, we also test for the impact of the programme on farmers expenditure on seeds (in USD). We present the results for both total expenditure of all crops, as well as for the 5 major cereals. Our results do not show any impact of the programme on the expenditure on seeds. Finally, for the quantity of seeds used by farmers, our tests for possible impact of the programme showed no statistical significance for all crops and cereals (Table A 6).

7.3.1.2 Chemical (Fertilizer) Use

Chemicals, especially fertilizer, are crucial for improving arid soil conditions that characterize farm lands in Niger and also help in mitigating crop losses. Our data shows that chemical use in our sample was fairly high at baseline, with 54.5% and 52.2% of households indicating that they had used chemicals and fertilizer, respectively, in the season preceding the survey. Typically, the efficiency of the chemicals is improved by the ability of farmers to properly store, handle and apply them. In line with this agro-dealers play a crucial part in ensuring that farmers receive the right usage, handling and storage instructions for the different types of chemicals they sell. We measured chemical use in three ways: Chemical adoption measured as the probability that a household uses at least one type of chemical to farm. We also examine expenditure and quantity of chemicals used by the farmers. We also show the estimates for fertilizer only as it is a chemical of great interest for Nigerien farmers.

Our results show that the training of the agro-dealers did not significantly impact on the proportion of households that use chemical on their farms as shown in Table A 9 and Table A 15. This result also holds for the impact on fertilizer use only. As with seed use, we also test for expenditure on chemicals by farming households. We note that households at baseline spent an average of US$48.40 on chemicals and about US$47.20 on fertilizer. In other words almost all the expenditure on chemicals was on fertilizer. We however find no significant impact of the training on expenditure on chemicals and fertilizers by farmers. (Table A 11 and Table A 17).

In Table A 13 and Table A 19 we show results that tests the impact of the programme on the quantity of chemical and fertilizer use respectively. The results show that the programme did not impact on the quantities of chemical and fertilizer used by farmers.

7.3.1.3 SWMT application

The final outcome of interest is the application of Soil and Water Management Techniques (SWMT) which are known to improve or preserve the quality of soil, the availability of moisture for germination and nourishment of crops, and the essential nutrients for crop growth. These techniques are also important for pest and disease control, and help reduce the manpower, time and effort required to manage the plot. The end goal of these techniques is to achieve and maintain high crop yields. Introducing SWMT to farmers was an intended goal of the intervention as per our theory of change. Of all the sampled households, 36.1% practiced at least one type of SWMT at baseline. The four most commonly employed techniques listed were, terracing, construction of water basins, crop rotation and fallowing.

The results in Table A 21 show whether the programme had an impact on the use of SWMT by the farmers. The IV results show that training had no significant impact on the probability of farmers using SWMT. Farmers indicated a difficulty in accessing credit, restricting them to the main SWMT practices which, coincidentally, require little to no financial investment. It is unlikely for farmers to engage in practices such as irrigation and the application of inoculant, which require the instalment of irrigation systems and purchase of inoculant.

7.3.2 Hypothesis 2: Training only impact on programme goals (T1 vs. T0)

7.3.2.1 Crop Yield

The theory of change posits that the training of agro-dealers and the subsequent adoption of inputs and production technologies by farmers, will ultimately result in higher crop yields for the farmers. We therefore estimated the impact of the intervention on crop yields. Crop yields used here, are computed as a ratio of output per cultivated plot size, and measured in kilogram per hectare (Kg/Ha). We first estimated the actual treatment effect for the yield of all crops combined, and also for a sub-set of crops (i.e. cereals which are the main crops grown in the study regions). We note from our results in Table A 23 that the results show no significant impact on crop yield. This result is not particularly surprising given that we did not find any impact on inputs as a result of the interventions. This result also holds for the main crops (cereals) grown by the farmers (Table A 23).

7.3.2.2 Pre-Harvest Losses

Here we investigated the hypothesis that the treatment (training only) will ultimately result in a reduction of crop losses. Crop losses here refers to pre-harvest crop losses and is measured as a percentage of total harvest lost to factors such as drought, flood, bush fire, pests, insects, and animals such as cattle, sheep, among others. Our results show no impact of the training on crop losses of the farmers (Table A 25).

7.3.3 Auxiliary Hypothesis: Training plus demonstration plot impact on outcomes and goals (T2 vs. T0)

This hypothesis is an offshoot of hypotheses 1 and 2, aimed at answering the same questions of significance of impact of training plus demonstration plots, as with the training only treatment. That is, a comparison of T2 vs T0, to show whether the programme had any effect for treated households compared to the control.

7.3.3.1 Improved seed use

The results do show that for the training plus demonstration plot treatment impacted significantly and positively on the probability of using improved seeds (Table A 3). This result also holds when we limit the estimates to main cereals only. This is consistent with the theory of change which posits that input use increases as a result of the treatment. This result is particularly interesting as we do find a negative impact of the training only treatment on the use of inputs. In a sense it reinforces the implicit thinking in the theory of change that demonstration does matter for training programmes in agriculture. We test for this demonstration effect for seed use under discussions in Section 7.3.4.

7.3.3.2 Chemical (Fertilizer) use

As with training only, training plus demonstration plot did not significantly impact chemical or inorganic fertilizer use as measured by prevalence, quantity and expenditure (Table A 9 and Table A 15).

7.3.3.3 SWMT application

Under SWMT we find no significant impact of the training plus demonstration plots on their application by farmers in the study period (Table A 21).

7.3.3.4 Crop Yield

In Table A 23 the results of impact estimates for training plus demonstration plots treatment for all the crops and also the major cereals are presented. We note that there was no significant impact of the training plus demonstration plots on crop yields – just as in the training only estimates.

7.3.3.5 Pre-Harvest Losses

Our results in Table A 25 show that pre-harvest losses were not significantly impacted by the training plus demonstration plots treatment.

7.3.4 Hypothesis 3: Demonstration plots further boost training impacts on outcomes and goals (T2 vs. T1)

Our Hypothesis 3 is premised on the assumption that establishing demonstration plots in addition to the training of agro-dealers has value addition in relation to both the outcomes and programme goals. As discussed in Section 7.1, we test for this hypothesis by comparing the impact of the training only treatment with that of training with demonstration treatments. In this section we discuss the significance of the tests between these two impact coefficients. Indeed, here we focus on instances where we get some significant results for at least the training with demonstration plot.

7.3.4.1 Improved seed use

In Table A 27, we presented the results of a model as in Equation 7.3, where we include both training only, and training and demonstration dummies in an IV regression on improved seed use. It is observed that training plus demonstration has a positive significant impact on the likelihood that a farmer will use improved seed by 35% for all crops (Eqn 1) and 25% (Eqn 4) for the cereals. This is indeed interesting when compared to the results obtained when the regressions were run separately. In the regressions under hypothesis 1, we found the impact of the training only to be negative and significant whilst that of the training and demonstration was positive and significant (Table A 3). Under this hypothesis therefore we test for whether the training plus demonstration impact is significantly higher than the training only. The p-values for a one tailed test of a null that the two treatments impacts are the same against the one-tailed alternative is rejected at 1% significance level. This therefore suggests that demonstration had significant value addition to the training only with respect to seed use. We note that the results is true for both the cereals only and also for all crops. For seed quantities and expenditure, we find that both treatment arms did not impact significantly on them. In other words when demonstration plots had been used in addition to the training, it increased the proportion of farmers that used improved seeds. However the intensity of improved seed use by a typical farmer did not change even with the demonstration effect.

7.3.4.2 Chemical Use

We showed in Table A 30 and Table A 31 the results for chemical and fertilizer use. As with hypotheses 1 & 2 we explore the probability of households using chemicals or fertilizers, as well as the value and quantity of chemicals used per household. Our results show that training plus demonstration did not impact on uptake of chemical (or indeed fertilizer) use by farmers. However we do find some evidence of the demonstration plot effect being significant at 5% in one of the fertilizer equation.

7.3.4.3 SWMT application

In the case of SWMT, there is also no recorded impact of the training and demonstration as shown by Table A 36. Given that the training and demonstration is not significantly different from zero, we do not test for the difference.

7.3.4.4 Crop Yield

Our results on yields is not surprising as we do not find any significant impact on the input use, except may be seed use. Even with seeds, what we do find is an increase in the probability of use as opposed to an increase in the average use per farmer. The results show that for both training and also training with demonstration, the impact is not significantly different from zero (Table A 23 and Table A 37).

7.3.4.5 Pre-Harvest Losses

As in the case of crop yields, our results show no significant impact of agro-dealer training and demonstration plots on pre-harvest crop losses reported by farmers (Table A 38).

7.4 Summary of Impact Results

The results discussed in this section shows very little impact overall, except in the case of improved seed use which was impacted positively in the case where agrodealers got training plus demonstration plots. We found that, not only did the programme increase seed use over the study period, we also established that the significance of the programme was driven by the use of demonstration plots. The otherwise, weak impact of the programme overall could be explained in a number of ways, as informed by discussions with key stakeholders. Some of the possible explanations, based on background information provided by regional experts, our regional partners, the programme implementers and stakeholders present at the workshop held in Niger, are as follows:

- **Time lag**: The study was conducted over a period of one year from baseline to endline. The theory of change was based on an impact on farmer-level indicators, following the successful training and subsequently, positive effects on agro-dealer operations. It is our estimation that the time lag for treatment effects to fully kick in was too short. One will expect some learning and assimilation to take place both at the agro-dealer and famer levels for the programme to take full effect.

- **Drought**: In our discussion related to crop yields and pre-harvest crop losses, it was uncovered that for Niger (as well as Mali and Burkina Faso) there was the occurrence of severe drought that affected yields during the study period. In this case, though we did not record a significant uptake of inputs, except seeds, it is plausible that any improvements in outcomes were eroded by the effects of the drought.

- **Lack of credit:** Another way to understand the stagnant level of adoption and use of inputs in Niger is the need for credit as some have argued. The programme proposal initially included credit as a treatment arm. However, due to operational constraints, it could not be launched until after the endline survey; as such, the impact could not be assessed. Interestingly, stakeholders present at the workshop held in Niamey indicated that credit was a major constraint, for both agro-dealers and farmers, to widely supply and adopt inputs. On their own, both of these stakeholders (agro-dealers and farmers) found it difficult to apply and qualify for credit, without financial literacy and the necessary collateral. It was also revealed that, without a strong network, agro-dealers and small-scale farmers were considered high-risk, making credit-access nearly impossible. It was therefore argued that part of the reason for the low level of input adoption and use was because of inadequate credit.

8 Discussion

8.1 Threats to Internal Validity

8.1.1 Contamination and Attrition

We noted in Chapter 6 that contamination of about 13% of the agro-dealers (and by extension households) seemed to have occurred with respect to the programme implementation and the study treatment assignments. In addition, there were close to a third of the agro-dealers for the study that had not been treated as at the start of the endline. This clearly compromised the internal validity of the study. Whilst this is problematic, we also note that the design of the study was such that information from farmers (which form the basis of the analysis) was for the farming season of the year that preceded the surveys. In other words, for the baseline survey in 2015, farmers were asked about agricultural practices and outcomes relating to the previous year's farming season. This is also true for the endline survey done in 2016. This means one needs to understand fully the timelines for the treatment of the agro-dealers to fully appreciate the extent of the contamination. In this case the level of contamination reported here constitutes an upper limit.

With respect to attrition we note that overall, a total of 1,363 households were interviewed in baseline. The number decreased in the endline to 1,237 signifying that we had an overall attrition rate of 9.2%. Given the level of non-adherence to treatment assignments, we use the ex post treatments as a basis for assessing the attrition rates across the different arms. We note from Table 2 that this ranged from 8.5% for the control, to 10.3% for the training only and 11.2% for the training and demonstration group.

In Table 3 we test for the significance or otherwise of the treatment arms in explaining the attrition using a logit regression. The results show that the odds of farmers in the training only (relative to those in the control) being attrited is not significant. This is also true for farmers in the training and demonstration group also. We also test this for the regions and note that the odds of being attrited in Zinder relative to Maradi is found to be significant.

Table 2 Sample attrition by treatment arms

	Training Only	Training plus demonstration	Control	Total
Entire Sample				
Baseline (2015)	399	125	839	1,363
Endline (2016)	358	111	768	1,237
Total Observation	757	236	1,607	2,600
Attrition Rate	10.3%	11.2%	8.5%	9.2%

Source: ISSER/INRAN Field Data 2015 and 2016

Table 3 Logit model on effect of ex-post treatment on attrition

	Attrition_Model11	Attrition_Model12	Attrition_Model21	Attrition_Model22
VARIABLES	Odd Ratio	dydx(*)	Odd Ratio	dydx(*)
Training Only	0.214	0.010	0.099	0.004
	(0.201)	(0.009)	(0.204)	(0.008)
Training and Demonstration	0.311	0.014	0.128	0.005
	(0.301)	(0.014)	(0.305)	(0.012)
Tahoua Region			0.095	0.004
			(0.237)	(0.009)
Zinder Region			-1.263***	-0.049***
			(0.226)	(0.008)
Constant	-3.074***		-2.571***	
	(0.121)		(0.148)	
Observations	2,600	2,600	2,600	2,600

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1
Source: ISSER/INRAN Field Data 2015 and 2016

8.1.2 Hawthorne and John Henry Effects

The Hawthorne and John Henry effects are reliant on subjects behaving differently as a result of their knowledge of their assignment to treatment or control groups. If a household or agro-dealer was aware of their assignment to a treatment group, they could work harder as a result of being observed. Therefore based on the definition of the Hawthorne effects, agro-dealers assigned to the control group were more likely to over-perform to counter what may seem like a downgrade compared to the treated groups. These may cause the study to incorrectly estimate the impact of the intervention.

The study of the programme was conducted at the household level even though the intervention was applied to agro-dealers. As a result, household members were not aware that they were in a particular treatment or otherwise, and being observed. Of course the change in the behaviour of the agro-dealers could, as per our theory of change, affect household outcomes. However, it is our view that Hawthorne and John Henry effects were negligible for this study. We in particular note that the randomized phased-in approach imposed by the study implied that there was no reason for agro-dealers to feel they were not part of the study. Those in the control grouping were made to understand that they would receive the intervention at a later date – they were essentially in a second batch.

8.2 Threats to External Validity

8.2.1 Heterogeneity

Although there are regional differences, our estimates showed little region level heterogeneity on the outcomes of interest. In other words, we did find any significant differences across the regions that will make scalability of the programme problematic. It is important to also mention that the programme implementers chose to undertake the programme in regions in the east, since there were similar programmes already running in other regions in the western part of Niger. We will therefore argue that the programme can in principle be scaled to other regions.

Another reason why we think scalability is not too problematic is the fact that the literature shows that the adoption of inputs by farmers is directly linked to the quality of the products (Bold, Kaizzi, Svensson, & Yanagizawa-Drott, 2015). Additionally, the agro-dealer's business model is reliant on the fact that their business performance is dependent on farmers purchasing more inputs from them. We therefore believe that agro-dealers's success depends on maintaining the quality of their products (inputs) to farmers. This will in turn guarantee increased profits and therefore their willingness to expand to other parts of Niger.

8.3 Stakeholder Expectations and Experiences

The results of this study were presented at a stakeholders' workshop in Niamey, Niger, in August 2016. Agro-dealers, FBO leadership, government representatives and researchers were present at this meeting, where both the intervention implementers and researchers presented on the scope and impact of the programme. Generally, participants felt that there should have been improvement with respect to impact on chemical and fertilizer use based on experience on the ground. However, they did agree that the response of farmers was a bit muted due to other factors such as difficulty in accessing credit. They therefore indicated that future programmes will be more effective if they included a more comprehensive credit component.

8.4 Key Lessons from this study

We conclude from this study that it is critical that the implementation and research teams are as closely aligned in objectives and contractual obligations as possible, to successfully conduct an evaluation such as this. If not, the consequence of different timelines and activity can increase the potential for contamination, even if not intentional. Since the study was performed in the course of the programme, our ex-ante assumption ahead of data collection was that the funders of the programme will undertake their own monitoring of the implementation to ensure compliance. Unfortunately, this was not done at the level of detail needed for such a study. We suggest that a proposal for any such evaluation should insist on a budget line for monitoring programme implementation to ensure that it is in line with study objectives.

9 Specific findings for policy and practices

The programme for which this impact evaluation was undertaken had the overall goal of improving smallholder farmers' access to inputs. This in turn was expected to impact use of inputs by farmers and, therefore, their productivity as determined by yields and crop losses.

This study assessed the programme objectives by testing the following broad hypotheses:

a. Training of agro-dealers improves smallholder farmers' access to and adoption of agricultural inputs, including chemicals and seeds
b. Training of agro-dealers increases smallholder farmers' crop yields and reduce crop losses
   The use of demonstration plots in addition to the training of the agro-dealers will further boost adoption and input use by farmers.

The main findings from the results can be summarized as follows:
Hypothesis 1 – Outcome indicators:

- *Impact on use on improved seeds*: We find a positive impact on improved seed use as measured by the likelihood of farmers adopting the input, following training plus demonstration plots for the selected agro-dealers. However, for training only we find that the impact was negative.

Hypothesis 2 – Impact indicators:

- *No impact on yield or crop losses:* We do not find any impact for any of the treatments on the impact indicators. This results is true even for sub-groups such as region type of crops.

Hypothesis 3 – Training plus demonstration plots

- *Impact on improved seed use:* We find significant differences in the likelihood of farmers adopting improved seeds, given agro-dealers' exposure to demonstration plots, added to the received training. In other words the demonstration plots was an important component of this programme.
- *No impact on top level programme goals:* We do not find any significant differences in yield or pre-harvest crop-losses attributable to the demonstration plots.

We conclude by noting that, generally, there is limited evidence that this programme impacted on farmer productivity. We do find limited evidence though, that there is value addition to having demonstration plots in addition to training. For any scaling up of the programme to occur there is the need to learn a bit more about the dynamics of why there was no significant increase in use of inputs amongst the farmers served by the agro-dealers. Maybe some of the more binding constraints to adoption and use of inputs in Niger is credit, as some have argued. Indeed, one of the main reasons mentioned by stakeholders as explaining why we did not find positive results related to limited access to credit. Even though this programme had it as part of the initial proposal, it remained one of the least successful arms of the programme implementation. We would argue therefore that there is the need to factor credit into the planning for any possible scale-up of such a programme.

Appendices

Appendix 1: Tables with results

Table A 1 Balance test results for indicators of interest

Indicators	Ex-Ante Treatment							Ex-Post Treatment						
	Mean				P-Values			Mean				P-Values		
	Overall	(T1)	(T2)	(T0)	T1 v T0	T2 v T0	T1 v T2	Overall	(T1)	(T2)	(T0)	T1 v T0	T2 v T0	T1 v T2
Outcome Indicators														
Improved Seed Use (% of households)														
All crops	24.7	24.5	28.9	20.2	0.315	0.067	0.355	24.2	20.1	26.4	25.9	0.203	0.946	0.114
Cereals	21.8	22.5	24.8	17.8	0.265	0.101	0.596	21.2	18.1	24	22.3	0.291	0.27	0.337
Value of Improved Seed (USD)														
All crops	3.75	2.9	5.4	2.8	0.881	0.219	0.214	2.92	3.6	3.9	2.4	0.527	0.757	0.382
Cereals	11.1	10.3	11.2	12	0.677	0.862	0.575	2.18	2.8	2.46	1.85	0.443	0.536	0.78
SWMT application (%)	35.2	34.9	29.3	42.1	0.258	0.052	0.381	36.1	40.4	40	33.5	0.525	0.46	0.805
Chemical use (%)	54.4	61.5	50.6	52	0.059	0.82	0.080*	54.5	59.9	51.2	52.4	0.167	0.846	0.224
Fertilizer use (%)	51.7	57.1	48.8	49.6	0.164	0.903	0.209	52.2	56.9	48	50.6	0.204	0.706	0.201
Value of Chemical (USD)	50.4	54.2	60.1	35.8	0.071**	0.010**	0.618	48.0	65.0	39.6	39.9	0.003***	0.755	0.009***
Value of Fertilizer (USD)	47.2	47.9	58.6	34.1	0.009***	0.052*	0.303	44.8	57.6	38.2	38.7	0.008***	0.69	0.015**
Impact Indicators														
Crop Losses (%)														
All crops	82.7	83	83.2	82.3	0.935	0.762	0.673	82.9	84.5	80.9	79.6	0.072*	0.354	0.805
Cereals	82.2	82.5	83	81.5	0.853	0.697	0.525	82.4	83.9	80.5	78.7	0.111	0.312	0.716
Crop Yields (kg/ha)														
All crops	193.1	165.9	204.3	192.7	0.123	0.352	0.688	186.2	165.9	204.3	192.7	0.123	0.352	0.888
Cereals	149.5	128.9	161.8	143.2	0.13	0.557	0.412	143.4	138	151.6	153.6	0.557	0.58	0.949
Other Household Characteristics														
Household size	10	10.2	9.6	10.1	0.911	0.179	0.178	10	10	10	10	0.796	0.83	0.949
Age of Head	49.6	47.7	50.7	50.3	0.060*	0.8	0.596	53	54	50	53	0.941	0.339	0.481
Education	24.1	27.1	21.4	24.1	0.556	0.547	0.053*	23.1	25.5	26.4	21.4	0.34	0.537	0.920
Write French	16.5	18.6	13.9	17.2	0.759	0.432	0.092*	16.5	19.8	9.68	16	0.342	0.36	0.191
Write local language	16.9	17.9	16.5	16.5	0.745	0.997	0.439	17.4	18.4	17.7	16.8	0.66	0.911	0.938
Read local language	16.3	16.5	15.4	16.9	0.923	0.748	0.504	16.8	16.8	16.9	16.8	0.994	0.988	0.991
Plot size (hectare)	7.49	7.67	8.46	6.26	0.37	0.384	0.539	7.8	10	6.1	6.9	0.334	0.42	0.233

Source: ISSER/INRAN field data 2015 and 2016

Hypothesis 1 Results

Table A 2 First stage results for seed use

	Training Only						Training plus Demonstration					
	Eqn 1		Eqn 2		Eqn 3		Eqn 4		Eqn 5		Eqn 6	
Variables	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
All Crops												
Training_Only (or Training_Demo)	0.71***	0.09	0.75***	0.09	0.82***	0.09	-0.05	0.13	-0.06	0.13	-0.05	0.13
Year_bus	0.02***	0.00	0.02***	0.00	0.02***	0.00	-0.01	0.01	-0.01	0.01	-0.01	0.01
Credit_dum	-0.24***	0.09	-0.19**	0.09	-0.17*	0.09	1.39***	0.13	1.38***	0.13	1.37***	0.13
Agassoc_dum	-0.17**	0.08	-0.18**	0.08	-0.20**	0.08	1.01***	0.18	1.04***	0.18	1.02***	0.18
Observations	1328		1328		1237		1328		1328		1237	
Cereals												
Training_Only (or Training_Demo)	0.79***	0.09	0.80***	0.09	0.84***	0.08	-0.07	0.13	-0.07	0.13	-0.07	0.13
Year_bus	0.02***	0.00	0.02***	0.00	0.02***	0.00	-0.01	0.01	-0.01	0.01	-0.01	0.01
Credit_dum	-0.22**	0.10	-0.18*	0.09	-0.16*	0.10	1.38***	0.13	1.37***	0.13	1.37***	0.13
Agassoc_dum	-0.19***	0.08	-0.20**	0.08	-0.21**	0.08	1.02***	0.18	1.04***	0.18	1.04***	0.18
Observations	1328		1328		1237		1328		1328		1237	

Note: These are first stage results for the two-stage IV results discussed in the report. Second stage results are presented below. The dependent variable for Eqn1 to Eqn3 is training_only while that of Eqn4 to Eqn6 is training_demo; ***, ** and * show statistical significance at the 1%, 5% and 10% levels respectively. Eqn1 and Eqn4 do not contain any of the control variables. Eqn2 and Eqn5 control for the regions, using regional dummies. Eqn3 and Eqn6 control for the regions and other household characteristics, namely, household size, age, sex, education and literacy of household head and average plot size per household. Source: ISSER/INRAN field data 2015 and 2016.

Table A 3 Impact estimates of programme on seed use

	Cereals						All Crops					
	IV – Training Only			IV – Training plus Demonstration			IV – Training Only			IV – Train plus Demonstration		
	Eqn 1	Eqn 2	Eqn 3	Eqn 4	Eqn 5	Eqn 6	Eqn 1	Eqn 2	Eqn 3	Eqn 4	Eqn 5	Eqn 6
Training_Only	-0.63***	-0.64***	-0.63***				-0.93***	-0.89***	-0.54**			
	(0.18)	(0.18)	(0.18)				(0.16)	(0.16)	(0.23)			
Maradi		0.30***	0.27***		0.30***	0.25***		0.28***	0.25***		0.29***	0.22***
		(0.07)	(0.07)		(0.07)	(0.07)		(0.07)	(0.07)		(0.07)	(0.07)
Tahoua		-0.00	0.00		0.02	-0.01		0.08	0.06		0.13	0.05
		(0.10)	(0.11)		(0.10)	(0.11)		(0.09)	(0.10)		(0.10)	(0.11)
Training_Demo				0.49**	0.43**	0.51**				0.69***	0.60***	0.75***
				(0.20)	(0.20)	(0.20)				(0.21)	(0.22)	(0.20)
Observations	1328	1328	1237	1328	1328	1237	1,328	1,328	1,237	1,328	1,328	1,237
Control Mean	0.223						0.259					

Note: The dependent variable is the first differenced improved seed use. The estimates are second-stage IV estimates; the first-stage results are reported above. Standard errors are in parenthesis; ***, ** and * show statistical significance at the 1%, 5% and 10% levels respectively. Eqn1 and Eqn4 do not contain any of the control variables. Eqn2 and Eqn5 control for the regions, using regional dummies. Eqn3 and Eqn6 control for the regions and other household characteristics, namely, household size, sex, education and literacy of household head and average plot size per household. Source: ISSER/INRAN field data 2015 and 2016

Table A 4 First stage results for seed expenses

	Training Only						Training plus Demonstration					
	Eqn 1		Eqn 2		Eqn 3		Eqn 4		Eqn 5		Eqn 6	
Variables	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Cereals												
Training_Only (or Training_Demo)	0.25**	0.099	0.26**	0.101	0.25**	0.101	0.25**	0.101	-0.01	0.053	-0.01	0.055
TFertsold_ton	0.00*	0.000	0.00*	0.000	0.00*	0.000	0.00*	0.000	0.00	0.000	0.00	0.000
empl_size	-0.01	0.014	-0.02	0.015	-0.02	0.014	-0.02	0.014	0.00	0.006	0.00	0.006
Year_bus	0.01	0.005	0.01	0.005	0.01	0.005	0.01	0.005	0.00	0.002	0.00	0.002
Fertsup_dum	0.09	0.090	0.13	0.101	0.13	0.102	0.13	0.102	0.04	0.057	0.04	0.058
Training_dum	0.00	0.104	0.00	0.112	0.00	0.115	0.00	0.115	0.07	0.053	0.07	0.053
Credit_dum	-0.05	0.098	-0.04	0.095	-0.03	0.097	-0.03	0.097	0.25***	0.087	0.25***	0.085
Agassoc_dum	-0.07	0.101	-0.07	0.101	-0.08	0.102	-0.08	0.102	0.09*	0.045	0.09*	0.046
Observations	1153		1153		1137		1153		1153		1137	
All Crops												
Training_Only (or Training_Demo)	0.25**	0.099	0.26**	0.101	0.25**	0.101	-0.012	0.051	-0.010	0.053	-0.011	0.055
TFertsold_ton	0.00*	0.000	0.00*	0.000	0.00*	0.000	0.000	0.000	0.000	0.000	0.000	0.000
empl_size	-0.01	0.014	-0.018	0.015	-0.016	0.014	0.002	0.005	-0.002	0.006	-0.003	0.006
Year_bus	0.007	0.005	0.007	0.005	0.007	0.005	-0.002	0.002	-0.003	0.002	-0.003	0.002
Fertsup_dum	0.088	0.090	0.126	0.101	0.130	0.102	-0.006	0.060	0.038	0.057	0.038	0.058
Training_dum	-0.002	0.104	0.003	0.112	0.001	0.115	0.055	0.057	0.069	0.053	0.070	0.053
Credit_dum	-0.054	0.098	-0.040	0.095	-0.034	0.097	0.23***	0.083	0.25***	0.087	0.25***	0.085
Agassoc_dum	-0.074	0.101	-0.074	0.101	-0.082	0.102	0.92*	0.049	0.09*	0.045	0.09*	0.046
Observations	1153		1153		1137		1153		1153		1137	

Note: These are first stage results for the two-stage IV results discussed in the report. Second stage results are presented below. The dependent variable for Eqn1 to Eqn3 is training_only while that of Eqn4 to Eqn6 is training_demo; ***, ** and * show statistical significance at the 1%, 5% and 10% levels respectively. Eqn1 and Eqn4 do not contain any of the control variables. Eqn2 and Eqn5 control for the regions, using regional dummies. Eqn3 and Eqn6 control for the regions and other household characteristics, namely, household size, age, sex, education and literacy of household head and average plot size per household. Source: ISSER/INRAN field data 2015 and 2016.

Table A 5 Impact estimates of programme on seed expenses

	Cereals						All Crops					
	IV –Training Only			IV –Training plus Demonstration			IV –Training Only			IV –Training plus Demonstration		
	Eqn 1	Eqn 2	Eqn 3	Eqn 4	Eqn 5	Eqn 6	Eqn 1	Eqn 2	Eqn 3	Eqn 4	Eqn 5	Eqn 6
Training_Only	-2.37	-2.31	-1.77				0.23	0.07	-0.98			
	(2.05)	(1.96)	(1.93)				(2.36)	(2.61)	(2.71)			
Maradi		-0.24	-0.03		-0.30	-0.07		0.07	0.26		0.07	0.25
		(0.44)	(0.49)		(0.38)	(0.46)		(0.78)	(0.87)		(0.74)	(0.84)
Tahoua		-0.44	-0.37		-0.87	-0.73		1.59	2.59		1.62	2.44
		(2.60)	(2.65)		(2.83)	(2.84)		(4.02)	(4.15)		(4.06)	(4.23)
Training_Demo				1.72	1.66	1.34				-0.06	-0.25	0.21
				(1.74)	(1.60)	(1.69)				(2.93)	(2.43)	(2.27)
Hansen test (P-value)	0.726	0.729	0.828	0.547	0.516	0.816	0.651	0.719	0.735	0.644	0.704	0.73
Observations	1,153	1,153	1,137	1,153	1,153	1,137	1,153	1,153	1,137	1,153	1,153	1,137
Control Mean	1.85						2.4					

Note: The dependent variable is the first differenced seed expenses. The estimates are second-stage IV estimates; the first-stage results are reported above. Standard errors are in parenthesis; ***, ** and * show statistical significance at the 1%, 5% and 10% levels respectively. Eqn1 and Eqn4 do not contain any of the control variables. Eqn2 and Eqn5 control for the regions, using regional dummies. Eqn3 and Eqn6 control for the regions and other household characteristics, namely, household size, age, sex, education and literacy of household head and average plot size per household. Source: ISSER/INRAN field data 2015 and 2016

Table A 6 First stage results for seed quantity

	Training Only						Training plus Demonstration					
	Eqn 1		Eqn 2		Eqn 3		Eqn 4		Eqn 5		Eqn 6	
Variables	Coef.	Std. Err	Coef.	Std. Err	Coef.	Std. Err.	Coef.	Std. Err	Coef.	Std. Err	Coef.	Std. Err
Cereals												
Training_Only (or Training_Demo)	0.25**	0.10	0.26**	0.10	0.25**	0.10	-0.01	0.05	-0.01	0.05	-0.01	0.05
TFertsold_ton	0.00*	0.00	0.00*	0.00	0.00*	0.00	0.00	0.00	0.00	0.00	0.00	0.00
empl_size	-0.01	0.01	-0.02	0.01	-0.02	0.01	0.00	0.00	0.00	0.01	0.00	0.01
Year_bus	0.01	0.00	0.01	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Fertsup_dum	0.09	0.09	0.13	0.10	0.13	0.10	-0.01	0.06	0.04	0.06	0.04	0.06
Training_dum	0.00	0.10	0.00	0.11	0.00	0.11	0.06	0.06	0.07	0.05	0.07	0.05
Credit_dum	-0.05	0.10	-0.04	0.09	-0.03	0.10	0.23***	0.08	0.25***	0.09	0.25***	0.09
Agassoc_dum	-0.07	0.10	-0.07	0.10	-0.08	0.10	0.09*	0.05	0.09*	0.05	0.09*	0.05
Observations	1153		1153		1137		1153		1153		1137	
All Crops												
Train_Only (or Train_Demo)	0.26**	0.099	0.26**	0.101	0.25**	0.101	-0.012	0.051	-0.010	0.053	-0.011	0.055
TFertsold_ton	0.00*	0.000	0.00*	0.000	0.00*	0.000	0.000	0.000	0.000	0.000	0.000	0.000
empl_size	-0.015	0.014	-0.018	0.015	-0.016	0.014	0.002	0.005	-0.002	0.006	-0.003	0.006
Year_bus	0.007	0.005	0.007	0.005	0.007	0.005	-0.002	0.002	-0.003	0.002	-0.003	0.002
Fertsup_dum	0.088	0.090	0.126	0.101	0.130	0.102	-0.006	0.060	0.038	0.057	0.038	0.058
Training_dum	-0.002	0.104	0.003	0.112	0.001	0.115	0.055	0.057	0.069	0.053	0.070	0.053
Credit_dum	-0.054	0.098	-0.040	0.095	-0.034	0.097	0.23***	0.083	0.25***	0.087	0.25***	0.085
Agassoc_dum	-0.074	0.101	-0.074	0.101	-0.082	0.102	0.09*	0.049	0.09*	0.045	0.09*	0.046
Observations	1153		1153		1137		1153		1153		1137	

Note: These are first stage results for the two-stage IV results discussed in the report. Second stage results are presented below. The dependent variable for Eqn1 to Eqn3 is training_only while that of Eqn4 to Eqn6 is training_demo; ***, ** and * show statistical significance at the 1%, 5% and 10% levels respectively. Eqn1 and Eqn4 do not contain any of the control variables. Eqn2 and Eqn5 control for the regions, using regional dummies. Eqn3 and Eqn6 control for the regions and other household characteristics, namely, household size, age, sex, education and literacy of household head and average plot size per household. Source: ISSER/INRAN field data 2015 and 2016.

Table A 7 Impact estimates of programme on seed quantity

	Cereals						All Crops					
	IV –Training Only			IV –Training plus Demonstration			IV –Training Only			IV –Training plus Demonstration		
	Eqn 1	Eqn 2	Eqn 3	Eqn 4	Eqn 5	Eqn 6	Eqn 1	Eqn 2	Eqn 3	Eqn 4	Eqn 5	Eqn 6
Train_Only	0.52	0.85	-6.70				-1.54	-1.82	-8.72			
	(2.63)	(2.48)	(8.13)				(2.50)	(2.42)	(8.47)			
Maradi		-0.37	0.90		-0.39	0.82		-0.39	0.78		-0.44	0.71
		(1.19)	(2.28)		(1.18)	(2.21)		(0.97)	(2.42)		(0.94)	(2.31)
Tahoua		-0.58	6.20		-0.76	5.30		0.50	7.14		0.17	6.13
		(2.52)	(6.67)		(2.82)	(6.03)		(2.51)	(6.68)		(2.49)	(6.11)
Train_Demo				2.55	2.95	0.53				1.85	1.18	-0.92
				(3.96)	(3.69)	(5.98)				(4.04)	(3.72)	(6.37)
Hansen test (P-value)	0.92	0.914	0.994	0.1187	0.148	0.992	0.719	0.662	0.947	0.283	0.218	0.927
Observations	1,153	1,153	1,137	1,153	1,153	1,137	1,153	1,153	1,137	1,153	1,153	1,137
Control Mean	4.69						4.95					

Note: The dependent variable is the first differenced seed quantity. The estimates are second-stage IV estimates; the first-stage results are reported above. Standard errors are in parenthesis; ***, ** and * show statistical significance at the 1%, 5% and 10% levels respectively. Eqn1 and Eqn4 do not contain any of the control variables. Eqn2 and Eqn5 control for the regions, using regional dummies. Eqn3 and Eqn6 control for the regions and other household characteristics, namely, household size, age, sex, education and literacy of household head and average plot size per household. Source: ISSER/INRAN field data 2015 and 2016

Table A 8 First stage results for chemical use

	Training Only						Training plus Demonstration					
	Eqn 1		Eqn 2		Eqn 3		Eqn 4		Eqn 5		Eqn 6	
Variables	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Training_Only (or Training_Demo)	0.85***	0.08	0.85***	0.08	0.84***	0.08	0.08	0.13	0.08	0.13	0.08	0.13
TFertsold_ton	0.00***	0.00	0.00***	0.00	0.00***	0.00	0.00	0.00	0.00	0.00	0.00	0.00
empl_size	-0.03*	0.02	-0.03*	0.02	-0.03*	0.02	-0.06	0.04	-0.06	0.04	-0.06	0.04
Year_bus	0.02***	0.00	0.02***	0.00	0.02***	0.00	-0.02***	0.01	-0.02***	0.01	-0.02***	0.01
Fertsup_dum	0.37***	0.08	0.37***	0.08	0.36***	0.08	-0.03	0.12	-0.03	0.12	-0.02	0.12
Training_dum	-0.06	0.09	-0.06	0.09	-0.06	0.09	0.58***	0.15	0.58***	0.15	0.58***	0.15
Credit_dum	-0.17*	0.09	-0.16*	0.09	-0.16*	0.09	1.16***	0.13	1.16***	0.13	1.16***	0.13
Agassoc_dum	-0.29***	0.09	-0.29***	0.09	-0.30***	0.09	0.94***	0.19	0.95***	0.19	0.95***	0.19
Observations	1511		1511		1362		1511		1511		1362	

Note: These are first stage results for the two-stage IV results discussed in the report. Second stage results are presented below. The dependent variable for Eqn1 to Eqn3 is training_only while that of Eqn4 to Eqn6 is training_demo; ***, ** and * show statistical significance at the 1%, 5% and 10% levels respectively. Eqn1 and Eqn4 do not contain any of the control variables. Eqn2 and Eqn5 control for the regions, using regional dummies. Eqn3 and Eqn6 control for the regions and other household characteristics, namely, household size, age, sex, education and literacy of household head and average plot size per household. Source: ISSER/INRAN field data 2015 and 2016.

Table A 9 Impact estimates of programme on chemical use

	IV –Training Only			IV –Training plus Demonstration		
	Eqn 1	Eqn 2	Eqn 3	Eqn 4	Eqn 5	Eqn 6
Training_Only	-0.13	-0.16	0.14			
	(0.15)	(0.15)	(0.20)			
Maradi		0.12*	-0.05	0.11*	0.11*	0.15**
		(0.06)	(0.08)	(0.06)	(0.06)	(0.07)
Tahoua		0.02	0.17	0.02	0.02	-0.04
		(0.09)	(0.11)	(0.09)	(0.09)	(0.10)
Margins	-0.13	-0.16	0.1	0.15	0.1	-0.03
Observations	1,511	1,511	1,362	1,511	1,511	1,362
Control Mean	0.524					

Note: The dependent variable is the first differenced chemical use. The estimates are second-stage IV estimates; the first-stage results are reported above. Standard errors are in parenthesis; ***, ** and * show statistical significance at the 1%, 5% and 10% levels respectively. Eqn1 and Eqn4 do not contain any of the control variables. Eqn2 and Eqn5 control for the regions, using regional dummies. Eqn3 and Eqn6 control for the regions and other household characteristics, namely, household size, age, sex, education and literacy of household head and average plot size per household. Source: ISSER/INRAN field data 2015 and 2016

Table A 10 First stage results for chemical expenses

	Training Only						Training plus Demonstration					
	Eqn 1		Eqn 2		Eqn 3		Eqn 4		Eqn 5		Eqn 6	
Variables	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Training_Only (or Training_Demo)	0.27***	0.10	0.27*	0.10	0.27*	0.10	-0.01	0.06	-0.01	0.06	-0.01	0.06
TFertsold_ton	0.00*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
empl_size	-0.02	0.01	-0.02	0.01	-0.02	0.01	0.00	0.00	0.00	0.01	0.00	0.01
Year_bus	0.01	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00*	0.00	0.00*	0.00
Fertsup_dum	0.07	0.09	0.11	0.11	0.11	0.10	0.00	0.06	0.03	0.06	0.03	0.06
Training_dum	0.00	0.10	0.00	0.11	0.00	0.11	0.07	0.06	0.09	0.06	0.09	0.06
Credit_dum	-0.08	0.09	-0.08	0.09	-0.07	0.09	0.20***	0.07	0.21***	0.08	0.21***	0.08
Agassoc_dum	-0.09	0.10	-0.09	0.10	-0.10	0.10	0.08*	0.05	0.08*	0.04	0.08*	0.04
Observations	1278		1278		1259		1278		1278		1259	

Note: These are first stage results for the two-stage IV results discussed in the report. Second stage results are presented below. The dependent variable for Eqn1 to Eqn3 is training_only while that of Eqn4 to Eqn6 is training_demo; ***, ** and * show statistical significance at the 1%, 5% and 10% levels respectively. Eqn1 and Eqn4 do not contain any of the control variables. Eqn2 and Eqn5 control for the regions, using regional dummies. Eqn3 and Eqn6 control for the regions and other household characteristics, namely, household size, age, sex, education and literacy of household head and average plot size per household. Source: ISSER/INRAN field data 2015 and 2016.

Table A 11 Impact estimates of programme on chemical expenses

	IV –Training Only			IV –Training plus Demonstration		
	Eqn 1	Eqn 2	Eqn 3	Eqn 4	Eqn 5	Eqn 6
Training_Only	5.98	6.31	7.04			
	(4.81)	(4.54)	(4.75)			
Maradi		-0.60	-0.36		-0.55	-0.35
		(1.69)	(1.72)		(1.84)	(1.87)
Tahoua		-2.85	-2.92		-2.41	-2.33
		(3.05)	(3.16)		(3.11)	(3.20)
Training_Demo				1.18	2.37	2.00
				(5.54)	(6.54)	(6.59)
Hansen test (P-value)	0.765	0.582	0.543	0.861	0.847	0.88
Observations	1,278	1,278	1,259	1,278	1,278	1,259
Control Mean	39.9					

Note: The dependent variable is the first differenced chemical expenses. The estimates are second-stage IV estimates; the first-stage results are reported above. Standard errors are in parenthesis; ***, ** and * show statistical significance at the 1%, 5% and 10% levels respectively. Eqn1 and Eqn4 do not contain any of the control variables. Eqn2 and Eqn5 control for the regions, using regional dummies. Eqn3 and Eqn6 control for the regions and other household characteristics, namely, household size, age, sex, education and literacy of household head and average plot size per household. Source: ISSER/INRAN field data 2015 and 2016.

Table A 12 First Stage Results for Chemical Quantity

	Training Only						Training plus Demonstration					
	Eqn 1		Eqn 2		Eqn 3		Eqn 4		Eqn 5		Eqn 6	
Variables	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Training_Only (or Training_Demo)	0.27***	0.10	0.27***	0.10	0.27***	0.10	-0.01	0.06	-0.01	0.06	-0.01	0.06
TFertsold_ton	0.00*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
empl_size	-0.02	0.01	-0.02	0.01	-0.02	0.01	0.00	0.00	0.00	0.01	0.00	0.01
Year_bus	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.00*	0.00	0.00*	0.00
Fertsup_dum	0.07	0.09	0.11	0.11	0.11	0.10	0.00	0.06	0.03	0.06	0.03	0.06
Training_dum	0.00	0.10	0.00	0.11	0.00	0.11	0.07	0.06	0.09	0.06	0.09	0.06
Credit_dum	-0.08	0.09	-0.08	0.09	-0.07	0.09	0.20***	0.07	0.21***	0.08	0.21***	0.08
Agassoc_dum	-0.09	0.10	-0.09	0.10	-0.10	0.10	0.08*	0.05	0.08*	0.04	0.08*	0.04
Observations	1278		1278		1259		1278		1278		1259	

Note: These are first stage results for the two-stage IV results discussed in the report. Second stage results are presented below. The dependent variable for Eqn1 to Eqn3 is training_only while that of Eqn4 to Eqn6 is training_demo; ***, ** and * show statistical significance at the 1%, 5% and 10% levels respectively. Eqn1 and Eqn4 do not contain any of the control variables. Eqn2 and Eqn5 control for the regions, using regional dummies. Eqn3 and Eqn6 control for the regions and other household characteristics, namely, household size, age, sex, education and literacy of household head and average plot size per household. Source: ISSER/INRAN field data 2015 and 2016.

Table A 13 Impact estimates of programme on chemical quantity

	IV –Training Only			IV –Training plus Demonstration		
	Eqn 1	Eqn 2	Eqn 3	Eqn 4	Eqn 5	Eqn 6
Training_Only	0.20	-0.59	-4.95			
	(9.35)	(9.66)	(10.22)			
Maradi		2.82	4.30		2.94	4.37
		(4.00)	(4.58)		(3.57)	(4.14)
Tahoua		6.34	4.27		6.59	4.05
		(6.56)	(5.88)		(6.93)	(6.02)
Training_Demo				-1.11	-4.60	-4.09
				(16.44)	(14.24)	(14.87)
Hansen test (P-value)	0.634	0.571	0.532	0.47	0.766	0.844
Observations	1,278	1,278	1,259	1,278	1,278	1,259
Control Mean	159.9					

Note: The dependent variable is the first differenced chemical quanity. The estimates are second-stage IV estimates; the first-stage results are reported above. Standard errors are in parenthesis; ***, ** and * show statistical significance at the 1%, 5% and 10% levels respectively. Eqn1 and Eqn4 do not contain any of the control variables. Eqn2 and Eqn5 control for the regions, using regional dummies. Eqn3 and Eqn6 control for the regions and other household characteristics, namely, household size, age, sex, education and literacy of household head and average plot size per household. Source: ISSER/INRAN field data 2015 and 2016

Table A 14 First Stage Results for Fertilizer Use

	Training Only						Training plus Demonstration					
	Eqn 1		Eqn 2		Eqn 3		Eqn 4		Eqn 5		Eqn 6	
Variables	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Training_Only (or Training_Demo)	0.85***	0.08	0.85***	0.08	0.84***	0.08	0.09	0.13	0.08	0.13	0.08	0.13
TFertsold_ton	0.00***	0.00	0.00***	0.00	0.00***	0.00	0.00	0.00	0.00	0.00	0.00	0.00
empl_size	-0.03*	0.02	-0.03*	0.02	-0.03*	0.02	-0.06	0.04	-0.06	0.04	-0.06	0.04
Year_bus	0.02***	0.00	0.02***	0.00	0.02***	0.00	-0.02***	0.01	-0.02***	0.01	-0.02***	0.01
Fertsup_dum	0.36***	0.08	0.37***	0.08	0.36***	0.08	-0.03	0.12	-0.03	0.12	-0.03	0.12
Training_dum	-0.06	0.09	-0.06	0.09	-0.06	0.09	0.58***	0.15	0.58***	0.15	0.58***	0.15
Credit_dum	-0.17*	0.09	-0.17*	0.09	-0.17*	0.09	1.16***	0.12	1.16***	0.13	1.16***	0.13
Agassoc_dum	-0.29***	0.09	-0.29***	0.09	-0.30***	0.09	0.94***	0.19	0.95***	0.19	0.95***	0.19
Observations	1511		1511		1362		1511		1511		1362	

Note: These are first stage results for the two-stage IV results discussed in the report. Second stage results are presented below. The dependent variable for Eqn1 to Eqn3 is training_only while that of Eqn4 to Eqn6 is training_demo; ***, ** and * show statistical significance at the 1%, 5% and 10% levels respectively. Eqn1 and Eqn4 do not contain any of the control variables. Eqn2 and Eqn5 control for the regions, using regional dummies. Eqn3 and Eqn6 control for the regions and other household characteristics, namely, household size, age, sex, education and literacy of household head and average plot size per household. Source: ISSER/INRAN field data 2015 and 2016.

Table A 15 Impact estimates of programme on fertilizer use

	IV –Training Only			IV –Training Demonstration		
	Eqn 1	Eqn 2	Eqn 3	Eqn 4	Eqn 5	Eqn 6
Training_Only	-0.16	-0.18	0.12			
	(0.14)	(0.15)	(0.20)			
Maradi		0.13**	0.06		0.12*	0.15**
		(0.06)	(0.08)		(0.06)	(0.07)
Tahoua		0.04	0.23**		0.04	-0.03
		(0.09)	(0.11)		(0.09)	(0.10)
Observations	1,511	1,511	1,362	1,511	1,511	1,362
Control Mean	40.34					

Note: The dependent variable is the first differenced fertilizer use; and the control variables are the sex of household head, household size, education status of household head, and age, sex,. The estimates are second-stage IV estimates; the first-stage results are reported above. Standard errors are in parenthesis; ***, ** and * show statistical significance at the 1%, 5% and 10% levels respectively. Eqn1 and Eqn4 do not contain any of the control variables. Eqn2 and Eqn5 control for the regions, using regional dummies. Eqn3 and Eqn6 control for the regions and other household characteristics, namely, household size, age, sex, education and literacy of household head and average plot size per household. Source: ISSER/INRAN field data 2015 and 2016

Table A 16 First stage results for fertilizer expenses

	Training Only						Training plus Demonstration					
	Eqn 1		Eqn 2		Eqn 3		Eqn 4		Eqn 5		Eqn 6	
Variables	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Training_Only (or Training_Demo)	0.27***	0.10	0.27***	0.10	0.27***	0.10	-0.01	0.06	-0.01	0.06	-0.01	0.06
TFertsold_ton	0.00*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
empl_size	-0.02	0.01	-0.02	0.01	-0.02	0.01	0.00	0.00	0.00	0.01	0.00	0.01
Year_bus	0.01	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00*	0.00	0.00*	0.00
Fertsup_dum	0.07	0.09	0.11	0.11	0.11	0.10	0.00	0.06	0.03	0.06	0.03	0.06
Training_dum	0.00	0.10	0.00	0.11	0.00	0.11	0.07	0.06	0.09	0.06	0.09	0.06
Credit_dum	-0.08	0.09	-0.08	0.09	-0.07	0.09	0.20***	0.07	0.21***	0.08	0.21***	0.08
Agassoc_dum	-0.09	0.10	-0.09	0.10	-0.10	0.10	0.08*	0.05	0.08*	0.04	0.08*	0.04
Observations	1278		1278		1259		1278		1278		1259	

Note: These are first stage results for the two-stage IV results discussed in the report. Second stage results are presented below. The dependent variable for Eqn1 to Eqn3 is training_only while that of Eqn4 to Eqn6 is training_demo; ***, ** and * show statistical significance at the 1%, 5% and 10% levels respectively. Eqn1 and Eqn4 do not contain any of the control variables. Eqn2 and Eqn5 control for the regions, using regional dummies. Eqn3 and Eqn6 control for the regions and other household characteristics, namely, household size, age, sex, education and literacy of household head and average plot size per household. Source: ISSER/INRAN field data 2015 and 2016.

Table A 17 Impact estimates of programme on fertilizer expenses

	IV –Training Only			IV –Training plus Demonstration		
	Eqn 1	Eqn 2	Eqn 3	Eqn 4	Eqn 5	Eqn 6
Training_Only	6.43	6.67	7.47			
	(4.90)	(4.61)	(4.85)			
Maradi		-0.32	-0.08		-0.25	-0.04
		(1.71)	(1.75)		(1.86)	(1.90)
Tahoua		-3.06	-3.13		-2.54	-2.46
		(3.06)	(3.18)		(3.07)	(3.17)
Training_Demo				0.80	1.78	1.38
				(5.53)	(6.59)	(6.69)
Hansen test (P-value)	0.761	0.637	0.68	0.775	0.732	0.811
Observations	1,278	1,278	1,259	1,278	1,278	1,259
Control Mean	38.7					

Note: The dependent variable is the first differenced fertilizer expenses; and the control variables are the sex of household head, household size, education status of household head, and age, sex,. The estimates are second-stage IV estimates; the first-stage results are reported above. Standard errors are in parenthesis; ***, ** and * show statistical significance at the 1%, 5% and 10% levels respectively. Eqn1 and Eqn4 do not contain any of the control variables. Eqn2 and Eqn5 control for the regions, using regional dummies. Eqn3 and Eqn6 control for the regions and other household characteristics, namely, household size, age, sex, education and literacy of household head and average plot size per household. Source: ISSER/INRAN field data 2015 and 2016

Table A 18 First stage results for fertilizer quantity

	Training Only						Training plus Demonstration					
	Eqn 1		Eqn 2		Eqn 3		Eqn 4		Eqn 5		Eqn 6	
Variables	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Training_Only (or Training_Demo)	0.25**	0.10	0.26**	0.10	0.25**	0.10	-0.01	0.05	-0.01	0.05	-0.01	0.05
TFertsold_ton	0.00*	0.00	0.00*	0.00	0.00*	0.00	0.00	0.00	0.00	0.00	0.00	0.00
empl_size	-0.01	0.01	-0.02	0.01	-0.02	0.01	0.00	0.00	0.00	0.01	0.00	0.01
Year_bus	0.01	0.00	0.01	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Fertsup_dum	0.09	0.09	0.13	0.10	0.13	0.10	-0.01	0.06	0.04	0.06	0.04	0.06
Training_dum	0.00	0.10	0.00	0.11	0.00	0.11	0.06	0.06	0.07	0.05	0.07	0.05
Credit_dum	-0.05	0.10	-0.04	0.09	-0.03	0.10	0.23***	0.08	0.25***	0.09	0.25***	0.09
Agassoc_dum	-0.07	0.10	-0.07	0.10	-0.08	0.10	0.09*	0.05	0.09*	0.05	0.09*	0.05
Observations	1278		1278		1259		1278		1278		1259	

Note: These are first stage results for the two-stage IV results discussed in the report. Second stage results are presented below. The dependent variable for Eqn1 to Eqn3 is training_only while that of Eqn4 to Eqn6 is training_demo; ***, ** and * show statistical significance at the 1%, 5% and 10% levels respectively. Eqn1 and Eqn4 do not contain any of the control variables. Eqn2 and Eqn5 control for the regions, using regional dummies. Eqn3 and Eqn6 control for the regions and other household characteristics, namely, household size, age, sex, education and literacy of household head and average plot size per household. Source: ISSER/INRAN field data 2015 and 2016.

Table A 19 Impact estimates of programme on quantity of fertilizer used

	IV –Training Only			IV –Training plus Demonstration		
	Eqn 1	Eqn 2	Eqn 3	Eqn 4	Eqn 5	Eqn 6
Training_Only	2.94	2.84	-1.31			
	(9.03)	(9.17)	(9.30)			
Maradi		1.49	2.91		1.71	3.06
		(3.80)	(4.33)		(3.45)	(3.99)
Tahoua		6.25	4.02		6.93	4.29
		(6.72)	(5.95)		(6.89)	(6.00)
Training_Demo				-4.29	-5.94	-5.52
				(15.76)	(14.30)	(14.49)
Hansen test (P-value)	0.227	0.285	0.211	0.197	0.262	0.233
Observations	1,278	1,278	1,259	1,278	1,278	1,259
Control Mean	153.6					

Note: The dependent variable is the first differenced quantity of fertilizer used; and the control variables are the sex of household head, household size, education status of household head, and age, sex,. The estimates are second-stage IV estimates; the first-stage results are reported above. Standard errors are in parenthesis; ***, ** and * show statistical significance at the 1%, 5% and 10% levels respectively. Eqn1 and Eqn4 do not contain any of the control variables. Eqn2 and Eqn5 control for the regions, using regional dummies. Eqn3 and Eqn6 control for the regions and other household characteristics, namely, household size, age, sex, education and literacy of household head and average plot size per household. Source: ISSER/INRAN field data 2015 and 2016

Table A 20 First stage results for the adoption of SWMTs

	Training Only						Training plus Demonstration					
	Eqn 1		Eqn 2		Eqn 3		Eqn 4		Eqn 5		Eqn 6	
Variables	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Training_Only (or Training_Demo)	0.85***	0.08	0.85***	0.08	0.84***	0.08	0.09	0.13	0.08	0.13	0.08	0.13
Year_bus	0.00***	0.00	0.00***	0.00	0.00***	0.00	0.00***	0.00	0.00***	0.00	0.00***	0.00
Credit_dum	-0.03**	0.02	-0.03**	0.02	-0.03**	0.02	-0.06***	0.04	-0.06***	0.04	-0.06***	0.04
Agassoc_dum	0.02***	0.00	0.0***	0.00	0.02***	0.00	-0.02***	0.01	-0.02***	0.01	-0.02***	0.01
Observations	1511		1511		1362		1511		1511		1362	

Note: These are first stage results for the two-stage IV results discussed in the report. Second stage results are presented below. The dependent variable for Eqn1 to Eqn3 is training_only while that of Eqn4 to Eqn6 is training_demo; ***, ** and * show statistical significance at the 1%, 5% and 10% levels respectively. Eqn1 and Eqn4 do not contain any of the control variables. Eqn2 and Eqn5 control for the regions, using regional dummies. Eqn3 and Eqn6 control for the regions and other household characteristics, namely, household size, age, sex, education and literacy of household head and average plot size per household. Source: ISSER/INRAN field data 2015 and 2016.

Table A 21 Impact estimates of programme on adoption of SWMTs

	IV –Training Only			IV –Training Demonstration		
	Eqn 1	Eqn 2	Eqn 3	Eqn 4	Eqn 5	Eqn 6
Training_Only	-0.06	-0.05	-0.06			
	(0.15)	(0.15)	(0.18)			
Maradi		0.11*	0.16**		0.10	0.14**
		(0.06)	(0.07)		(0.06)	(0.07)
Tahoua		0.04	-0.01		0.04	-0.01
		(0.09)	(0.10)		(0.09)	(0.10)
Training_Demo				0.33	0.29	0.29
				(0.23)	(0.23)	(0.24)
Constant						
Observations	1,511	1,511	1,362	1,511	1,511	1,362
Control Mean	33.53					

Note: The dependent variable is the first differenced adoption of SWMTs. The estimates are second-stage IV estimates; the first-stage results are reported above. Standard errors are in parenthesis; ***, ** and * show statistical significance at the 1%, 5% and 10% levels respectively. Eqn1 and Eqn4 do not contain any of the control variables. Eqn2 and Eqn5 control for the regions, using regional dummies. Eqn3 and Eqn6 control for the regions and other household characteristics, namely, household size, age, sex, education and literacy of household head and average plot size per household. Source: ISSER/INRAN field data 2015 and 2016

Results for Hypothesis 2

Table A 22 First stage results for crop yield (all crops)

	Training Only						Training Plus Demonstration					
	Eqn 1		Eqn 2		Eqn 3		Eqn 4		Eqn 5		Eqn 6	
Variables	Coef.	Robust Std. Err.	Coef.	Robust Std. Err.	Coef.	Robust Std. Err.	Coef.	Robust Std. Err.	Coef.	Robust Std. Err.	Coef.	Robust Std. Err.
All Crops												
Training_Only (or Training_Demo)	0.43***	0.10	0.36***	0.11	0.35***	0.11	0.05	0.06	0.05	0.08	0.06	0.08
Year_bus	0.02***	0.01	0.02***	0.01	0.02***	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Fertsup_dum	-0.07	0.10	-0.18*	0.11	-0.17*	0.10	0.07	0.08	0.13	0.10	0.13	0.10
Training_dum	0.09	0.09	0.11	0.11	0.10	0.11	0.03	0.07	0.12	0.10	0.12	0.10
Credit_dum	0.02	0.10	-0.13	0.12	-0.13	0.12	0.30**	0.11	0.33***	0.11	0.33***	0.11
Agassoc_dum	-0.09	0.10	-0.06	0.10	-0.07	0.10	0.18**	0.09	0.17**	0.08	0.17**	0.08
Observations	2358		1968		1949		2223		1833		1816	
Cereals												
Training_Only (or Training_Demo)	0.43***	0.09	0.36***	0.10	0.35***	0.10	0.05	0.06	0.04	0.08	0.05	0.08
Year_bus	0.01**	0.01	0.02***	0.01	0.02***	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Fertsup_dum	-0.07	0.10	-0.19*	0.10	-0.18*	0.10	0.06	0.08	0.11	0.09	0.11	0.10
Training_dum	0.10	0.09	0.12	0.11	0.11	0.11	0.04	0.07	0.12	0.10	0.12	0.10
Credit_dum	0.00	0.10	-0.15	0.12	-0.15	0.12	0.29**	0.11	0.32***	0.11	0.33***	0.11
Agassoc_dum	-0.10	0.10	-0.07	0.10	-0.07	0.10	0.17*	0.09	0.17**	0.08	0.17**	0.08
Observations	2256		1888		1869		2116		1748		1731	

Note: These are first stage results for the two-stage IV results discussed in the report. Second stage results are presented below. The dependent variable for Eqn1 to Eqn3 is training_only while that of Eqn4 to Eqn6 is training_demo; ***, ** and * show statistical significance at the 1%, 5% and 10% levels respectively. Eqn1 and Eqn4 do not contain any of the control variables. Eqn2 and Eqn5 control for the regions, using regional dummies. Eqn3 and Eqn6 control for the regions and other household characteristics, namely, household size, age, sex, education and literacy of household head and average plot size per household. Source: ISSER/INRAN field data 2015 and 2016.

Table A 23 Impact estimates of programme on crop yields

	Cereals						All Crops					
	IV –Training Only			IV –Training Demonstration			IV –Training Only			IV –Training Demonstration		
	Eqn 1	Eqn 2	Eqn 3	Eqn 4	Eqn 5	Eqn 6	Eqn 1	Eqn 2	Eqn 3	Eqn 4	Eqn 5	Eqn 6
Training_Only	-12.56	-12.57	-12.10				1.53	-0.10	0.82			
	(13.87)	(11.29)	(11.34)				(4.42)	(4.19)	(4.59)			
Maradi	-6.31	-5.95	-5.90	-4.28	-4.08	-3.92	-4.58	-12.30	-11.07	-13.26*	-11.48	-9.75
	(4.61)	(3.80)	(3.92)	(3.22)	(3.80)	(3.94)	(5.96)	(8.67)	(9.36)	(7.05)	(8.56)	(9.15)
Tahoua	-8.26	-10.85	-9.69	-15.14*	-13.48	-11.70		1.18	0.67			
	(5.69)	(9.91)	(10.62)	(7.84)	(9.41)	(9.97)		(6.87)	(6.97)			
Training_Demo				-6.42	-3.72	-4.44				-5.97	-4.04	-4.07
				(3.95)	(4.58)	(5.35)				(4.26)	(5.19)	(5.85)
Hansen test (P-value)	0.410	0.289	0.302	0.159	0.208	0.177	0.213	0.232	0.403	0.370	0.302	0.399
Observations	3,432	3,432	3,421	2,766	2,766	2,760	3,675	3,675	3,664	2,987	2,987	2,981
Control mean	143.2						192.7					

Note: The dependent variable is the first differenced crop yields. Standard errors are in parenthesis; ***, ** and * show statistical significance at the 1%, 5% and 10% levels respectively. Eqn1 and Eqn4 do not contain any of the control variables. Eqn2 and Eqn5 control for the regions, using regional dummies. Eqn3 and Eqn6 control for the regions and other household characteristics, namely, household size, age, sex, education and literacy of household head and average plot size per household. Source: ISSER/INRAN field data 2015 and 2016

Table A 24 First stage results for crop losses

	Training Only						Training Plus Demonstration					
	Eqn 1		Eqn 2		Eqn 3		Eqn 4		Eqn 5		Eqn 6	
Variables	Coef.	Robust SE	Coef.	Robust SE	Coef.	Robust SE	Coef.	Robust SE	Coef.	Robust SE	Coef.	Robust SE
All Crops												
Treatment	0.43***	0.10	0.36***	0.11	0.35***	0.11	0.049	0.059	0.05	0.08	0.06	0.08
Year_bus	0.01**	0.01	0.02***	0.01	0.02***	0.01	-0.003	0.003	0.00	0.00	0.00	0.00
Fertsup_dum	-0.06	0.10	-0.17	0.11	-0.17	0.10	0.062	0.081	0.11	0.10	0.11	0.10
Training_dum	0.09	0.09	0.11	0.11	0.10	0.11	0.036	0.077	0.12	0.10	0.12	0.10
Credit_dum	0.02	0.10	-0.12	0.12	-0.12	0.12	0.308***	0.115	0.33***	0.11	0.33***	0.11
Agassoc_dum	-0.09	0.10	-0.05	0.10	-0.06	0.10	0.175*	0.090	0.17**	0.08	0.17*	0.08
Observations	2507		2110		2090		2389		1992		1975	
Cereals												
Treatment	0.43***	0.10	0.36***	0.10	0.35***	0.10	0.04	0.06	0.04	0.08	0.04	0.08
Year_bus	0.01**	0.01	0.02***	0.01	0.02***	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Fertsup_dum	-0.07	0.10	-0.18*	0.10	-0.18*	0.10	0.06	0.08	0.11	0.09	0.11	0.10
Training_dum	0.10	0.09	0.12	0.11	0.11	0.11	0.03	0.07	0.12	0.10	0.11	0.10
Credit_dum	-0.01	0.10	-0.16	0.12	-0.16	0.12	0.30***	0.11	0.33***	0.11	0.33***	0.11
Agassoc_dum	-0.09	0.10	-0.06	0.10	-0.07	0.10	0.17*	0.09	0.17**	0.08	0.17**	0.08
Observations	2314		1942		1922		2190		1818		1801	

Note: These are first stage results for the two-stage IV results discussed in the report. Second stage results are presented below. The dependent variable for Eqn1 to Eqn3 is training_only while that of Eqn4 to Eqn6 is training_demo; ***, ** and * show statistical significance at the 1%, 5% and 10% levels respectively. Eqn1 and Eqn4 do not contain any of the control variables. Eqn2 and Eqn5 control for the regions, using regional dummies. Eqn3 and Eqn6 control for the regions and other household characteristics, namely, household size, age, sex, education and literacy of household head and average plot size per household. Source: ISSER/INRAN field data 2015 and 2016.

Table A 25 Impact estimates of programme on crop losses

	IV –Train Only			IV –Train Demonstration			IV –Train Only			IV –Train Demonstration		
	Cereals						All Crops					
	Eqn 1	Eqn 2	Eqn 3	Eqn 4	Eqn 5	Eqn 6	Eqn 1	Eqn 2	Eqn 3	Eqn 4	Eqn 5	Eqn 6
Training_only	0.97	1.08	1.57				0.28	1.51	1.99			
	(2.16)	(2.97)	(2.86)				(2.16)	(3.02)	(2.91)			
Maradi	-4.22***	-3.97**	-3.93***	-3.81***	-3.92**	-4.05***	-4.94***	-3.86**	-3.81**	-3.84**	-3.80**	-3.88**
	(1.47)	(1.61)	(1.51)	(1.41)	(1.59)	(1.48)	(1.51)	(1.70)	(1.61)	(1.53)	(1.67)	(1.58)
Tahoua	-1.75	-2.62	-2.16	-1.44	-2.74	-2.12	-2.71	-2.72	-2.31	-0.92	-2.86	-2.25
	(2.12)	(2.90)	(3.17)	(2.22)	(2.87)	(3.21)	(2.02)	(2.78)	(2.97)	(2.27)	(2.78)	(3.01)
Training_demo				-0.17	-2.94	-2.23				0.48	-2.24	-1.30
				(2.58)	(2.69)	(2.99)				(2.71)	(2.65)	(2.67)
Hansen test (P-value)	0.269	0.640	0.489	0.468	0.234	0.334	0.410	0.289	0.302	0.159	0.208	0.177
Observations	3,466	3,466	3,455	2,777	2,777	2,771	3,754	3,754	3,743	3,004	3,004	2,998
Control mean	81.5						82.3					

Note: The dependent variable is the first differenced crop losses. The estimates are second-stage IV estimates; the first-stage results are reported above. Standard errors are in parenthesis; ***, ** and * show statistical significance at the 1%, 5% and 10% levels respectively. Eqn1 and Eqn4 do not contain any of the control variables. Eqn2 and Eqn5 control for the regions, using regional dummies. Eqn3 and Eqn6 control for the regions and other household characteristics, namely, household size, age, sex, education and literacy of household head and average plot size per household. Source: ISSER/INRAN field data 2015 and 2016

Results for Hypothesis 3

Table A 26 First Stage results for hypothesis 3 indicators

VARIABLES	Training only	Training plus demonstration
Training_Only	1.28***	0.35***
	(0.04)	(0.05)
Training_Demo	0.86***	0.46***
	(0.04)	(0.06)
TFertsold_ton	-0.00***	-0.00
	(0.00)	(0.00)
empl_size	-0.01**	-0.06***
	(0.01)	(0.02)
Year_bus	0.02***	-0.03***
	(0.00)	(0.00)
Fertsup_dum	0.25***	0.00
	(0.03)	(0.04)
Training_dum	-0.00	0.45***
	(0.04)	(0.06)
Credit_dum	-0.11***	1.20***
	(0.04)	(0.05)
Agassoc_dum	-0.30***	1.17***
	(0.04)	(0.07)
Observations	9,079	9,079

Note: These are first stage results for the two-stage IV results discussed in the report for the third hypothesis. We estimated this using a biprobit regression to estimate the first stage results for the ex-post treatment variables (training_only and training_demo), using the ex-ante treatment variables and other identifying variables used as instrumental variables. Second stage results for all the indicators are presented below. ***, ** and * show statistical significance at the 1%, 5% and 10% levels respectively. Eqn1 and Eqn4 do not contain any of the control variables. Eqn2 and Eqn5 control for the regions, using regional dummies. Eqn3 and Eqn6 control for the regions and other household characteristics, namely, household size, age, sex, education and literacy of household head and average plot size per household. Source: ISSER/INRAN field data 2015 and 2016

Table A 27 Impact estimates of programme on seed use (IV estimations)

	Cereals			All Crops		
	Eqn 1	Eqn 2	Eqn 3	Eqn 4	Eqn 5	Eqn 6
Training_only	-0.16	-0.27	-0.29*	-0.12	-0.21	-0.25
	(0.18)	(0.17)	(0.17)	(0.19)	(0.18)	(0.19)
Training_demo	0.80***	0.72***	0.71***	1.04***	0.94***	0.94***
	(0.18)	(0.19)	(0.19)	(0.18)	(0.19)	(0.19)
Maradi		-0.30***	-0.27**		-0.18*	-0.17
		(0.11)	(0.11)		(0.11)	(0.11)
Tahoua		-0.26***	-0.24***		-0.21***	-0.20***
		(0.07)	(0.07)		(0.07)	(0.07)
Margins:						
training_only	-0.04	-0.06	0.06	-0.025	-0.046	-0.053
training_demo	0.25***	0.23***	0.22***	0.35***	0.32***	0.32***
H1: Training_Demo>Training_Only (P-value)	0.001	0.001	0.001	0.001	0.001	0.001
Observations	1,237	1,237	1,237	1,237	1,237	1,237

Note: The dependent variable is the first differenced seed use. Standard errors are in parenthesis; ***, ** and * show statistical significance at the 1%, 5% and 10% levels respectively. Eqn1 and Eqn4 do not contain any of the control variables. Eqn2 and Eqn5 control for the regions, using regional dummies. Eqn3 and Eqn6 control for the regions and other household characteristics, namely, household size, age, sex, education and literacy of household head and average plot size per household. Source: ISSER/INRAN field data 2015 and 2016.

Table A 28 Impact estimates of programme on seed expenses (IV estimations)

	Cereals			All Crops		
	Eqn 1	Eqn 2	Eqn 3	Eqn 4	Eqn 5	Eqn 6
Training_only	-5.10	0.31	0.14	-1.17	0.61	0.90
	(5.05)	(0.35)	(0.42)	(5.69)	(0.44)	(0.57)
Training_demo	15.16	0.21	-0.03	-16.96	-0.08	-0.23
	(28.48)	(0.19)	(0.45)	(29.10)	(0.35)	(0.76)
Maradi	-0.40	-0.11	-0.04	0.01	0.72	1.25
	(1.23)	(0.52)	(0.54)	(1.21)	(0.81)	(0.87)
Tahoua	-0.69	5.04	5.09	4.88	6.58	8.09
	(3.10)	(3.99)	(4.05)	(3.48)	(7.60)	(7.64)
H1: Training_Demo>Training_Only (P-value)	0.277	0.427	0.584	0.701	0.977	0.995
Observations	1,244	1,153	1,137	1,244	1,153	1,137
Control mean	1.85			2.4		

Note: The dependent variable is the first differenced seed expenses. The estimates are second-stage IV estimates; the first-stage results are reported above. Standard errors are in parenthesis; ***, ** and * show statistical significance at the 1%, 5% and 10% levels respectively. Eqn1 and Eqn4 do not contain any of the control variables. Eqn2 and Eqn5 control for the regions, using regional dummies. Eqn3 and Eqn6 control for the regions and other household characteristics, namely, household size, age, sex, education and literacy of household head and average plot size per household. Source: ISSER/INRAN field data 2015 and 2016

Table A 29 Impact estimates of programme on seed quantity used (IV estimations)

	Cereals			All Crops		
	Eqn 1	Eqn 2	Eqn 3	Eqn 4	Eqn 5	Eqn 6
Train_only	-0.36	0.65	2.05	-3.68	0.87	1.99
	(7.58)	(0.49)	(3.83)	(4.41)	(0.84)	(3.81)
Train_demo	-26.85	0.22	-4.62	-8.55	0.43	-4.11
	(48.57)	(0.88)	(5.55)	(36.38)	(0.30)	(5.40)
Maradi	1.03	-1.21	2.20	0.34	-0.84	2.08
	(2.44)	(1.69)	(3.61)	(1.71)	(1.27)	(3.73)
Tahoua	2.25	3.91	5.26	2.01	3.68	5.75
	(3.82)	(4.46)	(5.27)	(2.92)	(4.54)	(5.94)
H1: Training_Demo>Training_Only (P-value)	0.622	0.898	0.366	0.46	0.089	0.674
Observations	1,244	1,153	1,137	1,244	1,153	1,137
Control mean	4.69			4.95		

Note: The dependent variable is the first differenced seed quantity used. The estimates are second-stage IV estimates; the first-stage results are reported above. Standard errors are in parenthesis; ***, ** and * show statistical significance at the 1%, 5% and 10% levels respectively. Eqn1 and Eqn4 do not contain any of the control variables. Eqn2 and Eqn5 control for the regions, using regional dummies. Eqn3 and Eqn6 control for the regions and other household characteristics, namely, household size, age, sex, education and literacy of household head and average plot size per household. Source: ISSER/INRAN field data 2015 and 2016

Table A 30 Impact estimates of programme on chemical use (IV estimations)

	Eqn 1	Eqn 2	Eqn 3
Training_only	-0.02	-0.09	-0.07
	(0.15)	(0.16)	(0.16)
Training_demo	0.32	0.17	0.14
	(0.23)	(0.25)	(0.26)
Maradi		-0.15	-0.18*
		(0.10)	(0.10)
Tahoua		-0.15**	-0.14**
		(0.07)	(0.07)
Margins:			
Training_only	-0.01	-0.02	-0.02
Training_demo	0.09	0.05	0.04
H1: Training_Demo>Training_Only (P-value)	0.088	0.169	0.219
Observations	1,362	1,362	1,362

Note: The dependent variable is the first differenced fertilizer use. The estimates are second-stage IV estimates; the first-stage results are reported above. Standard errors are in parenthesis; ***, ** and * show statistical significance at the 1%, 5% and 10% levels respectively. Eqn1 does not contain any of the control variables. Eqn2 controls for the regions, using regional dummies. Eqn3 controls for the regions and other household characteristics, namely, household size, age, sex, education and literacy of household head and average plot size per household. Source: ISSER/INRAN field data 2015 and 2016

Table A 31 Impact estimates of programme on fertilizer use (IV estimations)

	Eqn 1	Eqn 2	Eqn 3
Training_only	-0.06	-0.12	-0.11
	(0.16)	(0.16)	(0.16)
Training_demo	0.36	0.22	0.18
	(0.22)	(0.24)	(0.25)
Maradi		-0.14	-0.18*
		(0.10)	(0.10)
Tahoua		-0.15**	-0.14**
		(0.07)	(0.07)
Margins:			
Training_only	-0.01	-0.03	-0.02
Training_demo	0.1	0.06	0.05
H1: Training_Demo>Training_Only (P-value)	0.046	0.097	0.137
Observations	1,362	1,362	1,362

Note: The dependent variable is the first differenced fertilizer use. The estimates are second-stage IV estimates; the first-stage results are reported above. Standard errors are in parenthesis; ***, ** and * show statistical significance at the 1%, 5% and 10% levels respectively. Eqn1 does not contain any of the control variables. Eqn2 controls for the regions, using regional dummies. Eqn3 controls for the regions and other household characteristics, namely, household size, age, sex, education and literacy of household head and average plot size per household. Source: ISSER/INRAN field data 2015 and 2016

Table A 32 Impact estimates of programme on chemical expenses (IV estimations)

	Eqn 1	Eqn 2	Eqn 3
Train_only	3.99	-1.54	-1.82
	(14.08)	(1.84)	(2.04)
Train_demo	52.02	-1.40	-1.35
	(127.48)	(3.13)	(2.39)
Maradi	-1.36	-3.40	-3.74
	(4.29)	(2.18)	(2.37)
Tahoua	-8.54	-5.32	-5.33
	(7.92)	(4.74)	(4.72)
Observations	1,422	1,278	1,259
H1: Training_Demo>Training_Only (P-value)	0.663	0.152	0.249
Control mean	39.9		

Note: The dependent variable is the first differenced fertilizer use. The estimates are second-stage IV estimates; the first-stage results are reported above. Standard errors are in parenthesis; ***, ** and * show statistical significance at the 1%, 5% and 10% levels respectively. Eqn1 does not contain any of the control variables. Eqn2 controls for the regions, using regional dummies. Eqn3 controls for the regions and other household characteristics, namely, household size, age, sex, education and literacy of household head and average plot size per household. Source: ISSER/INRAN field data 2015 and 2016

Table A 33 Impact estimates of programme on fertilizer expenses (IV estimations)

	Eqn 1	Eqn 2	Eqn 3
Training_only	24.47	-9.02	-13.47
	(20.09)	(22.43)	(23.19)
Training_demo	-90.48	-8.62	-12.01
	(162.70)	(16.62)	(14.86)
Maradi	-17.78	-19.80	-21.75
	(20.28)	(15.70)	(18.07)
Tahoua	6.07	13.89	-10.00
	(15.50)	(25.37)	(19.13)
H1: Training_Demo>Training_Only (P-value)	0.606	0.346	0.536
Observations	1,422	1,278	1,259

Note: The dependent variable is the first differenced fertilizer use. The estimates are second-stage IV estimates; the first-stage results are reported above. Standard errors are in parenthesis; ***, ** and * show statistical significance at the 1%, 5% and 10% levels respectively. Eqn1 does not contain any of the control variables. Eqn2 controls for the regions, using regional dummies. Eqn3 controls for the regions and other household characteristics, namely, household size, age, sex, education and literacy of household head and average plot size per household. Source: ISSER/INRAN field data 2015 and 2016

Table A 34 Impact estimates of programme on quantity of chemicals used (IV estimations)

	Eqn 1	Eqn 2	Eqn 3
Train_only	-4.26	-1.37	-1.89
	(17.80)	(3.56)	(4.20)
Train_demo	41.43	-3.59	-7.31
	(188.58)	(3.33)	(6.49)
Maradi	0.97	2.13	3.28
	(6.87)	(3.79)	(4.60)
Tahoua	7.19	17.05	6.17
	(10.05)	(11.68)	(10.37)
H1: Training_Demo>Training_Only (P-value)	0.562	0.496	0.491
Observations	1,422	1,278	1,259
Control mean	159.9		

Note: The dependent variable is the first differenced fertilizer use. The estimates are second-stage IV estimates; the first-stage results are reported above. Standard errors are in parenthesis; ***, ** and * show statistical significance at the 1%, 5% and 10% levels respectively. Eqn1 does not contain any of the control variables. Eqn2 controls for the regions, using regional dummies. Eqn3 controls for the regions and other household characteristics, namely, household size, age, sex, education and literacy of household head and average plot size per household. Source: ISSER/INRAN field data 2015 and 2016

Table A 35 Impact estimates of programme on quantity of fertilizer used (IV estimations)

	Eqn 1	Eqn 2	Eqn 3
Training_only	-8.37	-1.39	-1.97
	(27.43)	(3.56)	(4.20)
Training_demo	93.60	-0.22	-3.88
	(265.14)	(4.44)	(6.16)
Maradi	-0.97	1.64	2.65
	(9.77)	(3.71)	(4.52)
Tahoua	5.29	17.25	6.34
	(14.20)	(11.67)	(10.38)
H1: Training_Demo>Training_Only (P-value)	0.463	0.672	0.634
Observations	1,422	1,278	1,259
Control mean	153.6		

Note: The dependent variable is the first differenced fertilizer use. The estimates are second-stage IV estimates; the first-stage results are reported above. Standard errors are in parenthesis; ***, ** and * show statistical significance at the 1%, 5% and 10% levels respectively. Eqn1 does not contain any of the control variables. Eqn2 controls for the regions, using regional dummies. Eqn3 controls for the regions and other household characteristics, namely, household size, age, sex, education and literacy of household head and average plot size per household. Source: ISSER/INRAN field data 2015 and 2016

Table A 36 Impact estimates of programme on adoption of SWMT (IV estimations)

	Eqn 1	Eqn 2	Eqn 3
Training_only	-0.25*	-0.26*	0.13
	(0.15)	(0.15)	(0.10)
Training_demo	-0.06	-0.06	0.23
	(0.23)	(0.24)	(0.15)
Maradi		-0.59***	-0.78***
		(0.14)	(0.10)
Tahoua		0.38**	-0.03
		(0.17)	(0.13)
Margins:			
Training_only	.07*	.06	.06*
Training_demo	.16*	.14*	.14*
H1: Training_Demo>Training_Only (P-value)	0.102	0.147	0.151
Observations	1,511	1,511	2,686

Note: The dependent variable is the first differenced fertilizer use. The estimates are second-stage IV estimates; the first-stage results are reported above. Standard errors are in parenthesis; ***, ** and * show statistical significance at the 1%, 5% and 10% levels respectively. Eqn1 does not contain any of the control variables. Eqn2 controls for the regions, using regional dummies. Eqn3 controls for the regions and other household characteristics, namely, household size, age, sex, education and literacy of household head and average plot size per household. Source: ISSER/INRAN field data 2015 and 2016

Table A 37 Impact estimates of programme on crop yields (IV estimations)

	Cereals			All Crops		
	Eqn 1	Eqn 2	Eqn 3	Eqn 4	Eqn 5	Eqn 6
Training_only	-2.57	-1.04	-0.60	-2.05	-0.83	-0.99
	(6.50)	(2.62)	(2.77)	(6.04)	(2.31)	(2.42)
Training_demo	-5.38	-1.14	-1.44	5.89	0.11	-0.36
	(7.70)	(2.49)	(3.26)	(7.85)	(2.54)	(3.28)
Maradi	-3.35*	-4.51*	-4.78*	-3.87	-7.69***	-7.73**
	(1.89)	(2.70)	(2.80)	(2.45)	(2.95)	(3.03)
Tahoua	-4.23	-7.53	-9.84	-6.45	-6.84	-8.93
	(6.07)	(10.96)	(11.19)	(5.13)	(10.28)	(10.43)
Observations	3,350	3,350	3,319	3,502	3,502	3,471
H1: Training_Demo>Training_Only (P-value)	0.604	0.514	0.591	0.185	0.367	0.428
Control mean	143.20			192.7		

Note: The dependent variable is the first differenced crop. The estimates are second-stage IV estimates; the first-stage results are reported above. Standard errors are in parenthesis; ***, ** and * show statistical significance at the 1%, 5% and 10% levels respectively. Eqn1 and Eqn4 do not contain any of the control variables. Eqn2 and Eqn5 control for the regions, using regional dummies. Eqn3 and Eqn6 control for the regions and other household characteristics, namely, household size, age, sex, education and literacy of household head and average plot size per household. Source: ISSER/INRAN field data 2015 and 2016

Table A 38 Impact estimates of programme on pre-harvest crop losses (IV estimations)

	Cereals			All Crops		
	Eqn 1	Eqn 2	Eqn 3	Eqn 4	Eqn 5	Eqn 6
Training_only	4.86	2.23	3.01	2.91	2.23	2.93
	(2.97)	(1.61)	(1.51)	(2.58)	(1.59)	(1.49)
Training_demo	2.99	-0.20	0.36	4.39	-1.22	-0.77
	(3.68)	(1.43)	(1.35)	(3.66)	(1.34)	(1.19)
Maradi	-3.08***	-2.51**	-2.84***	-3.61***	-3.15***	-3.56***
	(1.07)	(1.17)	(1.10)	(1.03)	(1.18)	(1.11)
Tahoua		-0.02	-0.52	-0.88	-1.20	-1.96
		(3.24)	(3.52)	(2.08)	(3.20)	(3.46)
Observations	3,432	3,432	3,401	3,696	3,696	3,665
H1: Training_Demo>Training_Only (P-value)	0.661	0.915	0.947	0.902	0.699	0.895
Control mean	81.5			82.30		

Note: The dependent variable is the first differenced pre-harvest crop losses. The estimates are second-stage IV estimates; the first-stage results are reported above. Standard errors are in parenthesis; ***, ** and * show statistical significance at the 1%, 5% and 10% levels respectively. Eqn1 and Eqn4 do not contain any of the control variables. Eqn2 and Eqn5 control for the regions, using regional dummies. Eqn3 and Eqn6 control for the regions and other household characteristics, namely, household size, age, sex, education and literacy of household head and average plot size per household. Source: ISSER/INRAN field data 2015 and 2016

Appendix 2: Field notes and other information from formative work.

The main activities covered form the completion of the baseline report to date can be classified under 4 broad categories. These are:

a. Qualitative survey
b. Training and Implementation of Endline Survey
c. Analysis of Data

1. Qualitative survey

The qualitative survey begun on Tuesday, October 13th, 2015 and was completed by the 24th of November, 2015. Subsequently, feedback from the qualitative survey helped shape some of the questions for the end line instrument.

2. Training and Implementation of Endline Survey

Training of the enumerators for the endline survey was conducted in the city of Konni in Niger, from 9th to 18th May, 2016. The training involved discussion of the paper questionnaire followed by training on the use of CAPI for interviews. This was then followed by the pre-tests where the questionnaires were administered to agricultural producers in the villages of Saleawa 1, Killa 1 and 2 (Tahoua region). Following the pre-tests, the final, corrections of the questionnaire and fine tuning of the CAPI programme was undertaken. The practical exercises used during the training sessions was helpful since discussions were held on how to translate the questions in local languages without losing its original meaning. The pre-testing of the questionnaires allowed the team to correct certain deficiencies in practice and better refine the questionnaires.

Before the beginning of the fieldwork, the data base of the baseline study was preloaded to ensure accurate identification of the farmers who had been part of the interviews in the previous year (using the agreed sampling plan). Each enumerator then moved to the field with the list of farmers in the assigned villages. The field work began at Tahoua and Maradi on 19th May and at Zinder 20th May, 2016.

3. Analysis of Data

The field work was completed by the end of June and data analysis proceeded. The results were shared during a technical workshop with main key stakeholders (implementers, farmers and agro-dealers). This took place in Niamey on the 6th of September, 2016 (details are shared in the PIP report).

Two data analysis and report writing sessions were conducted from the 20th of August to the 4th of September in Koforidua and then from 3rd October to 6th October at the University of Ghana campus. During the first visit, Dr. Mamadou Adam was present from the 24th of August to support the analysis of the data as well as offer insights into components of the dataset.

Appendix 3: Pre-analysis plan.

1. Introduction

This pre-analysis plan outlines the methods, procedures, hypotheses to be tested, and specifications to be used in the analysis of the impact of the "Reinforcing Agro-dealers' Network in Niger" on smallholder farmers' access to and adoption of agricultural inputs in the Maradi, Zinder and Tahoua regions of Niger. Since the plan is prepared prior to the collection and analysis of the follow-up data, the plan can provide a useful reference in evaluating the final results of the study.

The plan is outlined as follows: Section 2 provides an overview of the study, Section 3 describes the research methodology, Section 4 outlines the procedure for statistical analysis and Section describes the expected results.

2. Overview of the Study

The Alliance for a Green Revolution in Africa (AGRA) and Contribution à l'Education de Base (CEB) in collaboration with about 15 other institutions are implementing "Reinforcing Agro-dealers' Network in Niger". The intervention aims to improve smallholder farmers' access to and adoption of agricultural inputs in the Maradi, Zinder and Tahoua regions of Niger. The specific objectives of the intervention are to: (i) strengthen agro-dealers' capacity to supply agricultural inputs to smallholder farmers; (ii) increase agro-dealers' access to commercial credit through linkages with financial institutions; and (iii) increase smallholder farmers' awareness of improved seeds, fertilizers and other technologies.

The International Initiative for Impact Evaluation (3ie) has contracted the Institute for Statistical, Social and economic Research (ISSER) to conduct an impact evaluation of the intervention. The aim of the study is to evaluate the impact of "Reinforcing Agro-dealers' Network in Niger" on smallholder farmers' access to and adoption of agricultural inputs in the Maradi, Zinder and Tahoua regions of Niger. The study will specifically analyze the impact of building the capacity of agro-dealers on smallholder farmers' access to and use of agricultural inputs; and to determine and analyze the constraints to the adoption and use of agricultural inputs by farmers.

The key activities of the programme to be evaluated are:

a) Training agro-dealers to improve upon inputs ordering and distribution.
b) Training agro-dealers on product knowledge, usage, marketing, and management of credit and stock.
c) Facilitate business relations between agro dealers and other private sector actors.
d) Bridging the huge gap between agro dealers and commercial banks and Micro finance Institutions for access to credit.
e) Facilitate the development of business plans by agro dealers to obtain credit.
f) Training of extension agents and agro dealers to advise farmers on best agricultural practices.
g) Establish demonstration plots to compare technologies in order to create awareness and demand for inputs.
h) Organize field days.

This analysis plan aims to pre-specify the analysis before comparing outcomes for treatment and control groups. By creating this analysis plan, which serves as a record of our ex ante planned analysis, we hope to minimize issues of data mining and specification searching. We use the control distributions for all the outcomes and perform treatment-control comparisons that explore the validity of our analysis (such as balance on pre-randomization characteristics).

The main evaluation questions under assessment are:

- Does strengthening agro-dealers' capacity to supply agricultural inputs improve smallholder farmers' access to and use of agricultural inputs?
- Which constraints affect the adoption and use of agricultural inputs by farmers and what is the impact on usage?

Theory of Change

The study is based on the theory of change relying on the fact that strengthening the institutional capacity of the farmer organizations by improving their accountability and ownership structure will in turn lead to well-aggregated structured farmer organizations that will have an aggregated demand for input and finances. It will also give the farmer organizations a voice. This will consequently bring change to the value chain and lead to the sustained value for farmers. A theory of change refers to an evaluation tool which involves looking at an intermediate and long-term goals of a comprehensive community initiative (CCI) and critically analyzing the necessary preconditions necessary to achieve it. It is described as a backward mapping of these preconditions and assessing if they will directly lead to the achievement of the outlined goals. (Anderson, 2005)

In this case, the current situation that the outlined project intervention hopes to solve is the low farm yields experienced as a result of poor farming conditions, practices and poor soils. In employing this tool, it has been identified that the lack of an effective distribution network and shortage of input supply hinders farmers' access to agricultural inputs such as fertilizer, improved seed etc. and aggravates the problem of poor soils, a factor that contributes to low yields. This leads to the hypothesis that enforcing agro-dealer networks will further improve farmer access to inputs.

Through backward analysis, preconditions necessary for strong agro-dealer networks include knowledge of the proper production, use and handling of inputs, services through which agro-dealers create value for farmers and business practices which ensure agro-dealerships remain operational in their respective communities. To accomplish this, training of agro-dealers is needed as a programme intervention. In the intermediate term it is expected that there will be an improvement in the supply of agricultural inputs such as fertilizers, seeds etc. It is also expected that the knowledge of their proper use and handling will spread to farmers. In the long-term, farm yield should improve.

Most literature has detailed the structure and importance of a theory of change approach to CCI evaluation. TOC works as an expectation management tool (Anderson 2005), which maps out, not only interventions and their expected outcomes, but how they are supposed to work. An example is the case of the Education for All (EFA) organizations' assessment of education monitoring on progress towards United Nation's education goals, where theory of change was employed to gauge not only if, but how, it might work. (Post, 2015)

Some authorities find that the theory of change approach widens the options available for CCI evaluation, which, hitherto, involved the following limited options: processing documentation of the initiatives without expectations about obtaining credible evidence of their impacts, trying to "force fit" the initiatives themselves into the framework of existing evaluation methods in order to estimate their impacts or put off evaluating initiatives until they were more "mature" and "ready" to be evaluated using existing strategies. (Connell and Kubisch)

This particular study meets the necessary criteria for a well-conducted theory of change as outlined by Connell and Kubisch. First of all, it is plausible because training of agro-dealers can lead to higher direct impact with farmers, through provision of inputs and guidance regarding their use, and eventually impact yield. Additionally, The project is doable. AGRA is able to provide the training in each of the communities for free, eliminating geographical and economical barriers to engaging in the training. Finally, with the outlined indicators for testing impact and yields, the theory is testable. Random selection of agro-dealers to treatment groups and both baseline and endline assessments of farmer production and welfare allows for statistical observation and testing of the size and significance of the impact. (Connell & Kubisch, 1998)

3. Methods

The study will utilize both qualitative and quantitative research methods. The study will rely greatly on quantitative data generated by two instruments; for agro-dealers and farm households. We will also employ the use of qualitative data to offer some enhanced understanding of the peculiar context of the impact evaluation. Specifically, the qualitative methods will be utilize in addressing questions relating to why farmers may not be adopting fertilizers, improved seeds and/or other agricultural inputs; what farmers think could explain low yields despite the adoption (or an increased adoption rate) of some agricultural inputs. The design of the quantitative survey instruments will also benefit from the qualitative component of the impact evaluation, such that the qualitative data will complement the quantitative data.

There will be two rounds of focus group discussions and a validation workshop. The first focus group discussion (FGD) will be before the baseline data collection in order to inform the planning and preparation of the survey. The second round of FGD will be after the end line survey to help better understand the results. The study will also make use of the result of the process evaluation which will be carried out by AGRA.

3.1. Sample Selection

The sample for the evaluation consists of 1,511 households randomly sampled from the 3 study regions (Maradi, Tahoua and Zinder) of Niger. The sample is selected such that approximately equal numbers selected into taking training (treatment group 1), selected into training with demonstration plots (treatment group 2), and selected out of training (control group).

The selection of agro-dealers will be based on a compiled register of agro-dealers within the three regions. Prior the study, these agro dealers will be located and earmarked for the entire sample. It is expected that 40 to 50 agro dealers will be selected in each region. In order to prevent contamination whereby farmers in a community are serviced by multiple agro dealers, we intend to sample one agro-dealer per community. However, we understand that, given the geographical distribution of the available agro-dealers, it is possible to have multiple in the same region.

Farm households will also be surveyed. The sample of farmers will be selected based on the agro dealer sample. For each agro dealer, 12-14 farmers serviced by the agro dealers, would be chosen.

In all, a total of 6 FGDs for farmers in the 3 regions and one focus group discussion for agro-input dealers will be undertaken. In each of the 3 regions we will conduct FGD for men and women. The first year FGDs will involve community leaders from 3 selected communities in each of the three regions. The selection of the communities will be based on initial discussions with the programme implementers and other stakeholders. This is geared at obtaining first-hand information on economic activities and general living conditions of people in the communities, and also assist in identifying other individuals for the subsequent FGDs.

3.2. Randomization and Intervention

The study uses a randomised phase-in approach. This approach ensures that all the Agro dealers that will be part of the study will also be part of the programme. Our approach will involve two main steps. Since the AGRA programme will be working with agro-dealers we will first randomise the Agro dealers into three experimental arms. We will select 40 agro-dealers for each group that will be included in the study. The agro-dealers will then be assigned to one of the four arms:

T (0): Pure control

T (1): Partial Treatment 1 – the selected agro-dealers will get only training

T (2): Full Treatment – the selected agro-dealers get both training and demonstration plots.

At a second stage we will sample 10 farmers from the respective communities in which each of the selected 40 agro-dealers operate. Our understanding from the CEB project document is that the actual application of the treatment will start in Year 2. Consequently, we will undertake a comprehensive baseline survey before the start of the treatment. After a period of 1 year we will conduct a comprehensive endline survey to assess the effect of the treatments.

3.3. Research Hypothesis

Our design allows us to test three explicit hypotheses:

H1: Training of agro-dealers improves smallholder farmers' access to and adoption of agricultural inputs. This will essentially be a test of T (1) versus T (0).

H2: Training and linking agro-dealers to demonstration plots improves smallholder farmers' access to and adoption of agricultural inputs. This will be a test of T (3) versus T (0).

H3: Training of Agro-dealers increases smallholder farmers' crop yields and incomes. This will essentially be a test of T (1) versus T (0).

H4: Training and linking them to demonstration plots improves smallholder farmers' crop yields and income. This will be a test of T (3) versus T (0).

The hypothesis H3 and H4 are similar to H1 and H2 except that the impact variables are in the last two hypotheses (H3 and H4) are crop yields and incomes whereas in the first two hypotheses they are on adoption. In testing these hypotheses we will also test for heterogeneous effects using gender, crop and other interesting farmer and FBO characteristics. In exploring the heterogeneous effects (sub-group analysis), we will apply the correction methods suggestions by Fink et al. (2014). The main heterogeneous effects will include gender, region, and group characteristics.

3.4. Data Collection

Data on the characteristics of agro-dealers to be listed as part of AGRA's agro-dealers' network programme will be collected from the Grantees. This will serve as a sampling frame from which households would be sampled. The data to be collected will include household demographic characteristics, the inputs that they mainly deal in, organisational structure and the years that they have been in operation. At the household level, two rounds of data collection will be undertaken on farmer level indicators. A baseline survey will be undertaken before the start of implementation. The survey instrument will be focused on the farming activity of farmers in communities in which the Agro dealers operate. So although we still collect the farmers' household information the emphasis will be on information on agricultural production, harvesting and marketing. In particular we will try and get information on farmers' crop yields and income. There will be an endline survey a year after the start of the implementation of the programme – a year after the baseline survey.

3.5. Time Frame of the Study

The entire study will span two years to encompass the initial focus group discussions, the baseline survey, the follow-up focus groups, the training and demonstration intervention and the final endline survey.
The Baseline survey will be completed between March and April of 2015, before the start of treatment. Following that, CEB will start their actual application of the treatment according to the groups outlined Section 3.2. The qualitative studies (focus group discussions) will occur from September to October of 2015, the results of which will inform the endline survey instrument. To study the impact of the treatment, the end line survey will be conducted between February and Mar, 2016)

4. Statistical Analysis

The entire project is expected to generate panel data of farm households and agro-dealers which will be used to capture the impact of the intervention at the end of the project. In the baseline survey, we summarize specific indicators which describe both the farm households and agro-input dealer. This baseline analysis will present demographic, education, agricultural production, income and welfare data which will serve as basis for comparison in the endline survey. Special attention will be paid to indicators which describe agro-input adoption and usage, access to agro-dealers, crop yield, training and credit access for farmers.

After the random assignment of the agro dealers to treatment groups, and the actual intervention, data on the same indicators will be collected for farm households. Comparisons will be made between baseline and endline data. Farm households will be tagged with the appropriate treatment group as assigned to the agro-dealer whose services they mainly access.

The general analytical framework upon which the evaluation of agro-dealer training is based on is the difference-in-difference approach. Employing this approach, the analysis will compare the yearly difference across the treatment groups between the baseline and endline to attempt to establish a significant relationship between the intervention and farm productivity

Following Kremer and Miguel (1998) we specify a model which captures the difference in project impact (outcome) across farmers within the communities for treatment and comparison agro-dealers as follows:

$$Y_{it} = \alpha + \beta_1 T + \beta_2 D + \beta_3 T \times D + X_{it}^{\prime}\delta + \varepsilon_{it} \quad (1)$$

Where

- Y_{it} is our variable of interest (yield, crop losses etc.) for household *i* at time t (t=0,1),
- *T* is a binary variable which takes the value of 0 in the base year and 1 in the follow-up period
- *D* is a binary variable which takes the value of 0 if individual is in the control group (no training), 1 if in the treatment (full or partial, depending on comparison) group.
- $X_{it}^{\prime}$ is a vector containing covariates which may influence our variable of interest.
- *TD* is an interactive variable. The coefficient of this interactive variable provides a measure of effect of the intervention which is referred to as the difference-in-difference estimator; and
- $\alpha, \beta_1, \beta_2 and\ \delta$ are parameters

An important merit of such an econometric method is that it allows us to include control factors in the estimation (both time-variant and time-invariant factors within the treatment and control groups). The opportunity to employ different individual and group behavioural characteristics (including gender, marital status, age categories, etc.) and other dummy variables for the different cohorts in the model permits the evaluation of the differential impact of the interventions on these groups.

Typically the difference-in-difference estimator is obtained in two steps. First, one takes the difference in the outcome indicator of interest, between the treatment and control farmers (the first difference). At the second stage one takes the difference of the first difference over time (hence the name 'difference-in-difference'). This can be expressed as follows:

-
- $\beta_3 = (\widehat{Y_{D2}} - \widehat{Y_{C2}}) - (\widehat{Y_{D1}} - \widehat{Y_{C1}})$ (2)

Where $(\widehat{Y_{D2}}\ and\ \widehat{Y_{C2}})$ are the respective averages of the outcome indicator in the treatment (*D*) and control (*C*) groups in the follow-up period (*t*=2) and, $(\widehat{Y_{D1}}\ and\ \widehat{Y_{C1}})$ are the corresponding averages for the base period (*t=1*).

The estimators obtained in Equations 3-6 can be summarised as follows:

Summary of Estimators in the Difference-in-difference Approach

Group	Before Change	After Change	Difference
Treatment Group	$\widehat{Y_{D1}} = \alpha + \beta_1$	$\widehat{Y_{D2}} = \alpha + \beta_1 + \beta_2 + \beta_3$	$\widehat{Y_{D2}} - \widehat{Y_{D1}} = \beta_2 + \beta_3$
Control Group	$\widehat{Y_{C1}} = \alpha$	$\widehat{Y_{C2}} = \alpha + \beta_1$	$\widehat{Y_{C2}} - \widehat{Y_{C1}} = \beta_2$
Difference	$\widehat{Y_{D1}} - \widehat{Y_{C1}} = \beta_1$	$\widehat{Y_{D2}} - \widehat{Y_{C2}} = \beta_2 + \beta_3$	$\Delta\Delta\hat{Y} = \beta_3$

The list of variables used in the tables to be used in the endline analysis are defined as follows:

Time 2	Categorical variable which takes the value of 1 in period 2; 0 otherwise
Treatdum	Categorical variable which takes the value of 1 if in treatment group and 0 if in control group
Treattime	Impact variable which measures the impact of the training on variables of interest. (difference-in-difference estimator)
Treattime_Maradi	Interaction of Treattime with Maradi region
Treattime_Zinder	Interaction of Treatime with the Zinder region
Treattime_Tahoua	Interaction of Treattime with the Tahoua region

5. Expected Results

Baseline

Expected results should show that access to and use of inputs is low for farm households. Seeds especially are sourced from their own harvests and only a small share of the farmers source their seeds from agro-input dealers. Organic fertilizer is more commonly used by households, although inorganic fertilizer use is high. Less than half of households engage in Soil and Water Management Techniques, designed to increase productivity on farm plots. The direct effect on agricultural productivity is low versatility of crops grown (mainly maize and millet) and even more modest yields, compared to FAO figures. Farm households record high post-harvest crop losses, more than half for most crops.

The results should also demonstrate that agro-dealers' operations are constrained by low access to credit and non-diversified training. Most agro-dealers have small operations, with very few employees on average. We expect to see that they deal primarily in fertilizer, specifically NPK. Agro-dealers on average s sell lesser volumes of fertilizer than they purchase from suppliers. Credit access is low for agro dealers, with few seeking loans/suppliers credit to run their business and even fewer successfully obtaining them. The loan amounts are low with high monthly interest rates. Majority received training in the past year, with emphasis placed on seed production on handling. Very few received business training. A small percentage of agro-dealers sponsored their own training, a possible effect of poor financial access.

Endline

Following the baseline survey, the treatment groups will receive their respective interventions and the same indicators from the baseline will be studied for both agro dealers and the farm households served. The intervention will increase agro-dealers' knowledge of the use and handling of a variety of agricultural inputs, thus enabling them to pass this knowledge on to farmers. The variables that record exposure to training, through number of sessions attended, and successful absorption of material, through the number of training sessions held by agro-dealers for farmers, should positively impact inputs supplied by the dealers and those adopted by the farmers. There will also be an increase in crop production, yield and welfare of farmers.

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Appendix 4: Informative tables and figures

Table A 39 Villages in study area with number of households listed

Village Name	HHs	Village Name	HHs	Village Name	HHs	Village Name	HHs
Adarawa	12	Djankaya2	47	Kanagani	217	Salewa 2	216
Affadekou	73	Dodo	175	Kandoussa	12	Saoulawa	52
Albaza	72	Dougouna	132	Kantche	346	Soro Daya	85
Allah Karabo	11	Douma	2	Kanya Magassa	62	Soura saraki	157
Angoual Manda	180	Dounkoula	143	Katanbague	55	Soura sarkin gaima	95
Angouwal Gamji 2	98	Faki1	310	Katare Dan Damaou	59	Takassaba	92
Ara Saboua	307	Faki2	130	Kegel	151	Takeita	217
Arifadi	76	Gada	238	Koci	60	Tarna	12
B Boulama	138	Gafati	287	Kodaou	117	Tchintchindi	184
B Chinsari	280	Galawa	147	Kodrawa	45	Tibiri (Soura Magagui Rogo)	96
B Galadima	174	Galmi	147	Koloma Dabagui	217	Tirmini	328
B Kadri	149	Gamba	134	Korin Galadima	84	Toundoun Elhadge	10
Baban Tapki	330	Gamgi	94	Korin Mirni	162	Tounfafi	328
Babul	152	Gamgi Saboua	37	Kotar	203	Tsernaoua Nadabar	163
Baka Tshomou	145	Gangara1	179	Koumshi	66	Tseydawa	47
Bakawa	127	Gangara2	170	Koundoumawa	576	Tshaounawa	69
Bamo	92	Gangar	63	Kourmawa	127	Tsouloulou	116
Bande	365	Garagoumsa	249	Languiwa	98	Yan Kouble	132
Bargaza	146	Gari Jari	108	Madarounfa secteur3'	93	madaoua (djamoul)	219
Bargouma	187	Garin Daoudou	209	Madarounfa secteur5'	55	sagouma	252
Batatsira	39	Garin Daour	85	Madateye	149	Salewa 2	216
Bazaga	191	Garin Malam Gamdji	123	Mahalba	36	Saoulawa	52
Bilmari Marafa	221	Garin Mama	68	Maizama	104	Soro Daya	85
Bini	83	Gigani 1	74	Malamawa et Wandaka	263	Soura saraki	157
Cerassa	153	Gigani 2	76	Matshchi	283	Soura sarkin gaima	95
Dadin Sarki	268	Giudan karo	259	May Tchibi et Kor	195	Takassaba	92
Dakache	12	Godo	205	May gean Guero	178	Takeita	217
Dakora Forage	120	Goumbi	383	Maza Da Jika	71	Tarna	12
Dan Belbellou	12	Goumda Gado	74	Maza Tshaye	35	Tchintchindi	184
Dan Gado	166	Gounda Tambari	103	Meto	100	Tibiri (Soura Magagui Rogo)	96
Dan Hako	22	Goure	145	Middick	354	Tirmini	328
Dan Kada	71	Gr Quartier Chateau 2,3,4'	163	Minari	105	Toundoun Elhadge	10
Dan Kire	75	Guidan Moudi	55	Nadara 2	356	Tounfafi	328
Dan Makaou	144	Guidan Tagno	151	Nakonni	81	Tsernaoua Nadabar	163
Daouche	586	Guidan hako	499	Natay	60	Tseydawa	47
Dasga	85	Jiratawa	87	Radhi	176	Tshaounawa	69

Village Name	HHs	Village Name	HHs	Village Name	HHs	Village Name	HHs
Dhan Madhaci	12	Ka Tare Garin Ousman	12	Sabon Gari	140	Tsouloulou	116
Dhoga Haoussa	39	Kabra	123	Sabon Gari Kolt (Kirya)	147	Yan Kouble	132
Dinji	41	Kach Fawa	203	Saddakaram	160	madaoua (djamoul)	219
Djan Bali	71	Kagna Mallam Gadja	194	Saho oubandawaki	254	sagouma	252
Djankaya1	47	Kagna Waziri	209	Salewa 1	170		

Table A 40 Agro-dealers by Region and Treatment Arm

Treatment Arms	Maradi	Tahoua	Zinder	Total
Training Only	18	9	20	47
Training plus Demonstration Plots	19	10	20	49
Control	17	9	20	46
Total	56	28	60	142

Source: ISSER/INRAN Field Data 2015 and 2016

Table A 41 Sample size and implied power of the tests of main hypotheses

Intra-Cluster Correlation	Number of Clusters per Treatment Arm	Number of Farmers per Cluster	Effect Size	Power	Total Number of Treatment Arms	Sample Size
0.15	40	10	0.1	0.15	3	1200
0.15	40	10	0.15	0.278	3	1200
0.15	40	10	0.25	0.625	3	1200
0.15	40	10	0.3	0.79	3	1200
0.15	40	14	0.1	0.163	3	1680
0.15	40	14	0.15	0.303	3	1680
0.15	40	14	0.25	0.675	3	1680
0.15	40	14	0.3	0.823	3	1680
0.1	40	10	0.1	0.178	3	1200
0.1	40	10	0.15	0.33	3	1200
0.1	40	10	0.25	0.719	3	1200
0.1	40	10	0.3	0.861	3	1200
0.1	40	14	0.1	0.193	3	1680
0.1	40	14	0.15	0.374	3	1680
0.1	40	14	0.25	0.779	3	1680
0.1	40	14	0.3	0.9	3	1680

Source: Compiled by the Authors from estimates using Optimal Design.

Table A 42 Summary of Actual Outcomes

Target Outcome	Actual Outcome
Creation of a directory of agro-dealers	This has been done and the agro-dealer positions mapped in all three regions
Training of agro-dealers in input technology and business. The target was 450	By Year 3, the target had been exceeded: Year 1 – 115; Year 2 – 246; Year 3 – 473;
The transfer of technology through demonstration plots. The target was 70 across the three regions	75 demonstration plots were established
Increase the Volume of seeds sold. The target was a 25% increase in volume	The volume of seeds sold increased from 700 MT in 2014 to over 1200 MT in 2015
Organization of Farmer Field days	6 farmer field days were organized yearly with more than 300 participants
Improved Access of agro-dealers to Credit	This has not happened due to both demand and supply side challenges. Financial Institutions are reluctant to provide credit due to the lack of guarantee from the agro-dealers. Agro-dealers for various reasons preferred other sources of finance.

Source: Compiled from a CEB Report

Figure A 1 Distribution of Sample by Region and Treatment

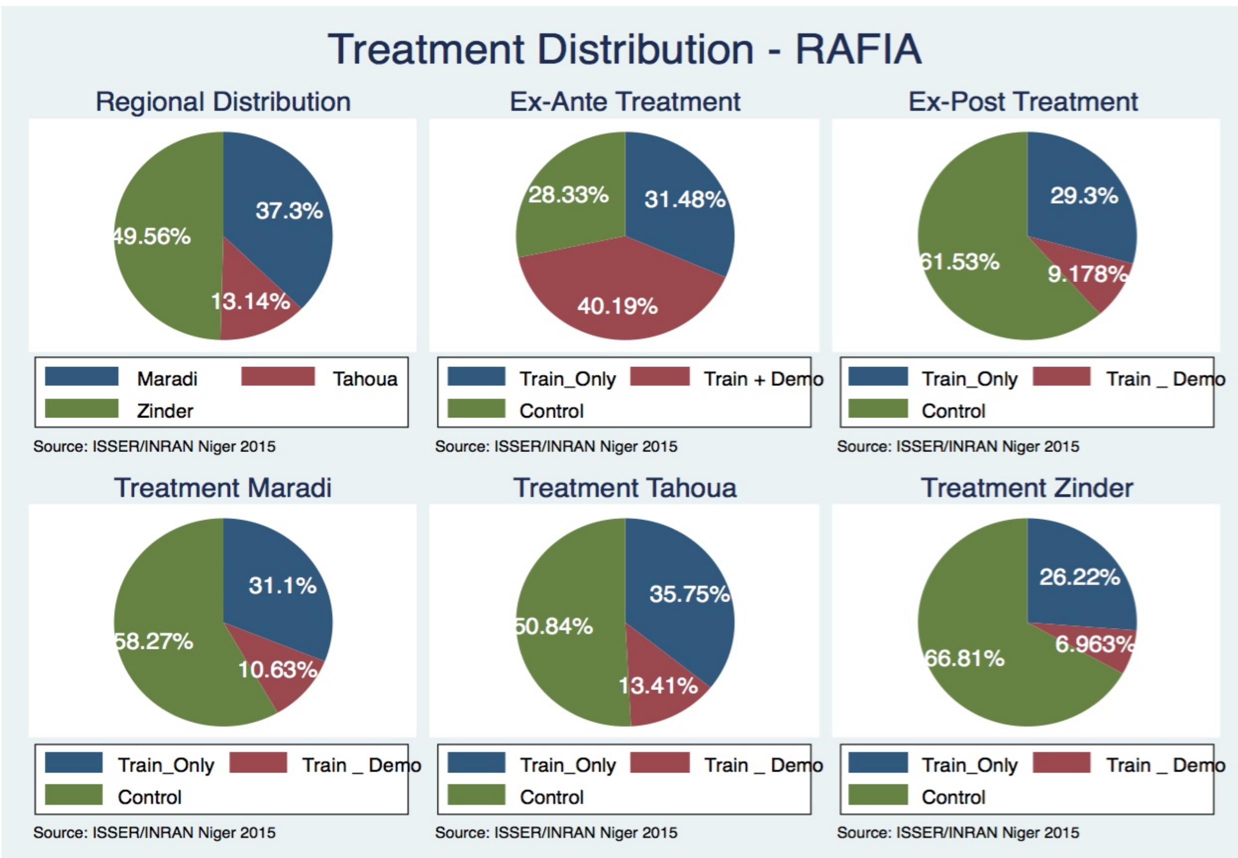

Table A 43 Variables and their Definition – Outcome Variables of Interest

Variable	Description
Crploss	% pre-harvest crop losses
Dcrploss	First differenced pre-harvest crop losses
Yield	Crop yields measured in Kg/Ha
Dyield	First differenced crop yields
Chem	Dummy=1 for chemical use by farmer
Dchem	First differenced chemical use
fert	Dummy=1 for fertilizer use by farmer
dfert	First differenced fertilizer use
chemexp	Chemical expense per household in US$
Dchemexp	First differenced chemical expense
Fertexp	Fertilizer expense per household in uS$
Dfertexp	First differenced fertilizer expense
Chemqty	Quantity of all chemicals used by households in kilograms
Dchemqty	First differenced chemical quantity
Fertqty	Quantity of fertilizer used by households in kilograms
Dfertqty	First differenced fertilizer quantity
Imp	Dummy=1 if household has used improved seed for at least one crop; 0 if not
Dimp	First differenced improved seed use for all crops
Impmajor	Dummy=1 if household has used improved seed for at least one of 5 main cereals; 0 if not
Dimpmajor	First differenced improved seed use for 5 cereals
seedval	Expenditure on improved seeds for all crops in US$
Dseedval	First differenced expenditure on improved seeds for all crops
Seedvalmajor	Expenditure on improved seeds for all crops in US$
dseedvalmajor	First differenced expenditure on improved seeds for 5 cereals
Seedqty	Quantity of improved seeds used for all crops
Dseedqty	First differenced quantity on improved seeds for 5 cereals
Seedqtymajor	Quantity of improved seeds used for 5 main cereals
dseedqtymajor	First differenced expenditure on improved seeds for 5 cereals
Swmt	Dummy=1 if household practices at least one swmt method
Dswmt	First difference of swmt use

Source: Authors

Table A 44 Variables and their Definition – Other Variables

Variable	Description
training_demo	Dummy=1 for farm households in the training plus demonstration treatment group
training_only	Dummy=1 for farm households in the training only treatment group
Training_Only	Dummy=1 for farm households in the ex-ante treatment group for training only
Training_Demo	Dummy=1 for farm households in the ex-ante treatment group for training only
TFertsold_ton	Quantity of fertilizer sold by agro-dealer
empl_size	Number of employees of agro-dealers
Year_bus	Year in which agro-dealer business started
Fertsup_dum	Dummy=1 if agro-dealers sold fertilizer
Training_dum	Dummy=1 for agro-dealers that received training
Credit_dum	Dummy=1 for agro-dealers that accessed credit
Agassoc_dum	Dummy=1 for agro-dealers that are members of agro-dealer associations
Reg_dum1	Dummy=1 for farm households in Maradi
Reg_dum2	Dummy=2 for farm households in Tahoua
Red_dum3	Dummy=3 for farm households in Zinder
Hhage	Age of household head
hhage2	Age of household head (squared)
Hhsex	Dummy for sex of household head (1=male)
Hhsize	Household size; number of members
Hheduc	Dummy=1 if household head has received some education.
Time	Time dummy 1=Endline 0=Baseline
Agdealercode	Agro-dealer identifier

Source: Authors

Appendix 5: Diff-in-Diff Estimations – Original Approach

Our original estimation was to follows the standard approach (Wooldridge, 2006, p-458) used for the difference-in-difference estimator by specifying a regression model such as:

$$y_{it} = \alpha + \beta_1 T_t + \beta_2 D_i + \beta_3 T_t D_i + \mu_i + \varepsilon_{it} \qquad (7.1)$$

Where,

- Y_{it} is our variable of interest (yields, seed use etc.) for household *i* at time t (t=1,2),
- T_t is a binary variable which takes the value of 0 in the base year and 1 in the follow-up period
- D_i is a binary variable which takes the value of 0 if individual is in the control group (late training) and 1 if in the treatment group (early training)
- $T_t D_i$ is an interactive term captured as the product of D_i and T_i . The coefficient of this interactive variable is essentially the difference-in-difference estimator
- μ_i and ε_{it} are respectively the unobserved individual effect and the random terms

Based on Equation (7.1), the difference-in-difference estimator is obtained in two stages. First, one takes the difference between the treatment and control respectively for baseline and endline periods. At the second stage, the difference between periods endline and baseline of the treatment-control differences is obtained. This can be represented as;

$$\hat{\beta}_3 = (\hat{y}_{2,T} - \hat{y}_{2,C}) - (\hat{y}_{1,T} - \hat{y}_{1,C}) \qquad (7.2)$$

An important merit of estimating the difference-in-difference model using Equation 7.1 is that it allows us to include control factors in the estimation – i.e. both time-varying and time-invariant factors within the treatment and control groups (Angrist & Pischke, 2008). The opportunity to employ different individual and group behavioural characteristics (including say gender of the farmer and region) and other dummy variables for the different cohorts in the model permits the evaluation of the differential impact of the interventions with respect to these groups.

In essence the estimation of the hypotheses 1 and 2 (as per Section 2) are essentially a test for the β_3 coefficient in Equation 7.1 for the variables of interest shown. In the case of hypothesis 1, our $D_{i,1}$ is the training only treatment dummy. For hypothesis 2, the $D_{i,2}$ is a training and demonstration plot treatment dummy. For hypothesis 3, we estimate a generalised form of Equation 7.1 which allows both treatment arms to be estimated in the same equation (see Glennerster & Takavarasha, 2013). We therefore estimate the equation:

$$y_{itd} = \alpha + \beta_1 T_t + \beta_2 D_{i1} + \beta_3 T_t D_{i1} + \delta_1 D_{i2} + \delta_2 T_t D_{i2} + \mu_{id} + \varepsilon_{itd} \qquad (7.3)$$

In this equation both treatment terms (D_1 and D_2) are present and so the difference-in-difference estimator for training only (D_1) and also training and demonstration plot (D_2) under hypotheses 1 and 2 are respectively obtained as;

$$\hat{\beta}_3 = (\hat{y}_{2,T,\mathbf{1}} - \hat{y}_{2,C,\mathbf{1}}) - (\hat{y}_{1,T,\mathbf{1}} - \hat{y}_{1,C,\mathbf{1}}) \qquad (7.4)$$

$$\hat{\delta}_2 = (\hat{y}_{2,T,\mathbf{2}} - \hat{y}_{2,C,\mathbf{2}}) - (\hat{y}_{1,T,\mathbf{2}} - \hat{y}_{1,C,\mathbf{2}}) \qquad (7.5)$$

Based on our parameter estimates from Equation 7.3, we can therefore test hypothesis 3 as a one-tailed test of $\delta_2 > \beta_3$.

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