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Impact of Reinforcing Agro Dealer Networks on Agricultural Productivity in Niger

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Abstract

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, due largely to poor soil quality and arid climate conditions. Input-use 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 to train agro-dealers in three regions in Niger namely, Maradi, Tahoua and Zinder. This study sought to evaluates the effect 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 looked at the performance of two treatment groups, who received training only or training plus demonstration, randomly assigned to agro-dealers. Though the design of the study followed a randomized phased-in approach and an IV approach in estimating the impact. The main findings of the study were Training plus demonstration plots increased adoption of improved seed, showing the added value of the demonstration component in the intervention, in encouraging seed use.

Introduction

In most sub-Saharan Africa countries, there is limited use of agricultural inputs by smallholder farmers even though there is empirical evidence of the benefits of its use. 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 1.1 kg per hectare compared to the already low West African average of about 16 kg per hectare (World Bank, 2016). 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 information on input markets and access to credit. Finally, farmer organizations are generally weak, and are therefore unable to mobilize and overcome some of the bottlenecks that farmers face.

Some have argued that factors affecting adoption be studied a bit more carefully as they can be very complex (Feder, 1985). The literature also points to the fact that programs that target farmers directly have had some impact on their incomes (Quinones, 1997). For instance, farmer training in farm management and technologies have recorded significant increases in farm income and profits for treated groups (Kilpatrick, 1996). 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 experiences 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 (Kelly, 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 this study, we analyze the impact of the 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 whether strengthening agro-dealers' capacity to supply agricultural inputs will improve smallholder farmers' access to, and use of, agricultural inputs? It sought to test three broad hypotheses:

- H1: Training of agro-dealers will improve smallholder farmers' adaption and use of agricultural inputs;
- H2: Training of agro-dealers will impact positively on smallholder farmers yields and reduce losses from farm crops;
- 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.

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

We followed the standard approach (Wooldridge, J. M., 2006) of difference in-difference estimator to analyses our hypothesis.

Material and methodology

Presentation of the study area

The proposed project, which forms the basis of this evaluation, was planned to cover three regions in the east side of Niger Republic namely Maradi, Tahoua and Zinder. In these three regions, 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 mainly sheep, goats and cattle. These three regions fall within two ecological zones: The Sudan Savanna ecological zone 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 move northward; with only 600 mm. 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. 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, 2002).

Programme methods and implementation

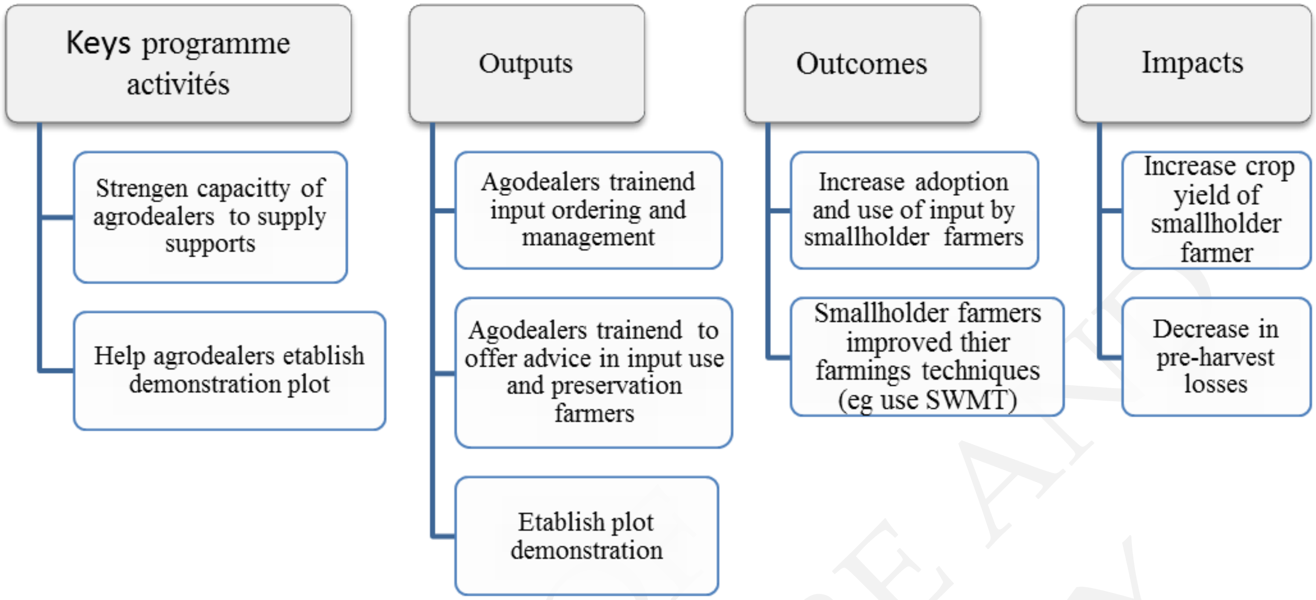
The programme mains methods were training agro-dealers, extension agents in many fields to improve their competencies in terms of inputs use demand and its distribution; and strengthening agro dealers associations. Training was offered in technical competence and business skills development. Technical 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. It concerns trainings in field with plots demonstration and in classroom trainings.

Demonstration plots are constructed and used as tools for technology transfer, as well as the proper location for these plots. 75 plots demonstrations (Maradi 24, Tahoua 24 and Zinder 27) were established by agro-dealers with the collaborating extension agents as part of the training. Demonstrations plots were used to show farmers the superiority of the proposed innovation (fertilizer, seed and pesticides use and application) compared to their traditional farm practices. Field days were also organized to exchange ideas with other farmers to create awareness and improve farmer demand for inputs.

A total of 125 agro-dealers were trained at workshops (Classroom training). They 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. This was to help equip agro-dealers with the ability to act as advisory agents for farmers.

Theory of Change

Most literature has detailed the structure and importance of a theory of change approach to comprehensive community initiative evaluation. Theory of change 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. This particular study meets the necessary criteria for a well-conducted theory of change (Connell & Kubisch, 1998). The implicit theory of change 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. This has higher direct impact with farmers.



Assumptions

1. Agrodealers will increase investments in their business
2. Agrodealers will engage more with smallholder farmers and will in turn be visited by the representative smallholder farmer
3. Agrodealers have a real need for training
4. Change in output dose not lead to significant price changes

Threats

1. The government intensifies its programme of supplying subsidized agriculture inputs
2. The untimely availability of inputs from agro-dealers
3. The supply of inputs from agro-dealers is inadequate to meet demand
4. Niger is prone to draught and this might affect outcomes

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

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

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.

Simple 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 A41. We note that based on an intracluster 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 "Contribution à l'Education de Base" 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.

Evaluation design, methods and implementation

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. These three treatment arms included the following:

T(0) –Pure control were supposed to get neither the training nor the demonstration plots in year1;

T(1) – Selected agro dealers were to get only training in year 1;

T(2) –Selected agro dealers were to get training and also set up a demonstration plot in year1.

The randomization essentially followed the stages of the design. At the first stage we obtained a list of 144 agro-dealers. 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 A40. The random assignment was done using Stata software. At the second stage we listed households in 142 villages in the three regions and we randomly selected 12 households (plus 3 as replacement) from each of the village. 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. In total, therefore, the study planned to interview 1704 farming households.

The study utilized both qualitative and quantitative research methods. We employed the qualitative method to enhance our understanding of the peculiar context of the impact evaluation. The quantitative survey instruments for the endline survey benefited from the qualitative component of the impact evaluation. A total of six focus group discussions for farmers in the 3 regions and one for Agro-input dealers were undertaken.

Survey Methodology

The sampling for the quantitative study followed the study design and was therefore centered around the agro-dealers. Using the agro-dealer list, the researchers targeted the communities that the agro-dealers had given as their base of operation. The agro-dealer data obtained was stratified by region. The region therefore formed the stratifying variable used for the sampling. After selecting the agrodealers (and therefore the villages) we then undertook a listing of households in the communities. Using 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.

Data Collection was done in two main sets – quantitative and qualitative data. Quantitative data was collected over two waves with structured questionnaire – a baseline in March 2015 and a follow-up in May 2016 – one year after. The baseline data collection was undertaken in March 2015 whilst that for the endline was in May 2016. The survey instrument used focused on the farming activity of farmers in the village in which the agro-dealers operate. Although some household information's 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.

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 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

Clearly the implementer had not followed strictly the assignments as agreed. 2SLS instrumental variables (IV) approach was used to estimate the impact. Other agro-dealer characteristics were included to account for the non-adherence.

Estimation approach

The high degree of contamination meant that the benefits of randomization were lost and the intentions 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 IV 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;

$$DD_{ii}^{pppppppp} = \alpha\alpha + \vartheta\vartheta_1 DD_{ii}^{aaaappaa} + \omega\omega_{ii} \qquad (7.1)$$

Where,

- $DD_{ii}^{pppppppp}$ is our ex-post treatment variable with the value of 0 if control and 1 if training was received,
- $DD_{ii}^{aaaappaa}$ is our ex-ante treatment variable with the value of 0 if control and 1 if training was assigned,
- $\vartheta\vartheta_1$ is the co-efficient measuring the effect of the ex-ante assignment on the likelihood of being treated ex-post
- $\omega\omega_{ii}$ 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;

$$yy_{ii} = \alpha\alpha + \gamma\gamma_1 DD_{ii}^{pppppppp} + \mu\mu_{ii} \qquad (7.2)$$

Where,

- yy_{ii} is the indicator of interest, i.e. impact and outcome variables,
- $DD_{ii}^{pppppppp}$ is the fitted values of the ex-post treatment following the first stage,
- $\gamma\gamma_1$ is the co-efficient measuring impact of the ex-post treatment on the indicator of interest.
- $\mu\mu_{ii}$ 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 (Angrist & Pischke, 2008).

The estimation of the hypotheses 1 and 2 are essentially a test for the γ_1 coefficient in Equation 7.1 for the variables of interest shown in Table A43 and Table A44. 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 (Glennerster & Takavarasha, 2013). We therefore estimate the equation:

$$y_{ipi} = \alpha + \beta_1 D_{i1} + \delta_1 D_{i2} + \mu_{ii} + \varepsilon_{ipi} \qquad (7.3)$$

Where,

- y_{ipi} 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_{ii} and ε_{ipi} 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, R. & Takavarasha, K., 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 (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 agrodealers. 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 (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.

Results

Sample Characteristics and balance test

Sample characteristics

The farm households studied were sampled from the three regions Maradi, Tahoua and Zinder (Table A1). 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 A1).

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 A1).

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 (Table A1).

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

$$YY_{ii} = \alpha\alpha + \rho\rho_1 DD1 + \varepsilon\varepsilon_{ii} \tag{7.4}$$

$$YY_{ii} = \alpha\alpha + \rho\rho_2 DD2 + \varepsilon\varepsilon_{ii} \tag{7.5}$$

$$YY_{ii} = \alpha\alpha + \rho\rho_3 DD3 + \varepsilon\varepsilon_{ii} \tag{7.6}$$

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: $\varrho_1 \neq 0$,

H^2_0: ϱ_2 =0 ; against

H^2_1: $\varrho_2 \neq 0$,

H^2_0: ϱ_3 =0 ; against

H^2_1: $\varrho_3 \neq 0$,

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 (Table A1).

Outcome Indicators

The outcome indicators are those that capture the behaviour of the households 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.

Impact Indicators

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 A1).

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.

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.

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 T0 group) and spent about US$ 2.92 per household on the inputs (Table A1). 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 A5, 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 A6).

Chemical 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-dealer 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 A9 and Table A15. 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 A11 and Table A17).

In Table A13 and Table A19 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.

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 A21 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.

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

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 A23 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 A23).

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 A25).

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.

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 A3). 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.

Other indicators

As with training only, training plus demonstration plot did not significantly impact on chemical or inorganic (Table A9 and Table A15), on SWMT (Table A21) and on crop yields (Table A23) and on pre-harvest losses (table A25).

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. 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.

Improved seed use

In Table A27, 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 A3). 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.

Others indicators

Our results show that training plus demonstration did not impact on uptake of chemical (or indeed fertilizer) use by farmers (Table A30 and Table A31). However, we do find some evidence of the demonstration plot effect being significant at 5% in one of the fertilizer equation. There is also no recorded impact of the training and demonstration (Table A36).

The results show that for both training and also training with demonstration, the impact is not significantly different from zero (Table A23 and Table A37) for crop yield. Our results show no significant impact of agro-dealer training and demonstration plots on pre-harvest crop losses reported by farmers (Table A38).

Discussion

Contamination and Attrition

We noted 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 nonadherence 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

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.

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 & al., 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.

Conclusion

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 agrodealers. 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.

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Appendices

Appendix 1: Tables with results

Table A 1 Balance test results for indicators of interest

	Ex-Ante Treatment							Ex-Post Treatment						
Indicators	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

Results for Hypothesis 1

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	30.9					

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 uantity. 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
Train ing_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
Train ing_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)			
Train ing_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
Train ing_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)
Train ing_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: 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

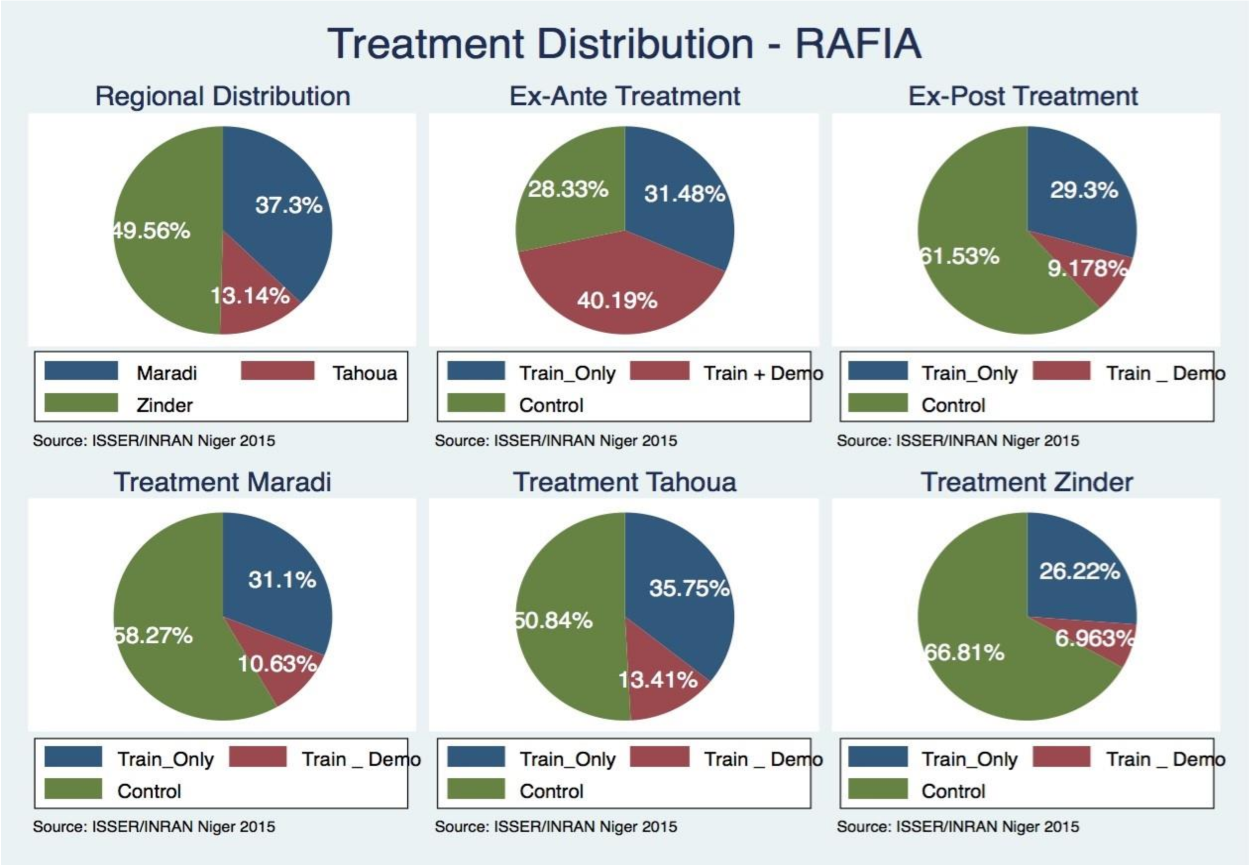

Table A 43 Variables and their Definition – Outcome Variables of Interest

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 3: 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;

$$\beta_3 = y_{2,T} - y_{2,C} - (y_{1,T} - y_{1,C}) \qquad (7.2)$$

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 generalized form of Equation 7.2 which allows both treatment arms to be estimated in the same equation (see Glennerster & Takavarasha, 2013). We therefore estimate the equation:

$$yyiippii = \alpha\alpha + \beta\beta 1 TTpp + \beta\beta 2 DDii1 + \beta\beta 3 TTppDDii1 + \delta\delta 1 DDii2 + \delta\delta 2 TTppDDii2 + \mu\mu iiii + \varepsilon\varepsilon iippii \quad (7.3)$$

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;

$$\beta\beta 3 = yy2,TT,\mathbf{11} - yy2,CC,\mathbf{11} - (yy1,TT,\mathbf{11} - yy1,CC,\mathbf{11}) \quad (7.4)$$

$$\delta\delta 2 = yy2,TT,\mathbf{22} - yy2,CC,\mathbf{22} - (yy1,TT,\mathbf{22} - yy1,CC,\mathbf{22}) \quad (7.5)$$

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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