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TITLE: IMPROVING FOOD SECURITY THROUGH THE INTRODUCTION OF NEW SEED VARIETIES

SUB-TITLE: WHICH MODALITIES ARE MOST COST-EFFFECTIVE IN PROMOTING USE OF NEW SEED VARIETIES IN UGANDA?

FINAL REPORT

ENDLINE REPORT:
DOES ESTABLISHMENT OF DEMONSTRATION PLOTS HAVE AN IMPACT ON FARMER'S AWARENESS, PERCEPTION AND USE OF IMPROVED MAIZE AND BEAN SEED

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ACRONYMS AND ABBREVIATIONS

AGRA	Alliance for a Green Revolution in Africa
CGIAR	Consultative Group on International Agricultural Research
FFS	Farmer Field Schools
IPW	Inverse Probability Weights
ICTs	Information and Communication Technologies
MAAIF	Ministry of Agriculture Animal Industry and Fisheries
MNCs	Multinational Companies
NAADS	National Agricultural Advisory Services
NARO	National Agricultural and Research Organization
NARS	Agricultural Research System
NGOs	Non-governmental Organizations
NSCS	National Seed Certification Service
NVRC	National Varieties Release Committee
ODK	Open Data Kit
PASS	Program for Africa's Seed Systems
PSL	Pearl Seeds Limited
RCT	Random Control Trial
SEPA	Seed Production for Africa Initiative
SMEs	Small and Medium Enterprises
SPSS	Statistical Package for Social Sciences
SSA	Sub-Saharan Africa
UBOS	Uganda Bureau of Statistics
UCA	Uganda Census of Agriculture
UNADA	Uganda National Agro-input Dealers Association
USP	Uganda Seed Project
USTA	Uganda Seed Traders Association

PLAIN LANGUAGE SUMMARY

The production and distribution of improved seed varieties that are adapted to local conditions, farmer awareness, access and use of the new improved locally adapted varieties are important prerequisites to attainment of high productivity in smallholder farms through crop improvement. In many SSA countries, seed delivery systems are poorly developed or are lacking. But even in countries where seed systems are relatively better developed, the uptake of new crop varieties is low, and it takes several years before smallholder farmers finally take them up, if at all. Agencies seeking to increase agricultural productivity through crop improvement often face challenges not only on how to increase smallholder farmers' uptake of improved varieties, but also how to speed up the adoption process amongst those farmers, including women farmers. Though multiple methods are used by private seed companies, government, and non-governmental agencies to promote seed of new crop varieties by creating awareness and promoting them, adoption studies show that many farmers in sub-Saharan Africa are not using such improved varieties or certified seed.

Demonstration plots and field days are almost always among methods used by seed companies and other players in the seed industry to create awareness and promote improved seed varieties. For example, all proposals that were submitted to the Alliance for a green revolution in Africa (AGRA) PASS programme between 2007 and 2013, requesting funding for commercialization of improved varieties, included a component on seed dissemination through demonstration plots, field days and other promotion approaches. In addition to the support given to local seed companies, PASS programme also supported breeding programmes and development of agro-dealers with a view to increase the range of varieties that are locally adapted, and improve availability and farmer access to the improved seed. According to PASS programme's theory of change, the promotion campaign mounted by local seed companies raise farmers' awareness, and together with other interventions in the seed value chain, will increase farmers' use of the improved varieties being promoted, and subsequently increase crop productivity, production and income. In-spite of the consistent investment of resources to promote seed of improved varieties, there is scanty information on the effectiveness or cost-effectiveness of seed promotion methods. This study's contribution is to provide evidence on the effects of demonstration plots (and field days) on farmers' awareness and uptake of improved varieties, and impact on yields and production. The study team was privileged to have an opportunity to evaluate an on-going seed promotion campaign as implemented by a local seed company in the east and western regions of Uganda.

The promotion strategy comprised radio spot adverts and radio talk shows which were aired through regional radio stations in the study areas. In addition, the seed company established demonstration plots

and held field days in selected areas that had been randomly assigned to a treatment group. Upon maturity of the crop, the seed company hosted farmers, extension agents and agro-dealers at the demo sites during a field day where views and more information about the varieties was shared. The idea behind use of demonstration plots in promotion of improved seed is that, farmers are more likely to adopt a new variety after: observing and verifying its attributes and performance in a demonstration plot in their locality; comparing performance of the promoted variety with other varieties grown in neighbouring fields and on their own farms; and, receiving clarifying information during field days. The promotion continued in the same areas over four cropping seasons commencing in the second cropping season of 2014/15 and ending in the first cropping season of 2015/16. Monitoring data showed the success rate in establishment of demonstration plots was about 70 percent which is quite high given the challenges normally encountered by seed companies such as failure due to delayed or insufficient rains.

Demo plots are costly to establish and maintain and hence are normally established in selected areas, and consequently not all farmers have access to them. Farmers who have access to demos are believed to have an advantage over those who do not and are more likely to adopt a new improved variety being promoted including the recommended cultural practices. The evaluation study sought to establish the effectiveness of demonstration plots in influencing the adoption behavior of smallholder farmers, including women farmers. Changes in outcomes in the treatment areas were compared to changes in outcomes in control (control) areas. Data used were from two waves of household survey conducted by the evaluation team, where both household and individual level data were collected. The baseline was conducted at the onset of the promotion campaign and the endline two years after the promotion campaign had commenced. Tests for attrition bias were conducted for both household and individual levels, and from the results we concluded that the differential attrition had no effect on the estimated effects.

Initially, the evaluation was designed as a randomized control trial with sub-counties as the units of randomization. However, due to randomization failure, the treatment effects have been estimated using the inverse probability weighted (IPW) approach. The estimator uses inverse propensity sores for each observation as weights when estimating the average treatment effects. The IPW estimator has robust properties and yields consistent estimators when the either treatment or outcome model is correctly specified, thus providing two chances to make a valid inferences. Post weighting balance tests showed a reduction in the sample bias in the overall sample as well as in the different strata.

The findings show that as a result of the demos established and field days held, there was: greater awareness and more positive attitude towards improved seed in general; greater awareness and better perception on the maize variety promoted; a reduction in proportion purchasing and acreage planted with recycled (retained) maize and bean seed; an increase in the proportion purchasing and acreage planted

with unrecycled maize seed; an increase in maize yield, and as a result, the volume of maize produced. However the magnitude of the effects was small, and was mainly for improved maize varieties. There was a better attitude towards improved varieties of both maize and beans; better perception and knowledge about the maize variety being promoted, but not on the bean variety promoted. As a result of better attitude and perception, there was a greater proportion of farmers who purchased and planted the maize variety promoted, as well as the acreage planted with the variety. Consequently, the maize yields obtained were higher and so was the volume produced, but not for beans.

Exposure also caused other positive changes in farmers' behavior. It led to an increase in farmers' use of unrecycled improved maize seed, and a reduction in the use of recycled (retained) improved seed for both maize and beans. It also increased awareness and use of other improved varieties which had already been introduced to farmers earlier, implying that demos and field days tend to instill confidence among farmers in the improved varieties in general, and varieties that they are already exposed to but probably lacked adequate information.

The findings from a qualitative study undertaken at the endline, in villages where demo plots had been established show that farmers in the vicinity of demo sites were highly aware, but this only resulted to a marginal uptake of the promoted varieties. Reason being that though farmers had a positive perception of the varieties because of their positive attributes, the negative attributes deterred wider uptake. Farmers also found costs of adoption to be prohibitive, and saw no difference in performance when compared to their home saved seed, implying that if farmers do not seed the benefits in an improved variety they will not adopt it. The other reasons given for not planting the seed were that improved seeds are not available and accessible because they could only be found in major towns. Farmers who wished to plant the seed and were ready to travel to major towns to get it indicated the seed was not commonly found (that means like others..). Non-availability of the seed in agro-dealer shops in shopping centres nearest to farmers would have affected uptake because travelling cost and time are important constraints for the farmers. The agro-dealers on their part indicated the seed is normally supplied late, particularly in the second season, while the seed company indicated the promotion had not raised demand for the seed in the areas of study.

The findings suggest that demonstration plots can be effective in creating awareness and promoting improved crop varieties however, seed companies and other players in the seed industry need to factor in their limited reach when planning their promotion campaigns. Investment in knowing what the client (farmer and consumer) wants in terms of seed attributes, and reduce costs of seed to commensurate with the benefits and the level of small holder agricultural development in their region or countries. Generally, the seed industry needs to identify and invest in promotion approaches which are more effective in

creating awareness and knowledge about new improved crop varieties, quickly and widely among smallholder farmers.

I. INTRODUCTION

1.1 Background

Uganda's Seed Sector

Like other low income countries in sub-Saharan Africa (SSA), Uganda's agriculture sector[1] is dominated by subsistence farming using traditional methods and low input use. According to the Uganda Census of Agriculture (UCA), 2008/09, most farmers use local seed where 91.7% out of the 3.6 million agricultural households that responded during the census, reported to have used local seed during the reference period (2007), while 31% of the households reported to have used improved or hybrids during the same period. Like many other African countries, Uganda embraced liberalisation and privatization of the seed industry which resulted to a marked increase in private sector participation (there are up to 23 registered seed companies/merchants by 2016 (USTA website)). However, even after privatization of the Uganda Seed Project (USP) and subsequent liberalisation of the seed industry during the period from 1995- 1999, adoption of improved seed in Uganda is still low relative to adoption rates observed in neighbouring countries like Kenya. Besides, only 20% of maize area is under improved seed and most of which is recycled seed.

Research institutions through the National Agricultural and Research Organization (NARO) conduct research and release improved seed varieties, while private companies undertake all aspects of seed production, promotion and marketing. According to PASS program reports (2011), in sub-Saharan Africa, marketing and promotion activities by seed companies are limited and largely restricted to multinational companies (MNCs) and larger small and medium enterprises (SMEs) with proprietary cultivars. The remaining SMEs multiply and market similar public sector varieties and hence gain little advantage in promotion. Consequently, the public-domain varieties, which constitute the bulk of certified seed production, receive little or no active promotion by those with direct interests in their adoption and sale. In Uganda, the limited marketing and promotion of seed is largely by third parties (National Agricultural Advisory Services (NAADS), NGOs, Uganda National Agro-input Dealers Association (UNADA)) who conduct demonstrations and establish multiplication plots, however, these efforts are limited and localised. The government is quite involved in dissemination and distribution of improved varieties released by the public sector. Since 2014, the army has been charged with monitoring and distribution of

[1]Agriculture is the mainstay of the Ugandan economy contributing 43% of the GDP. The agriculture sector employs 75% of the labour force and 80% of the population resides in rural areas.

inputs like seed, while NAADS's secretariat is tasked with projecting demand in the districts, verification of the seed supplied and payment of contracted suppliers. The involvement of the military in provision of advisory services has however been widely criticised by stakeholders as not being appropriate for agricultural extension (Kyambadde, 2014).

AGRA'S PASS Program

Only 25% of farmers in SSA use high yielding locally adapted seed and AGRA's Program for Africa's Seed Systems (PASS) committed itself to support improvement of seed and work to ensure that improved crop varieties get to farmers (2013 annual report by AGRA). The goal of PASS was to increase yields through an integrated program that cut across the seed value chain, from capacity building in crop breeding and seed production to having adequate quantities of preferred seed in agro-dealer shops. Most of the program's efforts were aimed at breeding, release of varieties, multiplication, quality control, production and distribution through expansion of the agro-dealer capacity and network. The programme: coordinated with the CGIAR system to rapidly disseminate existing improved seed varieties; fostered the development of a vibrant, competitive seed sector; supported the development of national agro-dealer networks- village retailers who get farm inputs to remote farmers, amongst others. The Program was organized into four sub-programs:

- Education for African Crop Improvement (EACI) which provided funding for the training of new generation of crop breeders and agricultural scientists
- Fund for the Improvement and Adoption of African Crops (FIAAC) which funded crop breeding in Africa to improve African crop varieties and promote their adoption by smallholder farmers.
- Seed Production for Africa (SEPA) which helped ensure that the improved crop varieties are produced and distributed through private and public channels (including seed companies, publicly-supported seed programs and public extension) so that farmers can adopt these varieties.
- Agro-Dealer Development Program (ADP) which provided training and credit to establish and support the growth of small agro-dealers, who are a primary conduit of seeds, fertilizers, and knowledge on their proper use, to smallholder farmers

In its theory of change, the program identified lack of information as one of the key barriers to agricultural technology adoption (Appendix Figure 1). Creating awareness amongst farmers and promoting the new seed varieties was therefore part and parcel of the programme's efforts to increase the proportion of smallholder farmers who adopt and benefit from the new crop varieties. Between 2007 and 2016, AGRA's PASS programme provided grants to national and local seed companies to support production, distribution and promotion of new seed varieties in their respective countries. No rigorous

evaluation of the impact of this programme or its components has been previously conducted. This study therefore sought to use rigorous amethods to evaluate the impact of the approaches commonly used by local seed companies to raise awareness and promote newly released varieties.

1.2 Review of approaches used to reach farmers with improved seed and other technologies

Agricultural extension officers are relied upon to disseminate information to farmers with a view to increase general awareness of new and improved farming methods. Farmer trainings, farm visits and agricultural shows are the approaches commonly used by the extension agents, with such visits and trainings focusing more on crop production than livestock production (Musa, 2013). However, this approach is curtailed by high transportation costs and poor infrastructure which make it difficult to reach farmers in remote areas. Moreover, dissemination of information has been limited by non-participation of many farmers in the training and visit (T&V) programs (Adeola, 2005). Farmer-to-farmer approaches are also in disseminating information about new technologies, and increasingly, lead farmers are also being used to disseminate information such as the case in Malawi (Khaila, et al., 2015). Lead farmers who are relatively young train other farmers, provide advice and monitor how other farmers use technologies being promoted. The approach is preferred because many farmers are reached at a lower cost, and the lead farmers are highly trusted by the target farmers. Farmers who have the same conditions as the target farmers in terms of land size and input use are said to be most influential to the target farmers on their rate of adoption behavior (BenYishay & Mobarak, 2013). More modern approaches that use information and communication technologies (ICTs) are increasingly being used in dissemination of agricultural information (Zhang, Wang & Duan, 2016). Using their mobile phones, farmers are able to access information about inputs availability and market information without travelling long distances to the physical offices. The most commonly used ICT methods are web portals e.g. M-Farm, call centres and use of text messages (SMS) and mobile internet based price information (Munsaka, 2010 and Solon, 2013). The effectiveness of these methods is constrained by limited access to internet, computers and mobile phones, particularly in poor rural households. While some studies show farmer field schools (FFS) to have positively impacted production and income (Davis et al., 2012; Friis-Hansen & Duveskog, 2012; Kabir & Uphoff, 2007; Van den Berg & Jiggins, 2007), some studies found there was no productivity improvement in Ethiopia where FFS was a leading extension method (Waddington et al., 2014). The mass media, print media, opinion leaders and extension workers are used to create awareness and disseminate new agricultural technologies (Ghatak, 2010; Mgbakor, Iyobor, & Okezie, 2013; Nazari & Hasbullah, 2010). Demonstration plots and field days are preferred because they create awareness about modern technologies but also motivate farmers to apply such technologies in their farms (Khan, Pervaiz, Khan, Ahmad, & Nigar, 2009; Kondylis & Mueller, 2010).

There are a number of studies which have focused on the effectiveness of demonstration plots (Khan et al., 2009) and field days (Amudavi et al., 2009; Carolan, 2008; Heiniger, Havlin, Crouse, Kvien, & Knowles, 2002), with mixed results on the effectiveness of demonstration plots. Some have found that demos were successful due to their practicability which made the practice easy to understand (Khan, Pervaiz, Khan, Ahmad, & Nigar, 2009; Kondylis & Mueller, 2010). While Kondylis & Mueller, 2012 found them to be more effective to a smaller group of people (mainly women) compared to the community as a whole. Field days were found to be effective in dissemination of information and adoption of a new technology because they reach a large number (Amudavi et al., 2009). They also suggest that field days should have an objective which is well defined and meet the needs of the targeted sample (Carolan, 2008), and well organised in order to meet the objective and to be effective in information delivery.

Rationale and objectives of the evaluation

Many efforts that are aimed at enhancing adoption of new varieties are not always supported with evidence on the effectiveness of methods used. A report by the independent science and partnership council of the CGIAR described the situation in awareness creation and seed promotion as follows: '*the likely effectiveness of measures employed to enhance farmer awareness and access to seed are vague and their likely effects questionable*'. Our review of proposals submitted in request for AGRA grants by various seed companies during the period 2007 to 2013 revealed that, a variety of methods are being used to raise awareness and promote new improved seed varieties, including mass media (radio, pamphlets, and fairs/shows), demonstration plots, field days and farmer field schools. Most players who are involved in dissemination or distribution of improved seed always establish demonstration plots so that farmers can verify the information on attributes and performance of the crop variety being promoted, and thereby increase uptake. This study provides evidence on the effectiveness of this commonly used method in increasing farmers' awareness and uptake of two relatively new varieties. The evaluation was of an on-going seed promotion campaign as implemented by a local seed company in the east and western regions of Uganda.

II. THE INTERVENTION, THEORY OF CHANGE AND HYPOTHESES

In its theory of change, the PASS program identifies lack of awareness about new seed of improved crop varieties, their attributes and availability as key barriers to adoption of locally adapted seed varieties. Creating awareness and increasing knowledge on new seed varieties amongst farmers through demonstration plots, field days and radio shows was, therefore, part and parcel of their strategy for increasing the proportion of smallholder farmers who adopt locally adapted new varieties of staple crops, for their benefit. The benefits include improved food security and increased household income (Appendix

Figure 1) from increased production. Therefore, over the years, AGRA's PASS programme has been supporting national and local seed companies to produce/multiply, distribute and promote new seed varieties in their respective countries. In its second phase (2012-2017), the PASS program placed an even great emphasis on the seed production and enhancement of farmer accessibility to improved seed, and pledged to help ensure that improved crop varieties were produced and distributed through private and public channels (including seed companies, publicly-supported seed projects, and public extension) so that smallholder farmers can adopt the varieties (PASS Annual Reports, 2012 to 2017). Increased access and availability of seed for improved crop varieties to smallholder farmers was assured through another sub-programme under PASS (agro-dealer development programme), which supported growth of small agro-dealers (training and credit), who are a primary conduit of seeds and other inputs like fertilizers and knowledge on their proper use. Through another sub-programme (FIAAC), PASS funded crop breeding in Africa with a view to improve African crop varieties and promote their adoption by smallholder farmers. In turn, these released improved varieties would reach the smallholder farmer through the activities of seed companies and agro-dealers.

This section discusses the intended outputs, short and intermediate outcomes, and impact as envisioned by AGRA's PASS programme:

Outputs:

i) increased awareness of improved crop varieties
ii) increased awareness of attributes of the improved crop varieties
iii) improved awareness of the availability of the improved crop varieties
iv) agro-dealers established
v) agro-dealers strengthened to deliver seed of improved crop varieties

Some of the important assumptions made by the programme include: the seed company has the capacity to roll out the promotion campaign according to plan and to monitor the seed promotion activities; funds for promotion campaign are adequate and availed on time; the promotion campaign (intervention) is successful; there is adequate and sustained demand for inputs from agro-dealer shops which have been established; agro-dealers access the support services needed to sustain seed and other input business; and, the seed quality control system works well.

Short-term Outcomes:

i) Increased knowledge of attributes of improved crop varieties
ii) Improved behavior towards locally adapted new varieties of staples

iii) Improved access to seed for the improved crop varieties for smallholder farmers

To realise the short-term outcomes, the important assumptions made included: the attributes of the new variety meet the needs of farmers hence farmers would prefer them; the agro-dealers are willing to stock the crop variety being promoted, and are in close proximity to the farmers; and, adequate the new crop varietie are available at the agro-dealer shops.

Intermediate Outcomes:

i) Increased adoption of locally adapted new crop varieties by small holder farmers

The programme assumptions to achieve these outcomes: the seed is available and is of high quality; farmers find the seed affordable and are willing to pay the selling price; farmers are willing to replace the old variety with the new one or have adequate land to increase acreage under the crop; and, farmers' knowledge about improved seed reaches a threshold which enables them to make a decision.

Impact:

i) improvement in smallholder income and
ii) improvement in household's food security

To move from the intermediate outcome to an impact at the household several conditions need to apply: the correct agronomic practices in crop production are used; the output markets function well; farmers have easy access to markets (low transaction costs); agro-dealers access the support services needed to sustain seed and other input business; there is adequate and sustained demand for inputs from agro-dealer shops which have been established; and, the quality control system is in place and functional.

Description of a typical seed promotion campaign

The seed company sponsors radio spot adverts which are aired through regional radio stations. The content of the advert is created by the seed company and includes attributes and performance of the variety and where it can be purchased. The spot adverts are aired during the growing season, but ideally in the planting period when farmers are making decisions about where to source seed from. The company also holds an hour long radio talk show. The company representative and agro-dealers who sell the variety being promoted participate in the show. Ideally the talk show is held on the day before the field day since it is aimed at informing and mobilising the listeners to attend the planned field day. Alternatively, it may be held on the day of the field day (evening show). The seed company also prints and distributes pamphlets about the company and seed varieties to extension officers in the target areas.

In some areas, the seed company establishes demonstration plots to provide the farmer hosting the demo (demo host), and other farmers with an opportunity to verify the information about the attributes and performance of the variety being promoted. Such demos are normally established near busy roads in order to increase the likelihood of being seen/spotted by farmers, extension agents and other stakeholders. Information on the attributes of the crop variety planted, the cultural practices and the seed company distributing the seed is displayed on billboards erected on the demo plot. The demo host is also trained in good agronomic practices and given information about the variety by the agents of the seed company.

The expectation of the seed company is that farmers view the crop in the demo plot, read information about the variety from the billboard, and/or visit the demo host to ask more information about the demonstrated variety and their experience with the variety.

A field day is held upon maturity of the crop at the site of the demo. The seed company hosts farmers and extension agents at the demo plot with a view to further reinforce/affirm or clarify the information the demo host and some farmers have learnt or experienced from the demo, and to provide accurate technical information to farmers about the variety, the cultural practices and where the variety seed can be bought from. Leaflets containing information about the variety and the seed company are also distributed during the field day. Farmers and extension agents learn about the field day through radio adverts, talk shows or mobilization by local leaders.

Demo plots (and accompanying field days) are costly to establish and maintain and hence are only established in selected areas. Consequently not all farmers have access to them. Farmers who have access to demos are believed to have an advantage over those who do not since they can verify the information received from other sources and validate their performance in their locality. Such farmers are more likely to adopt a new improved variety being promoted including the cultural practices that are recommended. Whether the farmers in treated areas visit the demonstration plots and attend field days depends on factors such as: distance to the demo plots/field day, access to information, access to demo/field day, the perceived benefits, including competing activities for farmers' time. This implies that the decision to visit a demo plot or attend a field day selective, and is likely to be influenced by farmers' gender.

The evaluation tests the following hypotheses:

Hypothesis I

Boosting radio messages by establishing demonstration plots and holding field days to create awareness and promote new improved varieties would induce a greater change in the farmers' adoption behavior (awareness, perception and knowledge) in areas where the demos have been established.

The impact on farmers' behavior was assessed by examining the changes in the following parameters: i) awareness – proportion of farmers aware of improved varieties generally and of the specific maize and bean varieties being promoted; ii) attitude towards improved maize and bean varieties in general – score on a Likert scale of 1 to 5; iii) perception of the new maize and bean varieties being promoted – score on a Likert scale of 1 to 5; and, iv) knowledge about attributes and cultural practices of the improved maize and bean varieties – a score based on the number of correct answers.

Hypothesis II

Establishment of demonstration plots and field days to showcase new improved varieties will lead to a greater adoption of the new improved varieties being promoted in areas where the demos have been established.

The impact on farmers' use of the improved seed being promoted was assessed through examination of the proportion (decimal) of farmers planting improved seed generally; proportion of farmers planting the maize and bean varieties being promoted; and, the acreage (acre) planted under the varieties.

Hypothesis III

Research Hypothesis: farmers who adopt the improved varieties being promoted through exposure to the demonstration plots would achieve higher yields;

Further, farmers who adopt the improved varieties being promoted through exposure to the demonstration plots would achieve higher production;

Further, farmers who adopt the improved varieties being promoted through exposure to the demonstration plots would achieve higher income.

The impact of the promotion campaign on adoption behavior and subsequently on PASS programme outcomes is shown by assessing changes in maize and bean yields (kg/acre) and households' production of maize and beans (kg), as well as households' annual cash income (UGX).

Additionally, given that the two varieties being promoted are relatively new in the area, in the market and amongst farmers, we sought to know the numbers and proportion of farmers reached by the promotion campaign. We also assess the number of farmers who visited demos or attended field days. Finally we assess the numbers that are aware about or planted the two new improved varieties. The question asked is: w*hat proportion of farmers were reached by the promotion campaign over the period of promotions (four seasons)?* Both *qualitative and quantitative approaches* were used.

III. CONTEXT

One of the pathways being followed to sustainably improve agricultural productivity is through crop improvement, which is embodied in improved seed varieties. Farmers in sub-Saharan Africa have a limited choice of improved varieties (AGRA website), and most plant seed of land races or varieties that were released more than 30 years ago (Hassan, 1998). Recent studies further argue that replacement of the old varieties with new ones rather than simply adopting maize hybrids is likely to have a significant effect of improved seed on maize productivity (Smale and Olwande, 2011). Consequently, the production and distribution of newly released improved seed varieties, and increase in farmer awareness, access and use of the new improved seed varieties are important prerequisites to increasing agricultural productivity in the region.

In many SSA countries, seed delivery systems are poorly developed or lacking. But even in countries where the seed systems are relatively better developed, the uptake of new varieties is very low and it takes years for farmers to finally take up new varieties, if at all. Though governments and development agencies often intervene to support the production, introduction and distribution of improved seed, particularly where commercial incentives are lacking, uptake of new varieties is still low in many regions. A study in Kenya found that the area-weighted average age for modern varieties, both open-pollinated and hybrids was 23 and10 years, respectively (Hassan et al. 1998). Such long lag periods denies crucial benefits to the farming community, especially smallholder farmers. Women and the poor are less likely to be aware of or take up new seed varieties due to their circumstances, which often disadvantages them. Similarly, they are also less likely to participate in seed promotion events such as field days and demos due to the same circumstances.

The first phase of AGRA's PASS was to improve the availability and variety of seeds that can produce higher and more stable yields in Sub-Saharan Africa. Most of the programme's efforts were aimed at breeding, release of varieties, multiplication, quality control, production and distribution through expansion of the agro-dealer capacity and network (2013 annual report by AGRA). By 2014, 59 improved varieties had been released and 54 varieties had been commercialised by private seed enterprises. And six companies supported by the programme. According to AGRA's PASS strategy, commercializing the new improved varieties released was the responsibility of the local seed companies. A reviews of proposals submitted by seed companies for funding (2007–2013) showed that their requests always included funds for dissemination of information about the new seed, setting up demonstration plots and holding field days, and other activities aimed at creating awareness and promoting use of improved seed.

The following strategies ensured that the findings are representative of the seed industry promotion campaigns, the seed varieties, and the farming population from eastern and western regions in Uganda

a. The evaluation team was linked, by AGRA programme officers, to one of the seed companies that had benefited from AGRA's PASS support and approached them with a request to partner in an evaluation. The idea was to undertake an evaluation as the promotion was being rolled out for selected improved crop varieties. While involving several seed companies in the evaluation would have controlled for the effects of the variety and company characteristics on uptake, it would have been a nightmare to manage or monitor compliance - since seed companies often promote their seed in different/diverse areas across the country. Furthermore, logistical and resources constraints could not allow involvement of more than one seed company in Uganda.

b. The implementing agency/seed company identified two varieties which were relatively new in the market. These varieties had been licensed to the implementing agency. This arrangement was suitable for the impact study since seed varieties could be traced to the company commercializing them. The team comprising evaluators and the seed company also identified regions where the company had not promoted the varieties, and agreed that the seed company would not establish demonstration plots to promote other varieties in the regions selected. This was important for ensuring no contamination occurred.

c. Seed companies apply more than one approach in promoting new improved seed. Mass media approaches were considered as the basic promotion because it is difficult to restrict access. All farmers in the study area would therefore receive messages about the new maize and bean varieties through the radio. Demonstration plots and field days were the promotion methods included as a treatment because it was possible to restrict access to the demos thereby reducing access to the demos for some farmers. This was achieved by establishing the demos in different administrative areas (sub-counties).

d. The number of demonstrations plots to be established for the impact study was determined by the resources available. Factors considered were: the capacity of the seed company to establish and manage the demonstration plots and hold field days for the two varieties, as well as the demos and field days which they had planned for the other varieties; and, the financial resources available for establishing the demos, monitoring compliance and holding field days to promote the two varieties for the purpose of the evaluation. This is the common situation in many local seed companies in the region.

e. Farmers within the vicinity of a demonstration plot were considered as the beneficiaries. It is said that demonstration plots can reach farmers within a radius of approximately 5 km (personal communication, 2014). However, demo plots are costly to set-up and maintain, and many seed companies normally set up one or two demos in a district, and not in all districts (personal communication). AGRA's SM&E programme did not wish to have the intervention of grantees altered, but a compromise was reached to establish two demos in a district. This was a reasonable number given that seed companies mainly establish none, one or at most two in a district. So, based on resources available, one demo was set up to serve a sub-county, which comprises several villages. Farmers who were residents in the sub-county where demos were established were considered to be treated.

f. Randomizing at the sub-county level addresses the problem of non-compliance/contamination. This was informed by baseline results which showed that farmers mainly used interpersonal communication for getting information or other farmers experiences about improved farming approaches and they are more likely to talk to fellow villagers. Few farmers travel more than 5 kilometers to the person they rely on for trusted information on improved farming practices.

g. It was important to have similar treatment and comparison groups. Visits to physically verify the location of the randomly selected study areas revealed that some of the sub-counties in the 'control' group did not match features of 'treatment' group. In consultation with agricultural officers in the respective areas, sub-Counties with relatively similar features to the treatment sites were identified. The matching features included: agro-ecological zone, agricultural production systems, infrastructural development and socio-economic factors.

h. The selection of areas of study was based on their importance in maize growing. From a list of maize growing districts in Uganda, the seed company identified the districts to host the study (both treatment and control areas) using the following criteria: presence of agro-dealers who stock their seed in the major towns; the seed promotion campaigns for the two varieties had not been held there before (in fact districts where they had not established demos ended up being selected); the seed company did not have planned promotion activities in those districts (USAID supported agri-inputs programme was also supporting seed promotion activities in some districts in Uganda, while the NAADS programme (OWC) was country wide); and their spread should not be too far from each

other for ease in transportation and other logistics. Four districts were selected using this approach, namely Hoima and Masindi in the western region and Iganga and Tororo in the eastern region.

i. Though this study evaluates the effectiveness of awareness creation and promotion methods for locally adapted improved varieties, the findings are widely applicable because of the following reasons. One, the two food crops (maize and beans) are popularly grown in the region by smallholder farmers, and is an important food crop and a cash crop for both men and women. They are an important staple in the diet and a source of income for poor and vulnerable communities, including women. The results of this study therefore offer valuable insights which are applicable across diverse agro-ecologies where these crops are mainly grown by smallholder farmers.

j. Besides, we used appropriate experimental design approaches to obtain results that are reflective of the true population, which enhances internal validity. The study area is of mid-altitude, which has ecological and socioeconomic conditions similar to most parts of the sub-Saharan Africa (SSA), implying that results are likely to be applicable to other areas from SSA. We also used mixed methods: combining qualitative and quantitative methods commonly used in socioeconomic research, which strengthens external validity.

IV. TIMELINE

Table 1: The timeline for implementation and impact evaluation activities

Activity	2014		2015			2016			2017		
	April-Aug	Sept-Dec	Jan-April	May-Aug	Sept-Dec	Jan-April	May-Aug	Sept-Dec	Jan-April	May-Aug	Sept-Dec
Planning and design											
Site and household identification											
Demo host identification, training											
Establishment of demos											
Monitoring of demos											
Field days											
Talk shows											
Radio sport adverts											
Data collection											
Analysis and writing											
Dissemination meetings and workshops											

V. EVALUATION: DESIGN, METHODS AND IMPLEMENTATION

5.0 Evaluation method

The quantitative and qualitative approaches used in the study are discussed below.

Design for Qualitative Assessment

Qualitative studies were conducted in January – February 2016 and again in September – October, 2017, to evaluate the farmers' response to the promotion campaign and their uptake of improved varieties. The studies also provided more insight on factors that may hinder uptake of improved seed, and thereby help in explaining findings from the quantitative study. Focus group discussions (FGDs) were conducted to explore farmers' perceptions about improved seed, their use of improved seed and constraints faced with respect to uptake of the improved seed. Two FGDs were conducted in each treatment sub-county totaling to 16. Farmers who attended the FGDs were selected randomly in the villages within the 8 sub-county with a maximum of 8-12 people per FGD. To cater for some participants not showing up, 10-20% more people (14 people) were invited to the FGD. The FGDs were held at the sub-county headquarters/nearest market centre where the farmers are familiar with and do not have to travel very far. The researcher ensured there was equal numbers of men and women. This is because there may be differences in the way men and women interact with the improved seed. During the FGDs the farmers were be provided with materials to make detailed notes thus ensuring there was no dominant participants and all participants were giving their opinions. During the data collection process the data was recorded (audio and video) and detailed notes were made. The data was collected by the researcher and one research assistant who was familiar and could speak the local language. In addition to FGDs, key informant interviews were conducted on selected sub-county leaders, leaders of the Operation Wealth Creation (OWC) initiative, demo hosts, and district level input service providers.

Design for Quantitative Assessment

The study team conducted an empirical investigation to evaluate the impact of a promotion campaign to increase use of improved maize and beans seed varieties by smallholder farmers on appropriate outcome variables. The promotion campaign included radio messages, establishment of demonstration plots and holding field days at the site of the demonstration plots. These are the commonly used approaches in promoting improved seed amongst smallholder farmers in the region.

The evaluation team randomly selected areas that were exposed to the full promotion campaign, which comprised demonstration plots and field days in addition to radio messages, and those that only received radio messages. This was done by randomly assigning the sub-counties to different treatments (treated and control). The nature of interventions made the target a 'catchment' which is a geographical area

within the vicinity of the intervention. This meant that all farmers residing within the vicinity of the intervention would belong to the treatment sample, whilst farmers not residing in these 'catchment' areas would belong to the control or comparison group. This made the design more of a group randomization type of study.

Instead of randomly assigning individual households to either the treatment or control, 'catchment' areas (in this case sub-counties) were randomly assigned into these two groups. Therefore, all households residing within a catchment area were assigned to the same condition i.e. treatment or non-treatment. In as far as the evaluation was concerned: i) Establishment of demonstration plots at the village, sub-county or district level is said to be the most efficient approach to deliver agricultural technology to farmers (reference). Moreover, maintaining the integrity of the experiment necessitated physically separating the treatment from the control groups because the effects of the treatment (demonstration plot) have potential to spillover to non-participants.

However, there are challenges associated with group randomization: individuals in the group may have correlated outcomes (e.g. the factors influencing varieties planted may be similar); group randomization has low power; and, there is the risk of failed randomization. In this study we take care of intra-cluster correlation by estimating robust standard errors for each coefficient. Group-randomized designs such as the approach taken in this study are also susceptible when a small number of randomization units are available. In the case of the Uganda study, financial and other constraints related to the capacity of the implementing agency meant that only 16 sub-counties could feasibly be comfortably included in the study. The funds available for the study were not sufficient to roll-out a promotion campaign covering more catchment areas. We applied bootstrap procedure, which is recommended for, among others, situations under which the sample size is insufficient for straight forward statistical inference.

- Given the problems highlighted above, we are not able to estimate the average treatment effect on the treated (ATT) but we are able to estimate the intention to treat (ITT), which is analogous to the average treatment effect (ATE), with the assumption that every household in sub-county participated in the demos and field days. ITT measures the difference between the treatment group mean and the control group mean as shown in equation below:

$$ATE = \tau = E[(Y1|W = 1) - E(Y0|W = 0)|X]$$

The treatment effect τ is identified, conditional on observed baseline covariates and there are no unobserved factors that are associated with the treatment assignment and the potential outcomes. This is the un-confoundedness assumption that is equivalent to the independence of e_i and of w_i, conditional on x_i in the equation:

$$y_i = \alpha + \tau . w_i + \beta' x_i + e_i \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

It is also assumed that the support of the conditional distribution of x_i given $w_i = 0$ overlaps completely with that of the conditional distribution of xi given $w_i = 1$. Equation (1) can be estimated using ordinary least squares (OLS). Rosenbaum and Rubin (1983), however, show that under un-confoundedness, independence of potential outcomes and treatment indicators also holds after conditioning solely on the propensity score $e(x) = pr(w_i = 1 | x_i = x)$:

$$w_i \perp\!\!\!\perp \left(y_i(0), y_i(i) | e(x_i)\right)$$

Under the assumption of no unmeasured confounder, all biases can be removed by adjusting for differences in covariates implying that within subpopulations homogenous in the propensity score there are no biases in comparisons between treated and control units (Imbens and Wooldridge, 2008). Thus, one can use sub-classification (Rosenbaum and Rubin, 1983) to adjust for the differences in the propensity score by partitioning the sample into strata by (discretized) values of the propensity score, and then analyse the data within each stratum as if the propensity score were constant and the data could be interpreted as coming from a completely randomized experiment (Imbens and Wooldridge, 2008). Alternatively, we can use the inverse propensity score weighting (IPW) method to adjust for the differences in covariates between the treated and control. Weighting creates a pseudo-population in which there is no confounding, so that the weighted averages reflect the averages in the true population.

We adopted the IPW procedure to estimate the treatment effects on the outcome variables. The IPW procedure offers a double robustness advantage in that if the binary model is correctly specified for the propensity score, the conditional mean functions need not be correctly specified (Imbens and Wooldridge, 2008). In the first stage we estimated a binary regression model using the treatment condition as the dependent variable to generate propensity scores which are the odds of a household falling in the treatment group. The scores were used in computing inverse probability weights which were then used in the second stage for the effects model. In the second stage effects model, we calculated both robust and cluster-robust standard errors (clustered at village level). We also estimated a regression with bootstrapped standard errors to account for the small number of units (sub-counties) in the study.

A particular concern with IPW estimators arises again when the covariate distributions are substantially different for the two treatment groups. We conducted balance, which showed imbalance between the treatment and control samples and used propensity score weighting procedure to correct for the imbalance. In addition to conducting covariate balance tests to find to which extent weighting reduces

bias in the estimation of treatment effects, we combined regression (equation 2) and weighting, which is more attractive than either method alone (Imbens and Wooldridge, 2008) to identify the impacts. Combining the regression and weighting gives an additional robustness by both removing the correlation between the omitted covariates and reducing the correlation between the omitted and included variables. The same covariates used in the IPW model to generate weights were used in the outcome regressions.

IPW estimators can be unstable when the sample size is too small because every observation must have a likelihood of being treated. In our case the sample size is large hence the IPW is unlikely to be unstable. It can also be unstable if the predicted values are close to zero because the IPW is the reciprocal of the predicted probabilities thus the weights will increase as probabilities tend to zero which makes the IPW unstable. We obtained robust results from three procedures, namely, double robust regression with and without clustering, and bootstrapping, which strengthen our confidence in the results.

To address the problem of attrition, we computed the inverse probability of weights to examine the influence of selective attrition on the effects. We fitted two separate models, one using the two stage inverse probability of attrition weighted regression to adjust our impact estimates for attrition bias (Weuve et al. 2012), and another without the attrition weights. In the first stage of the inverse probability of attrition regression, we estimated a logistic regression model using attrition as the dependent variable to generate propensity scores which are the odds of a household dropping out of the survey. The scores were used in computing attrition weights which were then used in the second stage for the effects model.

Description of variables included in the models

The outcome variables of interest:

Sources of information was binary with 1 if the respondents named a source of information and 0 if otherwise.
Awareness is the proportion of farmers aware of improved varieties generally and of the specific maize and bean varieties; 1 if aware and 0 if otherwise.
Attitude towards improved maize and bean varieties is a score on a Likert scale of 1 to 5. Farmers were asked 5 questions regarding their attitude towards improved maize and bean seeds.
Perception of the maize and bean varieties being promoted is a score on a Likert scale of 1 to 5 (strongly agree to strongly disagree). Farmers were given 10 statements which they either agreed or didn't agree with the statements.
Knowledge about attributes and cultural practices of the improved maize and bean varieties is a score of based on the number of correct answers. Farmers were asked seventeen questions regarding the attributes

of the new improved seed and agronomical activities. If the farmer answered a question correctly he was given 1 and if wrong he was given 0.

Acres planted under PH5052 - this is the area (in acres) planted with PH5052 in seasons 1 & 2, year

Acres planted under NABE15 - this is the area (in acres) planted with NABE15 in seasons 1 & 2, year

Proportion that planted PH5052 - (Dummy with a value of 1 for those who planted, 0 otherwise)

Proportion that planted NABE 15- (Dummy with a value of 1 for those who planted, 0 otherwise)

Proportion that purchased improved maize seed/bean seed - (Dummy with a value of 1 for those who planted, 0 otherwise), any improved variety

Acres un-recycled improved maize/bean - Acreage (acres) planted with un-recycled improved maize/bean seed

Acres recycled improved maize/bean - Acreage (acres) planted with recycled (retained) improved maize/bean seed

Acres local maize/bean- Acreage (acres) planted with local maize/bean seed

Acres mixed maize/bean - Acreage (acres) planted with both unrecycled improved and local maize seed

Acreage under maize /bean - Acreage (acres) planted with maize/bean

Production of Maize/ beans (kg) - the total volume of maize/beans harvested in kilograms

Yield of Maize/beans (kg/acre) - the volume of maize/beans harvested per acre of land

Season all - season 1 and 2 combined

Covariates included in estimation of the treatment model:

The *continuous variables* used as covariates at the household level analysis and the individual (male and female respondents) level analysis are; distance to the major market (h61) and distance to improved seed seller (h67) in kilometres, log of asset value (lnassetvalue), the size of the household in terms of adult equivalent (ae_1), acreage under banana (banana), sorghum (sorghum), sweet potatoes (sweetpotatoes), groundnuts (gnuts), and other crops (other), and log of farm size (lnfarmsize) in acres.

The *binary variables* included as covariates at the household level analysis and the individual (male and female respondents) level analysis were: single marital status of the household head (1=single, 0 otherwise), married marital status of the household head ((1=married, 0 otherwise)), and salary employment status of the household head ((1=salaried, 0 otherwise).

Some variables were only included in the *household level analysis*, such as; age of the household head (age_HH), age of the household head squared (age_HH2), age of the household head cubed (age_HH3), gender of the household head (gender), and education level of the household head (edu).

Finally, a few variables were only included in the *individual level analysis*, namely: age of the respondent (age_respondent), age of the respondent squared (age2_ resp), age of the respondent cubed (age__resp3), and education level of the respondent (edu).

The education level is defined as a categorical variable where: 0=none; 1=none; 2-primary education; 3=secondary education; and 4=tertiary education.

5.1 Sample size determination

Sample size calculation was based on a minimum differential in adoption rate of the treatment group over that of the control group of 10 percent, 80% power using standard statistical tests which were based on a two-sided significance of 5% probability of Type I error. Because the households were sampled from village clusters, the calculations controlled for intra-cluster correlation. It also catered for 20 percent attrition rate over the 3 years (2014 – 2017). The required sample size to detect a minimal change of 10% in the primary indicators was 2,162 to 2,770 households depending on the indicator. A stratified random sampling procedure was followed in selecting the households that would be interviewed over the entire study period.

Having randomly picked four sub-counties from each of the four study districts, the second stage involved randomly selecting villages from those sub-counties. Lists were drawn of all villages in each of the selected sub-counties, and fourteen (14) villages were randomly drawn from each sub-county, which translated to 56 villages from each district and a total of 224 villages across the four districts. In the third stage, households to be interviewed were randomly selected as follows: data on the number of households in each of the selected villages was obtained from the Uganda Bureau of Statistics (UBOS) census data and a list of household names in each village provided/generated together with the local/village council chairmen. Based on the number of households in each of the villages, fifteen random numbers were generated and used to select 15 households from each village. The number of households to be interviewed in each village was 10 out of the 15 that had been randomly selected. At the baseline, the additional five households were allowed for drop outs (e.g. households that couldn't be traced or were not present at the time of interviews). The final calculated sample comprised of 2,247 households.

Data - Panel Farm Household Surveys

Three waves of surveys (baseline, midline and endline) were conducted. The baseline was conducted at the beginning of the promotion campaign (2014), the midline at the end of the first year after commencement of the promotion campaign, and the endline two years after commencement of the

promotion. The surveys captured farm, household and individual level data for each year since commencement. Crop related data was collected for all the four seasons during the promotion campaign period, namely: season 2 of 2014; 1 and 2 of 2015; and 1 of 2016. During the three waves of surveys, the team interviewed the same households as those that were interviewed at the baseline. Information sought included household and farm characteristics, farmer awareness and knowledge as well as farmer attitudes, perceptions and decision making with regard to use of new varieties. In addition, information was collected on farmers' use of improved varieties and acreage planted with the new variety, the yields obtained and other benefits. The interviews were engendered for some of the questions such as awareness, attitude, perception and knowledge. Data on crop production practices were collected at the plot level.

The Statistical Package for Social Sciences (SPSS) has been used in cleaning and handling data while STATA was used in estimating the outcomes.

Data Collection and Quality Control

The survey data were collected from a random sample of households drawn from both the treatment and control. Structured questionnaires were used in data collection at the baseline (provided in the appendix). For the midline and endline surveys, the paper questionnaires were coded using open data kit (ODK) and administered using tablets. The questionnaires contained modules for: household, individuals in the household and farm plot. All modules were administered to the main respondent who was either the head or the spouse. In addition, the spouse to the main respondent was also interviewed using the individual level module. In absence of any of the spouses, the interview was held with the adult present who was well versed with the farming activities of the household. Before the actual survey, the questionnaires/tools for each wave/round of survey were pre-tested in office and in the field to ensure the questions were correctly framed.

The field data team comprised enumerators and supervisors, all of them graduates in agricultural economics or related fields, and fluent in the local languages spoken in eastern and western Uganda. Training of enumerators and field supervisors was conducted over two weeks for each wave or round of survey. The training included trainees administering a full questionnaire to fellow trainees during classroom sessions, and to farmers in the field, in the presence of a trainer.

During data collection, the group was organised in four teams, each comprising one supervisor and six enumerators. In addition, there were three overall supervisors working closely with the teams and checking the completeness of data being collected. The data collected were checked every evening by the immediate supervisors and any arising issues addressed before the start of interviews the following day. During data collection village chairmen/leaders guided the team so that they could reach most of the

targeted farmers. It was reported that some farmers did not want to participate, particularly in the endline survey because they did not envision any benefits from the exercise. However, the field supervisors were trained to handle such cases which ensured drop offs were minimised.

Data entry was necessary for the baseline survey where paper questionnaires were used. In this case data entry clerks were trained and experienced on how to minimize data entry errors. Checks were made by the supervisors after entry. Data collected in all three waves were cleaned to ensure consistency. Data cleaning was carried out by experienced research assistants. For quality control, uniform syntaxes were used during data coding and cleaning, and the cleaning exercise supervised by senior research assistants.

Baseline data collection was from November to December 2014. Efforts were made to trace and interview all the households identified during sampling and sample size determination. Some of the sampled households were, however, not reached or were not interviewed due to refusals or unavailability or dissolution of the household. The number of households reached were 2,133[2], comprising 1,886 male and 247 female headed households (Appendix Table 15). The individual respondents were 3,090, comprising 1,442 males and 1,648 females from the 2,133 households (Appendix Table 16). 1,069 were in the treatment sample and 1,064 were in the control (Table 2).

A midline survey was conducted halfway into the promotion campaign, and data were collected between mid-November 2015 and early February 2016.The interviews were conducted in the same households, which were identified during sampling. Efforts were made to track as many households as possible. The final sample size was determined by farmers' availability during the survey period, and whether they consented to be interviewed. The sample size for the midline survey was 2,133[3] households, comprising 1,853 male and 280 female headed households (Appendix Table 17). The individual respondents were 3,513, comprising 1,602 males and 1,911 females from the 2,133 households (Appendix Table 18). Out of the households that were interviewed in each wave, only 2,020 households were interviewed in both baseline and midline surveys. Some of the households interviewed during the baseline survey were not interviewed/reached in the follow-up (midline) survey due to refusals or unavailability or dissolution of the household. In addition, some households not reached in baseline survey were interviewed during the midline survey.

[2]A household size of 2,133 is well within the calculated sample size, which allows for an attrition rate of 20% per year.

[3]A household size of 2,133 is well within the calculated sample size, which allows for an attrition rate of 20% per year.

An endline survey was conducted two years into the promotion campaign. Data were collected during the period January to March 2017. As was the case at the midline, the follow-up interviews were conducted in the same households which were identified during sampling and efforts were made to track all the households. The final sample size was determined by farmers' availability during the survey period and whether they consented to be interviewed. The sample size for the endline survey was 2,035[4] households, comprising 1,763 male and 272 female headed households (Appendix Table 19). The individual respondents were 3,283, comprising 1,476 males and 1,807 females from the 2,035 households (Appendix Table 20).

Out of the interviewed households, only 1,953 households were interviewed in all three surveys i.e. at baseline, midline and endline. Some of the households interviewed during the baseline or midline surveys were not interviewed/reached in the follow-up (midline, endline) surveys due to refusals or unavailability or dissolution of the household. In addition, some households not reached in baseline or midline surveys were interviewed during the endline survey. Table 2 shows the number of households interviewed or dropping out at each wave and the attrition rates, while Table 3 shows the distribution of households that were interviewed in all three waves (to form a three-wave panel). A shown in the Table 2, the overall attrition rate was 5.3 percent at the midline and 8.4 percent at the endline. The attrition rate for the treatment group was 4.8 percent and 8 percent at the midline and endline, respectively. The attrition rate for the control group was 5.8 percent and 8.9 percent at the midline and endline, respectively.

Table 2: Number of households in each wave and in panel and rates of sample attrition

	Treatment	Control	Total
Calculated sample size	1125	1122	2247
Households reached in each wave			
Baseline	1069	1064	2133
Midline	1078	1055	2133
Endline	1023	1012	2035
Appear in both panels			
Panel (Baseline & Midline)	1018	1002	2020
Panel (Baseline & Endline)	1022	1013	2035

Panel (Midline & Endline)	983	970	1953
Panel (Baseline, Midline, Endline)	983	970	1953
Attrition rates (%)			
Baseline-Midline	4.87%	5.82%	5.30%
Baseline-Endline	4.40%	4.80%	4.59%
Midline-Endline	5.1%	4.08%	4.6%
Baseline-Midline-Endline	8.04%	8.83%	8.44%

Table 3: Distribution of Households in the panel

	Baseline			Midline			Endline		
	Treatment	Control	All	Treatment	Control	All	Treatment	Control	All
Hoima	252	240	492	252	240	492	252	240	492
Masindi	214	217	431	214	217	431	214	217	431
Tororo	260	260	520	260	260	520	260	260	520
Iganga	257	253	510	257	253	510	257	253	510
Total	983	970	1953	983	970	1953	983	970	1953

Table 4: Number of respondents in each wave and in the baseline endline panel data and rates of attrition (individual level)

Households that were interviewed in each wave	Treatment		Control		Total	
	Female	Male	Female	Male	Female	Male
Baseline	819	730	829	712	1648	1442
Endline	897	741	910	735	1807	1476
Panel Baseline&Endline	660	552	675	507	1,335	1,059
Attrition Rate						
Baseline-Endline	-9.52%	-1.51%	-9.77%	-3.23%	-9.65%	-2.36%
Baseline-Endline (panel)	19.41%	24.38%	18.58%	28.79%	18.99%	26.56%

Table 4 shows the attrition for individual level survey. At the endline, the total number of males and females interviewed increased, however, male and female interviewed during both surveys (the baseline and endline) were fewer. The higher attrition rates recorded could be because the baseline data were collected between Nov and December (the end of the year makes festivity period) when household members are likely to be present/within their farms, while the endline was conducted between January

and March when the head or spouse are likely to be away. The overall attrition rate was 27 and 19 percent for male and female respondents respectively. The differential attrition rate for males was 25 and 29 percent in the treatment and control samples respectively. There was no differential attrition for females. These attrition rates are quite high and warrant further analysis to test for attrition effects on outcomes.

5.2 Threats to internal validity

Attrition

It was important to check whether households were self-selecting out of the treatment or control groups because attrition not only reduces statistical power by decreasing the sample size, it also compromises external validity when dropouts are unrepresentative of the original sample thereby degrading the representativeness of those who remain (Orr, 1999). Attrition threatens internal validity by biasing the treatment effect estimates if: the missing cases are not random; depends on observed or unobserved variables. Factors that cause attrition cannot be assumed to be represented among the observed variables OR to be random, so we checked whether there were systematic differences between the original sample and the dropouts (results presented in next section).

Non-compliance

Compliance in this study refers to whether all the sub-counties assigned to the treated group received the treatment that is whether the intervention was implemented as planned. Various challenges in implementation of the promotion campaign were encountered but the main one was achieving 16 demos (in each selected site) as planned. From monitoring reports and we gathered that the success rate of demos being planted and field days held was about 70 percent - the implementing agency held field days at the demo plots which were successfully established. The main causes of the 30 percent non-compliance was failure to establish some of the demos as planned, or failure of the established demos due to drought or pest attack. These has been attributed to late delivery of the demo kits by the seed company, late planting or not planting by hosts due to late/failed rains or non-delivery of kits. 70 percent compliance in the demos established is reasonable. While non-compliance is a threat because it leads to underestimation of the treatment effect, in this study non-compliance can be seen as a reflection of the natural conditions under which such promotion campaigns are conducted in the region of study i.e. low capacity of the seed companies and a myriad of challenges faced in the field.

Spillover effects

From the description of the assignment of the intervention, the treatment and non-treatment areas are delineated as administrative blocks (sub-counties). Households residing in treated areas were closer to the intervention and hence likely to see/visit the demo or attend field days. The households residing in control areas had poor proximity to the intervention (because of the distances between treatment areas and control areas), and hence were unlikely to visit/see the demos or field days. Though the interaction between households across the two groups was somewhat hindered by distance, it cannot be completely ruled out. The theory of change is that farmers who've had direct contact with demos and field days would share the information with their peers (relatives and neighbours). Diffusion of the information would occur through 'interpersonal communication' between farmers who have the information and others, as well as through observation of farms planted with the new varieties. Over time diffusion may occur to areas beyond the treatment areas also referred to as spillovers, and failure to account for such spillovers would lead to under estimation of the true effect of the seed promotion campaign. In this study, however, there were no farmers in control group who visited the demos or attended field days that had been organized by the implementing agency (Table 5), hence we can safely conclude that spillover of treatment into control areas was negligible if at all.

Table 5: Participation by survey by sample by gender

		Midline				Endline			
		Treatment		Control		Treatment		Control	
		Male	Female	Male	Female	Male	Female	Male	Female
Participation in demonstration plots, field days and radio programs	Any demonstration plot	0.3	0.21	0.21	0.17	0.4	0.37	0.37	0.29
	N	612	547	549	551	480	395	457	414
	Demonstration plots by PSL	0.24	0.23	0	0	0.23	0.24		1
	N	185	111	113	93	190	138	0	1
	Any field day	0.27	0.16	0.2	0.12	0.34	0.26	0.34	0.23
	N	499	522	470	517	406	403	410	378
	Field day by PSL	0.23	0.16	0	0	0.21	0.14		0.5
	N	133	86	96	60	130	96	0	2
	Any radio program	0.84	0.78	0.82	0.76	0.86	0.81	0.85	0.81
	N	605	597	550	576	480	481	504	493
	Radio program by PSL	0.16	0.17	0.14	0.13	0.2	0.14	0.2	0.18
	N	506	466	452	438	414	389	430	398

Note: N stands for the number that was aware, a question that was asked before asking whether they visited a demo, attended a field day or heard a radio program/advert.

VI. PROGRAMME: DESIGN, METHOD AND IMPLEMENTATION

6.0 Areas of intervention

In this section we describe the selection of the programme intervention areas, and the approaches (interventions) used by the implementing agency (local seed company) to create awareness and promote two relatively new seed varieties which the company has been licensed to multiply and distribute.

The selected seed company identified two relatively new improved varieties for the study, namely, a maize hybrid named PH5052, and a composite bean variety NABE 15.

Like other local seed companies, the seed company uses the mass media (radio and pamphlets) in its strategy, to disseminate information and promote use of seed of new crop varieties. In some areas, in addition to use of mass media, the seed company also establishes demonstration plots, and holds field days. The expected outcomes from such a promotion campaign are improved awareness and use of the new varieties and subsequently increase in productivity and production of the crops.

Table 6: Study Areas

District	Sub-County	Type of Group
Hoima	Kyaigambire	Treatment
	Kitoba	Control
	Kiziranfumbi	Treatment
	Bugambe	Control
Masindi	Pakanyi	Treatment
	Bwijanga	Control
	Myria	Control
	Karujubu	Treatment
Iganga	Nambale	Treatment
	Makutu	Control
	Igombe	Treatment
	Nawandala	Control
Tororo	Mulanda	Control
	Molo	Control
	Kilewa	Treatment
	Nagongera	Treatment

Once sub-counties were assigned to the treatment groups (Table 6), the next task was to identify suitable sites for the demonstration plots. The process of selecting hosts/sites for the demonstration plot was more complicated because the demos needed to be placed where farmers were likely to view them. The identification of suitable sites, therefore, entailed following the seed company's (PSL) criteria for screening areas for suitability and the willingness of farmers to host demos. Seed companies normally

establish their demonstrations on farm plots located along busy roads (tarmac or otherwise) in the district so that many people can see the crop growing. The field days are also held at these sites where the demos are established. While the seed company's preference was along roads leading to major markets, the study team convinced the seed company to deviate from its normal practice and instead establish the demos closer to where the farmers reside (inside the rural areas). Sites selected were, therefore, along busy roads deeper in the rural areas. Once such sites/farms were identified, the owners of the 'potential demo sites/suitable sites' received information on the purpose of demo and the implementation plan and then asked whether they were willing to host/serve as demo hosts. A list was drawn of those that were willing to host the demo, and thereafter two (2) farms within the sub-county were selected to be the hosts. It became difficult to assign the demo sites randomly because, farm plots with preferred features were not many and some farmers turned down the implementing agency's request to host the demos.

Though the intervention is at the sub-county level, the unit of analysis (where change is expected to occur) is the farm household, therefore, all households falling within sub-counties in the 'treatment' group were considered treated.

6.1 The intervention

In the control areas, the seed company transmitted messages about the new varieties only through radio messages.

In the treated areas, the seed company augmented messages transmitted via radio with demonstration plots which also included holding of field days at the demo sites. The seed promotion ran for four (4) concurrent cropping seasons, namely: season 2 of 2014; 1 and 2 of 2015; and 1 of 2016.

Through the Radio: Messages about the maize and bean varieties were transmitted using radio spot adverts and radio talk shows which were aired in local languages through local and regional radio stations. The message about the new varieties was intended to reach all farmers in both treatment and control areas, including farmers outside the study area. The radio adverts were to be aired for one month during the cropping season, while talk shows were held once during a growing season, for one hour, usually the evening before or after the field day. The implementing agency aired the talk shows and spot adverts via three radio stations.

Establishment of Demonstration Plots: Farmers who had agreed to host the demonstrations (referred to as a demo hosts) had also agreed to set aside about one half of an acre to plant the maize variety PH5052 and another half an acre to plant the bean variety NABE 15, which were being promoted. The seed company committed itself to provide the demo hosts with a 'technology pack' comprising the maize seed (PH5052), and the bean seed (NABE 15), fertilizer and information on the cultural practices for each crop

variety. Selection of the demo sites was described in the preceding section. The seed company's field personnel would deliver the 'technology pack' at the demo hosts house, train the farmer and monitor the crop performance.

Each demonstration plot was aimed at serving farmers within its vicinity in nearby villages. Hence the targeted farmers were those residing in villages falling within the sub-Counties assigned to the treatment group. In each district, the seed company committed to establish two demo plots in each of the two sub-Counties assigned to the treatment group. It is said that demonstration plots can reach farmers within a radius of approximately 5 km. However, demo plots are costly to set-up and maintain (estimated costs were US Dollar nine hundred and forty for a demonstration plot and field day), so seed companies normally set one or two demos in a district, and not in all districts. In total we randomly selected 16 demonstration sites.

Field days were to be held at the site of the demonstration plots when the maize crop had reached physiological maturity.

Various challenges were encountered by the implementing agency when the promotion campaign was being rolled out including: refusals by some of the listed/potential demo hosts to participate; late arrival of the rains and inadequate rainfall; destruction of demo plots by livestock; poor/incorrect labelling and destruction of sign boards at demo plots; and low turnout during some of the field days.

VII. IMPACT ANALYSIS, RESULTS AND DISCUSSION

7.0 Results

Baseline characteristics (original sample) - Source: 3ieTW4/1010 Baseline Report

Household level characteristics

Household size averaged 6.7 for the original sample. This is comparable to results from other surveys such as the 2008/09 agricultural census data that reports an average household size of 5.5 – 6.0 (Okoboi and Barungi, 2012) and the IFPRI household survey (Benin et al., 2011) the reports an average household size of 5.0 – 5.3. Baseline data from this study shows a demographic structure that is consistent with the country's demographic structure where about half of the population is under 15 years, and up to 60% of the population is below 19 years (UNFP, 2013). Most household members in the sample households were educated only up to primary level, which is consistent with statistics reported elsewhere (Benin et al., 2011; Okonya et al., 2013). The average education level for the head of household was 7 years and household members that had attained secondary level education were 20%. These low levels of education

could have implications on the way farmers perceive, synthesize and respond to innovations (Feder et al. 1985; Asfaw and Admassie, 2004).

The average age of household head was 46 - 45 years which is consistent with statistics reported by most Ugandan studies that report an average age 43 to 45 years for heads of households (Benin et al., 2011; Okoboi and Barungi, 2012). Most households in the study sample were male headed with less than 12% of the households reported as female headed. This statistic is well below those reported from 2008/09 agricultural census, which reported male headed household to range from 65% to 78% (Okoboi and Barungi, 2012). The main occupation of heads of households in the study sample was farming. The amount of land accessed for farming is 5.7 acres. Most land accessed by households was through inheritance followed by cash purchase, renting-in. Most households owned farm sizes ranging from 2 to 5 acres with an average of 3.56 acres overall. A small proportion of households owned livestock with only up to 25% owning local cattle, 32% owning local chicken, 20% owning goats and 14% owning pigs. The numbers of livestock owned were also few at 1.24 tropical livestock unit (tlu). Farmers travel 7.2 kilometres to the nearest main market for crops while the sellers of seed and fertilizer are located 8.2 and 8.9 kilometres away respectively.

The major crops grown in the study areas include maize, beans, cassava, bananas, ground nuts and sweet potatoes in order of decreasing importance as determined by acreage allocated to the crops. The distribution of crops in terms of acreage is consistent with national averages reported from the 2005/06 Uganda National Household Survey where maize was allocated more land compared to other crops, followed by cassava, beans, bananas and sweet potatoes. The proportion of households using organic manure on maize and beans was well below 1% and the proportion of households using chemical fertilizers on maize was 7.3%. The rates of chemical fertilizer use per acre, for the farmers that applied fertilizers, were higher for maize compared to beans. The amounts of fertilizer used on average for the overall sample was very low being less than 2 kg per household for maize and close to 0.1 kg per household for beans. The amounts reported from the survey are well below the amount used in sub-Saharan Africa (SSA) but consistent with the low usage of fertilizers in the region. According to Druilhe and Barreiro-Hurlé (2012), use of fertilizer in sub-Saharan Africa in 2006-2008 was 7.1kg/ha of arable and permanent cropland compared to that of South Asia at 129.4 kg/ha, East and Southeast Asia at 109.6 kg/ha and Latin America at 104.8 kg/ha.

The proportion of households that used new improved seed were higher for maize compared to beans. The acreage planted with maize in the main season was 1 acre and more than half of it was planted with local seed. About 0.14 acres were planted to retained seed in the main season. The acreage planted with

beans was 0.6 acres and half of it was planted with local seed. On seed acquisition, 87% of households that accessed new (not retained) hybrid seed obtained it through cash purchases. On the other hand, households that planted retained hybrid seed obtained it from their own previous harvests while others obtained retained seed from other farmers (about 10% in the treatment group and 14% in the control group). Over 70% of farmers who planted local varieties used their own seed from previous harvests while only 13% purchased it. The average yield for maize was 628 kg/acre which is translated to 1550 kg/ha which is slightly below the national average of 1.96 t/ha reported by Okoboi (2010) from the Uganda national Household Survey of 2005/06. The average yield for beans was 199.3 kg/acre which translates into 492 kg/ha. This yield figure is consistent with the estimated national average of 0.5t/ha (FAOSTAT, 2011).

The characteristics of male and female respondents in individual level survey are shown in Table 7. The male respondents were mainly household heads while the female respondents were mainly spouses. The gender of the heads of households were male with just a few having female heads. The average age of the male respondents was 44 years, while that for females was lower at 40 years and 39 years in the treatment and control samples respectively, which is relatively young considering that this was a rural setting. There was a marginal difference between the treatment and control for female respondents, in terms of their age and gender of household head.

Table 7: Male and female individual respondent characteristics in the original sample

	Male				Female			
	Overall	Treatment	Control	Pvalue	All sample	Treatment	Control	P value
Age of the respondent	44.481(0.394)	44.65(0.549)	44.314(0.565)	0.67	39.462(0.35)	40.073(0.502)	38.88(0.481)	0.086
Relation of the respondent to the head	1.106(0.011)	1.095(0.016)	1.117(0.017)	0.33	1.903(0.012)	1.885(0.017)	1.918(0.017)	0.345
Gender of household head	0.977(0.004)	0.978(0.006)	0.977(0.006)	0.895	0.887(0.01)	0.869(0.014)	0.904(0.014)	0.075
Age of household head	45.892(0.396)	46.137(0.555)	45.65(0.564)	0.539	46.01(0.372)	46.494(0.536)	45.549(0.517)	0.204
N	1442	730	712		1648	819	829	

Characteristics of households in the panel

Only 1,953 households were interviewed in all three surveys i.e. at baseline, midline and endline. These are the households that were included in the analysis for the treatment effects. Results in Table 8 show that the age, gender, education of the household heads, and the labour available from the household (AE)

was similar in the two samples. However the control group accessed more land, had more assets, but was further from markets and services, and had lower income. These are important differences which cannot be ignored because they would bias estimates of the treatment effects.

Table 8: Baseline characteristics of the households in the panel (Baseline-Midline-Endline)

	Baseline-Midline-Endline Panel			
	All sample	Treatment	Control	P value
Gender of the Household head (male = 1, female =0)	0.885(0.007)	0.88(0.01)	0.89(0.01)	0.47
Adult equivalent	5.594(0.056)	5.61(0.08)	5.578(0.079)	0.777
Total Income (UGX)	5518933 (1807290)	7254193 (3625964)	3817111 (411818)	0
Asset value (UGX)	1763674 (75025)	1547956 (79606)	1975234 (126126)	0
Crop income (UGX)	3444586 (1801991)	5105913 (3622041)	1815273 (349821)	0
Livestock income (UGX)	1980195 (131723)	2031631 (179624)	1929750 (192534)	1
Off farm income (UGX)	202440 (19503)	228112 (32706)	177262 (21517)	0
TLU total (Tropical livestock index)	1.25(0.061)	1.088(0.059)	1.41(0.106)	0.008
Distance to extension advice (Km)	5.768(0.118)	5.557(0.169)	5.975(0.164)	0.08
Distance to veterinary help (Km)	6.439(0.136)	5.972(0.179)	6.897(0.203)	0
Distance to A.I service (Km)	8.864(0.171)	7.862(0.227)	9.847(0.252)	0
Distance to the nearest animal feed seller (Km)	7.394(0.174)	6.294(0.208)	8.472(0.274)	0
Distance to the nearest agro dealer (Km)	3.646(0.09)	3.434(0.122)	3.855(0.131)	0.02
Distance to the seller of improved seed (Km)	12.506(0.19)	11.4(0.265)	13.591(0.269)	0
Distance to the seller of inorganic fertilizer (Km)	12.107(0.245)	12.057(0.338)	12.155(0.355)	0.84
Distance to the Major market for farm produce (Km)	6.006(0.147)	5.62(0.205)	6.384(0.21)	0.01
Distance to the nearest electricity supply point (Km)	7.881(0.167)	6.74(0.223)	8.999(0.242)	0
Distance to the nearest milk dairy (Km)	9.023(0.174)	7.996(0.233)	10.031(0.255)	0
Distance to the nearest livestock market place (Km)	8.038(0.17)	7.302(0.232)	8.76(0.246)	0

	Baseline-Midline-Endline Panel			
	All sample	Treatment	Control	P value
Distance to the nearest public telephone (Km)	8.619(0.168)	7.704(0.233)	9.516(0.239)	0
Education (years) household head	7.055(0.108)	6.997(0.155)	7.112(0.152)	0.6
Age (years) household head	46.469(0.332)	46.88(0.471)	46.065(0.469)	0.22
Land accessed (acres)	5.742(0.293)	5.165(0.223)	6.307(0.538)	0.052
Marital status single	0.011(0.002)	0.009(0.003)	0.012(0.003)	0.54
Marital status monogamous	0.704(0.01)	0.694(0.015)	0.714(0.014)	0.331
Marital status polygamous	0.156(0.008)	0.16(0.012)	0.151(0.011)	0.576
Marital status divorced	0.014(0.003)	0.019(0.004)	0.009(0.003)	0.073
Marital status widowed	0.09(0.006)	0.097(0.01)	0.083(0.009)	0.279
Marital status separated	0.026(0.004)	0.021(0.005)	0.03(0.005)	0.173
Occupation salary earner (yes=1, no =0)	0.052(0.005)	0.05(0.007)	0.055(0.007)	0.611
Other occupation (yes =1, no =0)	0.11(0.007)	0.124(0.011)	0.096(0.009)	0.05
Occupation farming (Yes =1, no =0)	0.775(0.009)	0.756(0.014)	0.793(0.013)	0.049
Log Farm size (acres)	1.446(0.035)	1.371(0.041)	1.52(0.056)	0.032
N		983	970	

From the original sample, only 1059 males and 1333 females were interviewed during both surveys, the baseline and at the endline. These numbers mean that an adult male (or female) was interviewed in the same household during each wave. Table 9 shows their characteristics for female respondents were similar except for the marginal difference in their age and gender of head of household. The male respondents were majorly household heads, while the female respondents were spouses with a few being heads. The gender of heads of the households was majorly male with a few being female. The average age of the male respondents was 44 years, while that for females was lower at 40 years and 39 years in the treatment and control samples respectively.

Table 9: Characteristics of the male and female respondents in the panel (baseline-endline)

	Male				Female			
	Overall	Treatment	Control	Pvalue	All sample	Treatment	Control	P value
Age of the respondent	45.716(0.452)	45.522(0.628)	45.918(0.652)	0.628	40.286(0.388)	41.022(0.567)	39.583(0.53)	0.06
Relation of the respondent to the head	1.072(0.011)	1.086(0.017)	1.058(0.014)	0.017	1.901(0.013)	1.88(0.019)	1.92(0.018)	0.346

Gender of household head	0.989(0.003)	0.981(0.006)	0.996(0.003)	0.006	0.842(0.01)	0.832(0.015)	0.852(0.014)	0.299
Age of household head	46.794(0.457)	46.966(0.639)	46.615(0.654)	0.639	47.222(0.409)	47.932(0.595)	46.543(0.562)	0.089
N	1059	518	541		1333	685	648	

NB: 1,333 females not 1,335 due to missing variable

7.1 Effects of attrition

Tables 2 and Table 4 show there was overall and differential attrition of the households, and of male and female respondents. We proceeded to check, using descriptive analysis, whether dropping off of households was systematic by testing for differences in characteristics of dropouts in the two samples. Results in Table 2 (in a separate HH folder) show that the dropout households (either because they were not available or did not consent for interview during midline and endline surveys) were similar to the households in the overall sample in most household characteristics except a few. Compared to the original sample, the dropouts: had a smaller household size and adult equivalent; had a younger household head; were more likely to be separated from a spouse; were residing further from a public phone, seller of inorganic fertilizer, agro-dealer, and veterinary service provider. The results further show that, in the sample of dropouts, the households assigned to treated and control groups, are similar to the original samples in all variables except in occupation and farm size. However, the treated sample in original sample had a slightly greater number of households whose heads reported other occupations as their main occupation and farming as their main occupations, and had smaller farm size as well.

Results for the attrition tests using the inverse probability of attrition weights (IPW) procedure show significant attrition effects on two outcomes namely, the acreage under PH5052 and the proportion of households who planted the variety. However, the effects on both outcomes are significant in the regression with and without attrition weights (Table 10), which means that the differential attrition had no effect on the estimated effects on outcomes i.e. did not cause a bias in estimates of the treatment effects. Similarly, results for male (Table 10) and female (Table 11) respondents show that though there was a significant attrition effects on awareness of PH5052 for both gender, and on perception towards NABE15, the effects on both outcomes are significant in the regression with and without attrition weights. In-spite of lack of evidence of attrition bias, we included covariates in the effects model to reduce any residual bias caused by post-treatment differential attrition.

Table 10: Treatment effects with and without attrition weights.

Variable	ATE from (Double Robust)	ATE from regression
Acres under PH5052 season 1	0.004**(0.001)	0.004**(0.001)
Acres under PH5052 season 2	0.001(0.001)	0.001(0.001)

Variable	ATE from (Double Robust)	ATE from regression
Acres under PH5052 all seasons	0.004*(0.002)	0.004*(0.002)
Acres under NABE15 season 1	-0.012(0.011)	-0.001(0.002)
Acres under NABE15 season 2	0.001(0.001)	0.001(0.001)
Acres under NABE15 all season	-0.012(0.012)	0(0.003)
Acres un-recycled improved maize season 1	0.047(0.149)	0.044(0.154)
Acres recycled improved maize season 1	-0.042(0.052)	-0.048(0.053)
Acres local maize season 1	-0.019(0.034)	-0.018(0.034)
Acres mixed maize season 1	0.01(0.042)	0.009(0.042)
Acres un-recycled improved maize season 2	0.032(0.097)	0.03(0.1)
Acres recycle improved maize season 2	-0.039(0.064)	-0.04(0.065)
Acres local maize season 2	-0.011(0.029)	-0.006(0.027)
Acres mixed maize season 2	0.012(0.039)	0.01(0.04)
Acres un-recycled improved maize season all	0.07(0.164)	0.066(0.168)
Acres recycle improved maize season all	-0.052(0.095)	-0.058(0.096)
Acres local maize season all	-0.001(0.097)	0.002(0.098)
Acres mixed maize season all	-0.012(0.008)	-0.012(0.009)
Acres un-recycled improved bean season 1	0.01(0.029)	0.01(0.03)
Acres recycle improved bean season 1	-0.031(0.031)	-0.031(0.031)
Acres local bean season 1	-0.025(0.039)	-0.026(0.041)
Acres mixed bean season 1	-0.026(0.041)	-0.014(0.041)
Acres un-recycled improved bean season 2	0.002(0.014)	0.003(0.014)
Acres recycle improved bean season 2	-0.012(0.024)	-0.01(0.025)
Acres local beans season 2	-0.012(0.03)	-0.007(0.029)
Acres mixed bean season 2	0(0.017)	0.001(0.018)
Acres un-recycled improved bean season all	0.008(0.032)	0.009(0.034)
Acres recycle improved bean season all	-0.023(0.039)	-0.021(0.039)
Acres local beans season all	-0.028(0.06)	-0.026(0.062)
Acres mixed bean season all	-0.023(0.052)	-0.011(0.054)
Acreage under maize	-0.098(0.454)	-0.117(0.462)
Production of Maize (kg)	76.919(272.244)	67.56(279.755)
Yield of Maize (kg/acre)	63.11(52.073)	63.149(53.885)
Acreage under beans	-0.072(0.083)	-0.054(0.083)
Production of beans (kg)	-11.921(37.958)	-12.016(39.377)
Yield of beans (kg/acre)	17.76(39.162)	16.027(38.271)
Acres under maize season 1	-0.014(0.134)	-0.024(0.137)
Acres under maize season 2	0.012(0.123)	0.01(0.126)
Acres under bean season 1	-0.061(0.056)	-0.055(0.058)
Acres under bean season 2	0.027(0.033)	0.035(0.035)
Proportion that planted PH5052 season1	0.002**(0.001)	0.002**(0.001)
Proportion that planted PH5052 season2	0.001(0.001)	0.001(0.001)

Variable	ATE from (Double Robust)	ATE from regression
Proportion that planted NABE15 season1	-0.004(0.005)	0(0.002)
Proportion that planted NABE15 season2	0(0.001)	0(0.001)
Proportion that purchased improved maize seed season 1	0.027(0.06)	0.027(0.061)
Proportion that purchased improved maize seed season 2	0.002(0.051)	0.002(0.051)
Proportion that purchased improved bean seed season 1	-0.003(0.026)	-0.001(0.025)
Proportion that purchased improved bean seed season 2	-0.01(0.027)	-0.007(0.026)
N	3905	3905

7.2 Propensity score analysis and balance tests

The covariates included in the logistic regression to generate propensity scores are provided in Table 11. The selection was informed by theory as well as the need to control/balance the differences observed between the treated and control households in the panel. We included distances to major market and improved seed seller were included in the model to represent the distances to hard and soft infrastructure (roads, electricity, markets and services). The asset and farm size variables reflect on a household's wealth as well as income. The other variables were all included in the model. For the individual level model, we included the respondent's gender, age, relationship to the household head and gender of the household head (Table 12 and 13).

Table 11: Means of covariates in the first and second stage estimations (baseline): Household level

Variables	All sample	Treatment	Control	p-value
Distance to the Major market for farm produce (Km)	7.514(0.196)	6.629(0.248)	8.38(0.3)	0
Distance to the improved seed seller (Km)	8.088(0.189)	7.34(0.261)	8.821(0.271)	0
Log of asset value (UGX)	13.901(0.03)	13.884(0.041)	13.917(0.044)	0.133
Adult Equivalent	5.425(0.06)	5.48(0.086)	5.371(0.084)	0.324
Marital status single	0.023(0.004)	0.019(0.005)	0.027(0.006)	0.162
Marital status married	0.859(0.009)	0.858(0.012)	0.86(0.012)	0.977
Banana Acreage	0.345(0.015)	0.315(0.018)	0.375(0.023)	0.094
Sorghum Acreage	0.06(0.005)	0.059(0.008)	0.062(0.007)	0.151
Sweet potatoes Acreage	0.293(0.011)	0.318(0.017)	0.269(0.013)	0.023
Groundnuts Acreage	0.364(0.013)	0.337(0.017)	0.392(0.02)	0.01
Other crops Acreage	2.115(0.1)	1.905(0.103)	2.319(0.17)	0.039
Salaried occupation	0.042(0.005)	0.037(0.007)	0.048(0.008)	0.295
Gender of the respondent (male = 1, female =0)	0.88(0.008)	0.878(0.012)	0.881(0.011)	0.713

Education level of the household head/respondent	2.347(0.021)	2.339(0.03)	2.354(0.029)	0.403
Age of the respondent	47.06(0.354)	47.547(0.5)	46.583(0.5)	0.464
Log of farmsize	1.863(0.017)	1.785(0.024)	1.939(0.024)	0
N	1953	983	970	

Table 12: Means of covariates in the first and second stage estimations (baseline): Male respondents

Variables	All sample	Treatment	Control	p-value
Distance to major produce market	7.583(0.244)	6.658(0.305)	8.578(0.38)	0
Distance to the nearest improved seed seller	8.467(0.242)	7.768(0.338)	9.217(0.344)	0.003
Log of asset value	13.947(0.037)	13.859(0.051)	14.042(0.053)	0.016
Adult Equivalent	5.528(0.077)	5.58(0.11)	5.472(0.108)	0.483
Single	0.017(0.004)	0.013(0.005)	0.022(0.006)	0.268
Married	0.885(0.01)	0.869(0.014)	0.902(0.013)	0.092
Banana Acreage	0.351(0.02)	0.332(0.026)	0.371(0.029)	0.314
Sorghum Acreage	0.06(0.007)	0.058(0.009)	0.063(0.012)	0.731
Sweet potatoes Acreage	0.284(0.014)	0.313(0.021)	0.253(0.017)	0.028
Groundnuts Acreage	0.372(0.017)	0.338(0.023)	0.408(0.026)	0.037
Other crops Acreage	2.216(0.134)	1.981(0.137)	2.468(0.235)	0.067
Salaried	0.023(0.005)	0.015(0.005)	0.031(0.008)	0.067
Education level of the household head	7.06(0.142)	7(0.19)	7(0.213)	0.107
Age of the respondent	46(0.45)	45(0.61)	46(0.66)	0.693
Age Squared	2296(45.17)	2271(61.96)	2322(66)	0.599
Age tripled	125841(3760.08)	123593(5207)	128258(5439)	0.566
Log of farmsize	1.879(0.021)	1.81(0.029)	1.953(0.031)	0.001
N	1442	730	712	

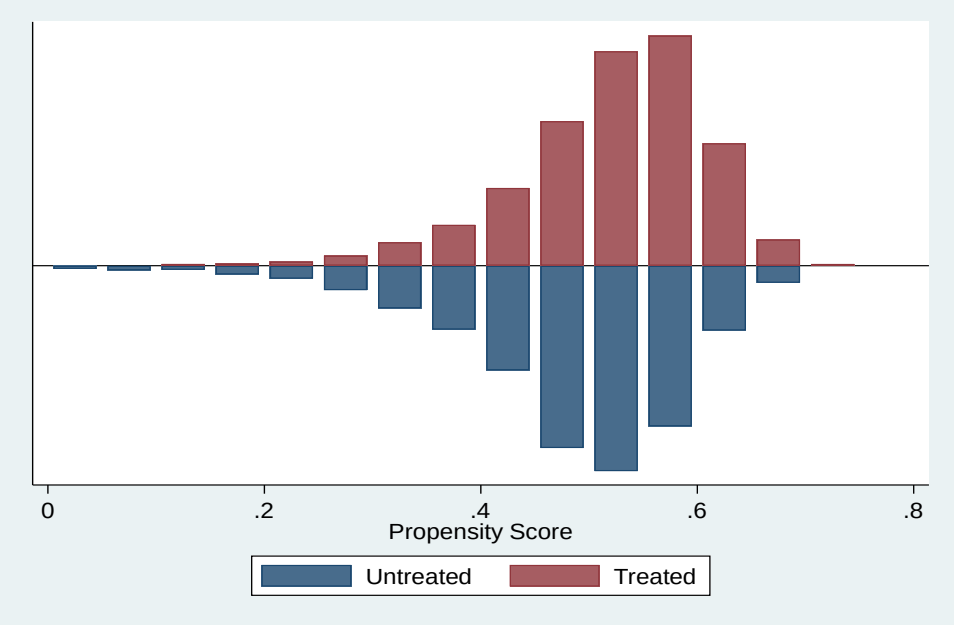
Table 13: Means of covariates in the first and second stage estimations (baseline): Female respondents

Variables	All sample	Treatment	Control	p-value
Distance to major produce market	7.693(0.217)	6.698(0.267)	8.659(0.337)	0
Distance to the nearest improved seed seller	7.553(0.195)	6.669(0.253)	8.412(0.293)	0
Log of asset value	13.789(0.033)	13.76(0.046)	13.817(0.048)	0.386
Adult Equivalent	5.344(0.065)	5.411(0.095)	5.278(0.09)	0.309
Single	0.021(0.004)	0.02(0.005)	0.022(0.006)	0.76
Married	0.772(0.011)	0.782(0.016)	0.762(0.016)	0.373

Banana Acreage	0.336(0.015)	0.327(0.022)	0.344(0.022)	0.585
Sorghum Acreage	0.078(0.007)	0.069(0.009)	0.086(0.011)	0.216
Sweet potatoes Acreage	0.314(0.012)	0.34(0.018)	0.289(0.016)	0.03
Groundnuts Acreage	0.366(0.015)	0.331(0.019)	0.4(0.022)	0.019
Other crops Acreage	2.015(0.103)	1.859(0.117)	2.166(0.167)	0.135
Salaried	0.043(0.006)	0.046(0.008)	0.04(0.008)	0.606
Education level of the household head	6.87(0.133)	7(0.188)	7(0.188)	0.54
Age of the respondent	40(0.39)	41(0.55)	40(0.54)	0.191
Age Squared	1818(35.11)	1863(51.53)	1775(48)	0.212
Age tripled	90907(2675.96)	94312(4017)	87597(3548)	0.21
Log of farmsize	1.832(0.02)	1.753(0.028)	1.908(0.028)	0
N	1648	819	829	

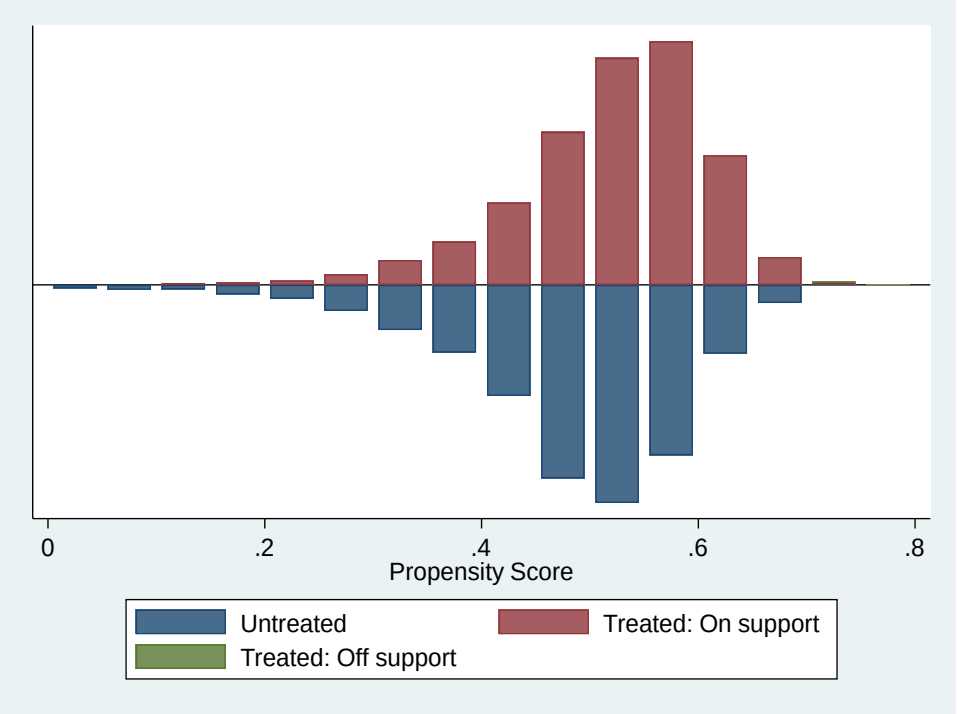
Graphical representation of the results before and after propensity score matching (Figures 1 - 6) show a good overlap between the treated and control samples. Most of the households and respondents are on-support. Only four (4) households, two (2) male and two (2) female respondents were dropped (off-support). The propensity score was used for creating the inverse probability weights for the treated and control samples. As indicated in earlier section, the weighting reduces the bias between the treated and control samples. Quantitative and qualitative post-weighting balance test results are provided in Figures 7 - 9, and in Tables 14 - 16. Using propensity score, the household level and individual samples were divided into quintiles to create strata or sub-samples with equal propensity scores. The balance tests for each block are provided in the Appendix Tables 1 - 9.

Distribution of Propensity Score across Treatment and Control Groups at Household level



Treatment= 1,961 Control= 1,945 N=3906

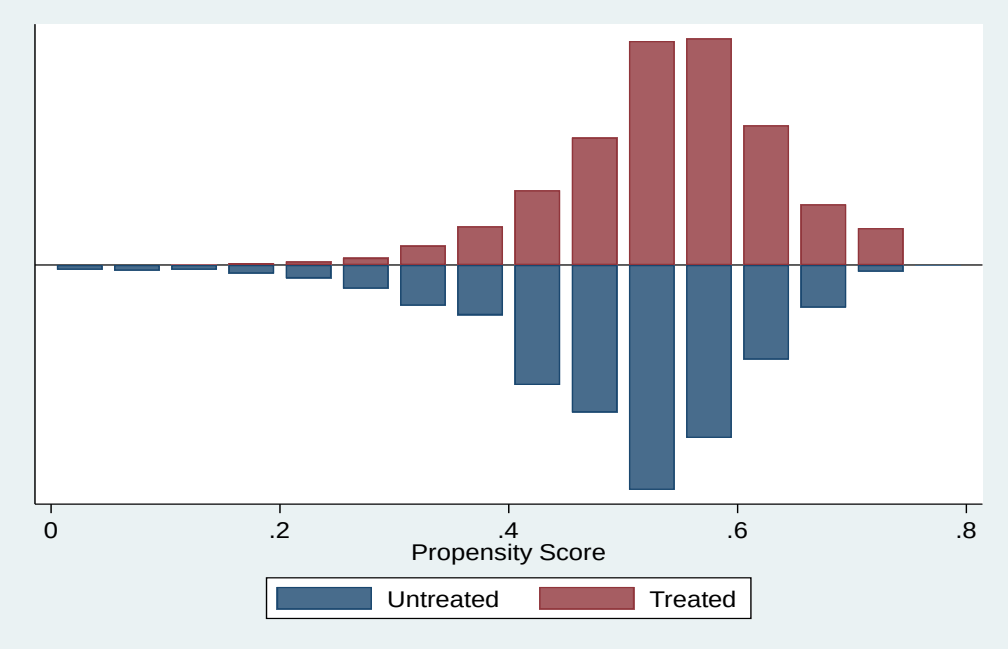
Figure 1: Propensity score graph showing distribution of Propensity Score across Treatment and Control Groups for all household sample before matching



Note: Only 4HHs are off support and 3901 are on support

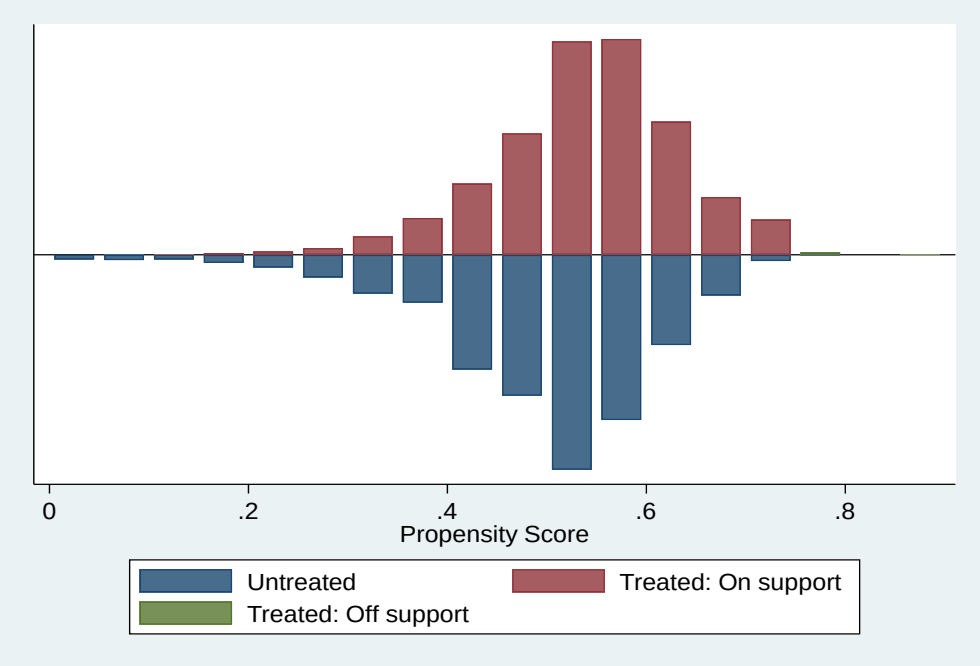
Figure 2: Propensity score graph showing distribution of Propensity Score across Treatment and Control Groups for all household sample after matching

Distribution of Propensity Score across Treatment and Control Groups at individual level: Male respondents



Treatment= 1,101 Control 1,107 N=2,118

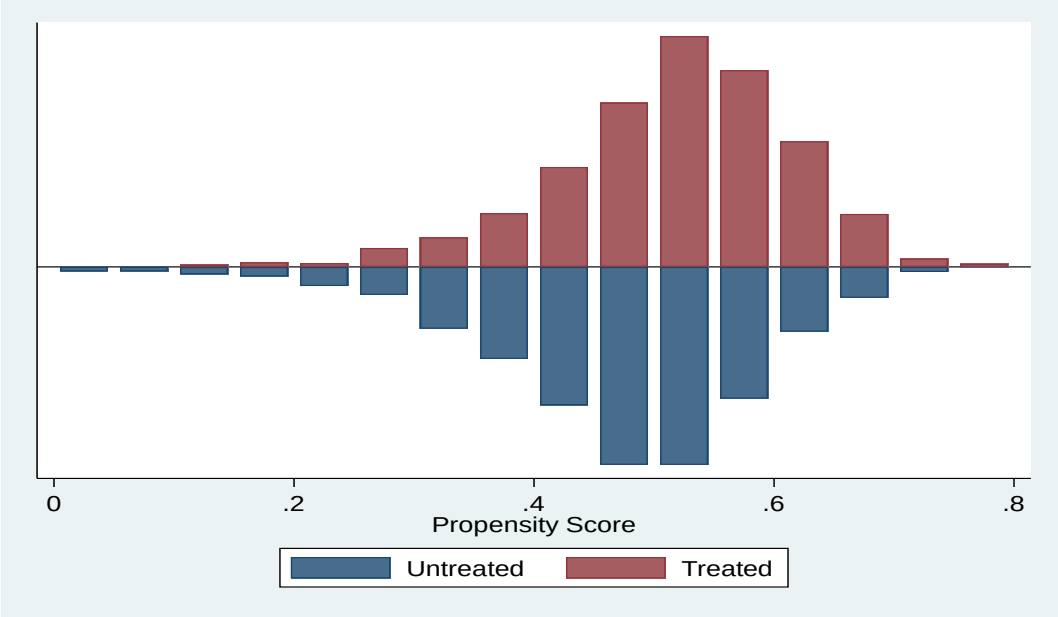
Figure 3: Propensity score graph showing distribution of Propensity Score across Treatment and Control Groups among Male Respondents before matching



Note: Treatment= 1,094 Control= 1,017, 4 respondents are off support, 2111 respondents are on support and 3 respondents are missing

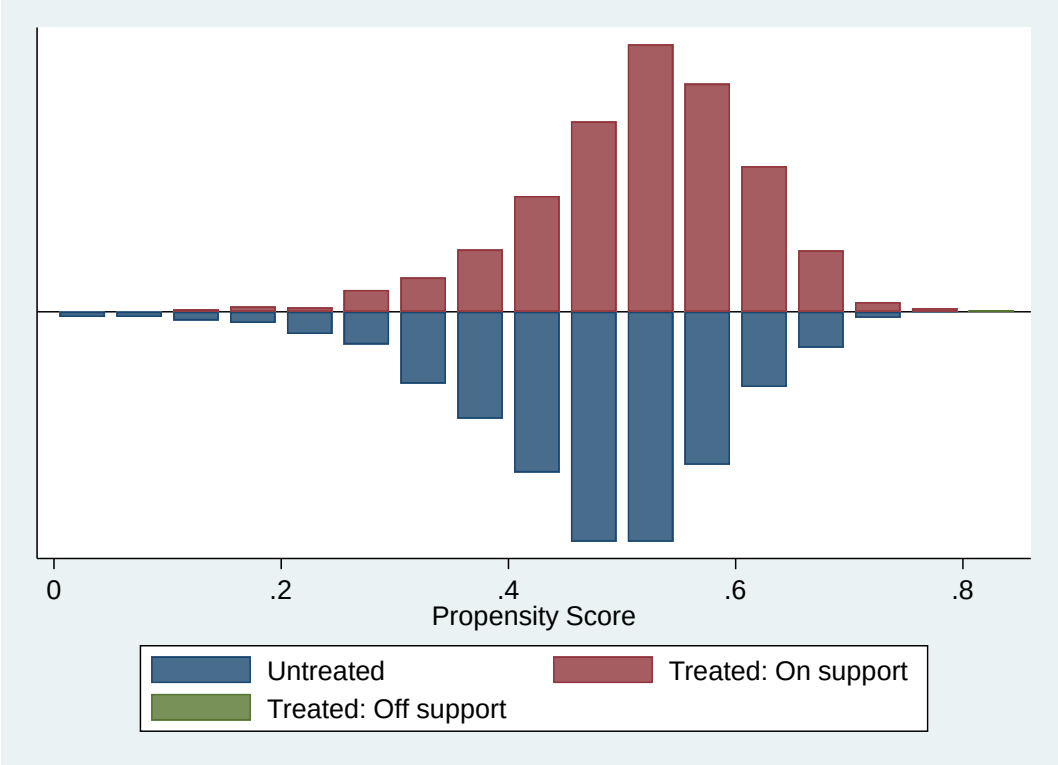
Figure 4: Propensity score graph showing distribution of Propensity Score across Treatment and Control Groups among Male Respondents after matching

Distribution of Propensity Score across Treatment and Control Groups at individual level: Female respondents



Treatment= 1,317 Control= 1,351 N= 2,668

Figure 5: Propensity score graph showing distribution of Propensity Score across Treatment and Control Groups among Female Respondents before matching



Note: 2 respondents are off support and 2665 respondents are on support, 2 are missing

Figure 6: Propensity score graph showing distribution of Propensity Score across Treatment and Control Groups among Female Respondents after matching

Table 14 and Figure 7 shows a balance between the treated and control samples at the household level in all covariates because the remaining sample bias is small. Similarly, Tables 15 and 16, and Figures 8 - 9 show a balance in the two samples for male and female respondents. The within strata biases for each covariate are provided in the appendix (Appendix Tables 1 - 9). They are within the proposed maximum standardized differences for specific covariates (Austin, 2009; Stuart el al., 2013). These results mean that using inverse probability weights was adequate in removing selection that would biases the treatment effect estimates. We therefore proceeded to estimate treatment effects by including the weights and all covariates which were included in the treatment (logistic) model.

Table 14: Sample bias in overall sample before and after matching (household level)

	Unmatched sample			Matched sample		
Variable	Mean Treated	Control	%bias	Mean Treated	Control	%bias
Distance to major produce market	5.73	7.34	(22.90)	5.73	5.88	(2.20)
Distance to the nearest improved seed seller	6.92	8.65	(24.10)	6.92	7.26	(4.70)
Log of asset value	13.63	13.75	(8.80)	13.63	13.63	-
Adult Equivalent	5.38	5.26	5.20	5.38	5.30	3.50
Single	0.01	0.02	(4.10)	0.01	0.01	(0.40)
Married	0.85	0.86	(1.40)	0.85	0.85	0.30
Banana Acreage	0.32	0.38	(10.90)	0.32	0.33	(1.00)
Sorghum Acreage	0.08	0.08	-	0.08	0.09	(1.50)
Sweet potatoes Acreage	0.34	0.34	0.70	0.34	0.33	2.90
Groundnuts Acreage	0.37	0.42	(6.90)	0.37	0.38	(0.60)
Other crops Acreage	2.40	2.90	(11.50)	2.40	2.43	(0.60)
Salaried	0.04	0.05	(3.80)	0.04	0.04	0.10
Gender	0.88	0.88	(0.90)	0.88	0.88	1.00
Education level of the household head/respondent	2.33	2.36	(3.90)	2.33	2.32	0.50
Age of the household head/respondent	48.00	47.00	3.10	48.00	48.00	(0.20)
Age Squared	2,490.00	2,455.00	2.30	2,490.00	2,496.00	(0.40)
Age tripled	140,000.00	140,000.00	1.00	140,000.00	140,000.00	-
Log of farmsize	1.58	1.69	(14.20)	1.58	1.60	(2.90)

Table 15: Sample bias before and after matching: male respondents

	Unmatched			Matched		
Variable	Mean Treated	Control	%bias	Mean Treated	Control	%bias

Distance to major produce market	5.86	7.53	(23.30)	5.86	6.01	(2.10)
Distance to the nearest improved seed seller	7.55	8.87	(17.30)	7.55	7.83	(3.60)
Log of asset value	13.67	13.90	(18.80)	13.67	13.71	(3.40)
Adult Equivalent	5.55	5.46	3.90	5.55	5.52	1.40
Single	0.01	0.02	(7.40)	0.01	0.01	0.70
Married	0.88	0.91	(11.00)	0.88	0.90	(7.60)
Banana Acreage	0.34	0.40	(10.30)	0.34	0.34	(0.90)
Sorghum Acreage	0.08	0.08	2.60	0.08	0.08	-
Sweet potatoes Acreage	0.35	0.35	0.20	0.35	0.34	(1.70)
Groundnuts Acreage	0.38	0.42	(6.60)	0.38	0.38	0.30
Other crops Acreage	2.62	3.20	(11.50)	2.62	2.64	(0.40)
Salaried	0.02	0.03	(8.80)	0.02	0.02	0.80
Education level of the household head/respondent	6.81	7.31	(10.80)	6.81	6.87	(1.20)
Age of the household head/respondent	47.00	47.00	0.50	47.00	47.00	(0.60)
Age Squared	2,430.00	2,438.00	(0.60)	2,430.00	2,442.00	(0.80)
Age tripled	140,000.00	140,000.00	(1.20)	140,000.00	140,000.00	(0.90)
Log of farmsize	1.63	1.74	(14.20)	1.63	1.64	(1.20)

Table 16: Sample bias before and after matching: female respondents

	Female respondents (U)			Female respondents (M)		
Variable	Mean Treated	Control	%bias	Mean Treated	Control	%bias
Distance to major produce market	5.84	7.56	(23.80)	5.84	5.94	(1.50)
Distance to the nearest improved seed seller	6.46	8.20	(25.60)	6.46	6.72	(3.70)
Log of asset value	13.59	13.69	(7.40)	13.59	13.59	(0.10)
Adult Equivalent	5.48	5.30	7.40	5.48	5.40	3.10
Single	0.02	0.01	1.60	0.02	0.02	0.20
Married	0.79	0.77	4.10	0.79	0.79	(0.50)
Banana Acreage	0.32	0.38	(10.40)	0.32	0.33	(0.60)
Sorghum Acreage	0.09	0.09	(0.20)	0.09	0.10	(1.80)
Sweet potatoes Acreage	0.39	0.37	3.80	0.39	0.37	3.10
Groundnuts Acreage	0.38	0.41	(5.10)	0.38	0.38	0.60
Other crops Acreage	2.42	2.93	(12.00)	2.42	2.43	(0.20)
Salaried	0.05	0.05	2.00	0.05	0.05	1.10
Education level of the household head/respondent	7.00	7.00	3.80	7.00	7.00	1.80
Age of the household head/respondent	42.00	41.00	6.90	42.00	42.00	1.60
Age Squared	1,983.00	1,897.00	6.40	1,983.00	1,960.00	1.70
Age tripled	100,000.00	96,526.00	6.10	100,000.00	1.00	5.10
Log of farmsize	1.57	1.69	(16.50)	1.57	1.59	(2.80)

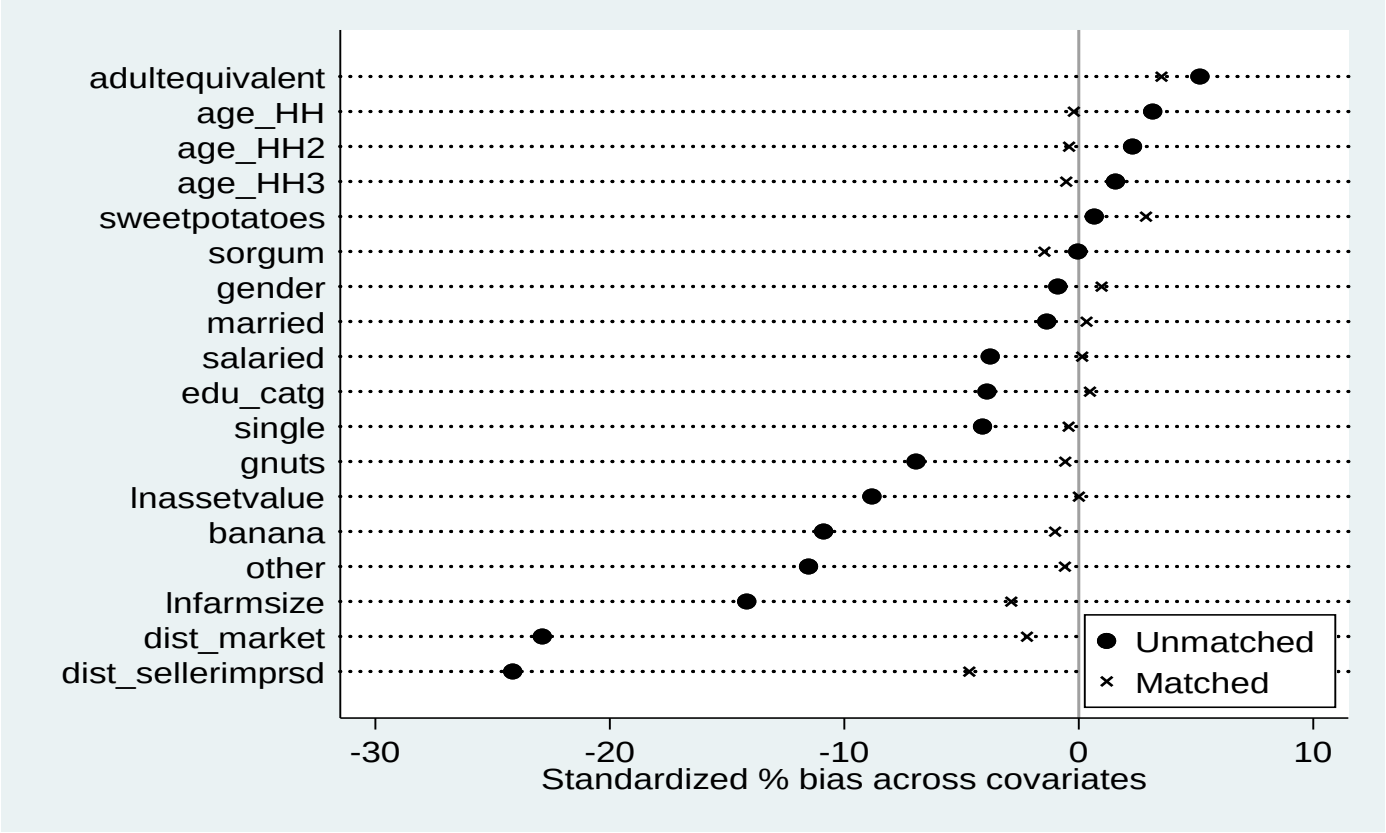


Figure 7: Dot graph showing covariate balance before and after matching (household level)

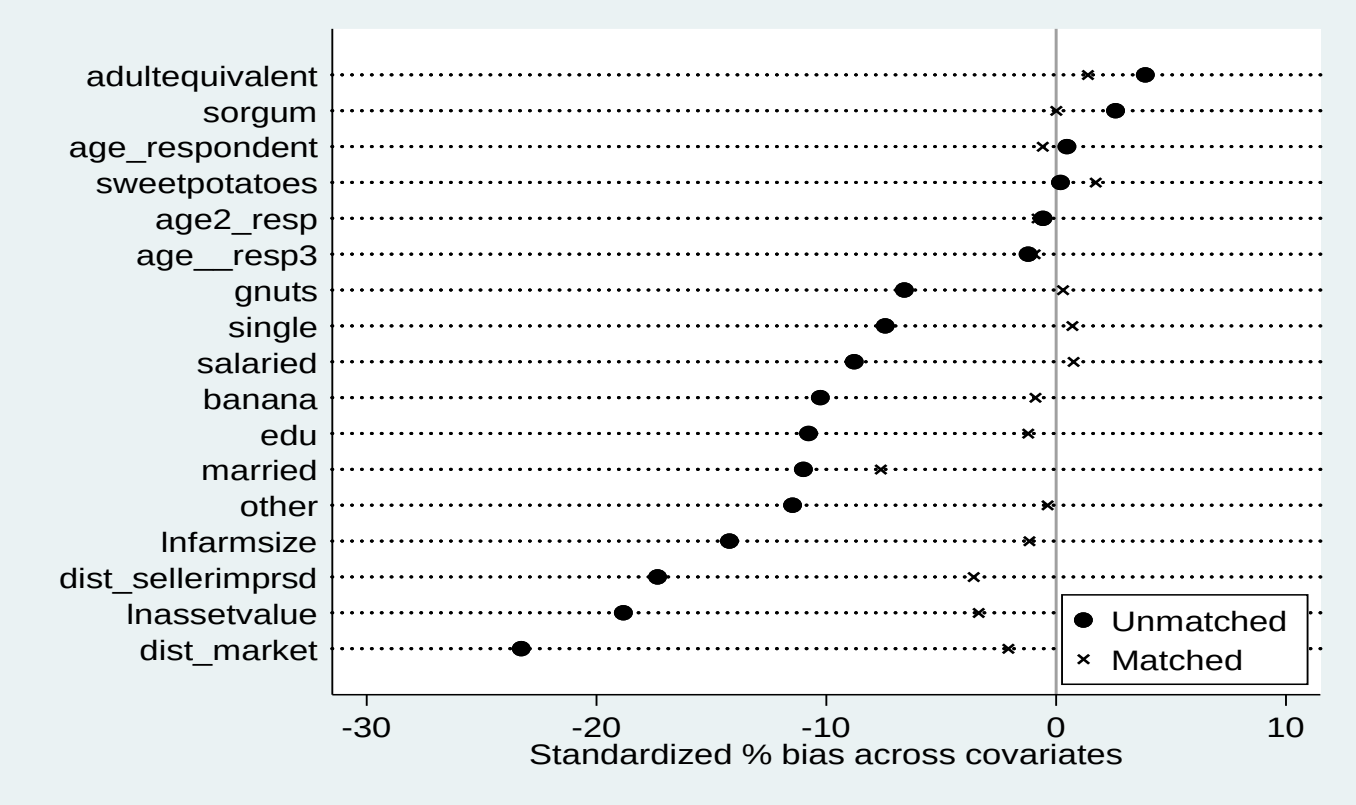


Figure 8: Dot graph showing covariate balance before and after matching (male respondents)

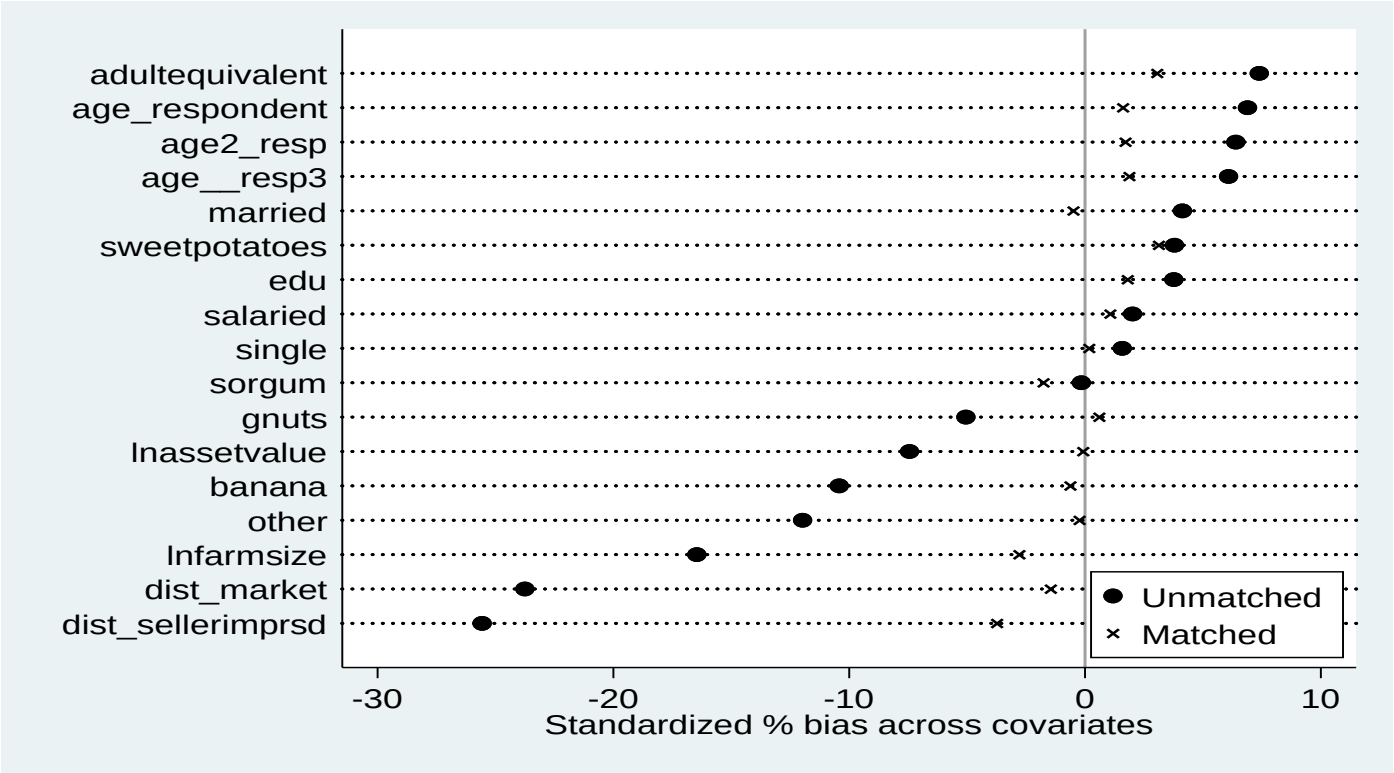


Figure 9: Dot graph showing covariate balance before and after matching (female respondents)

7.3 Monitoring Results

Farmer awareness and involvement in promotion campaign by survey by sample by gender

Table 5 shows there are farmers in the treated and control sample who visited the demos and attended field days held by the implementing agency. The N stands for the number that was aware, a question that was asked before asking whether they attended or heard. The number attending demos increased progressively from the first to the second year after commencement of the promotion campaign, however there was no increment in farmers who attended field days or heard the radio adverts. Out of those who were aware about each of the promotions, only 23 - 24 percent of the female and male farmers visited a demo, and only 21 percent and 16 percent of the male and female farmers attended a field day. Though more farmers were aware about the demos, field days and radio programmes, to some extent, these numbers reflect on the realities in the area of study in terms of farmers' response to such promotion campaigns and also on the capacity of small seed companies to mount an effective promotion campaign.

Sources of information about improved seed

Farmers rely on several sources for information about improved seed. Results in Table 17 and 18 and show that exposure to demos and field days statistically increased the proportion of farmers (both male and females) sourcing information on improved seed from demos and field days. The effect was 3.4 percent and 2.4 percent for male and female farmers respectively. The impact of exposure was not statistically significant on farmers' reliance on the other sources.

Table 17: Effects of exposure to demos and field days on sources of inform on improved seed: Male respondents

		Average treatment effect		
Indicator	Outcome variables	Regression	Double Robust Regression	
		Bootstrap	Cluster-Robust Standard Error	Robust Standard Error
Sources of Information on Improved seeds	Demonstration plots	0.034(0.01)***	0.035(0.012)***	0.035(0.01)***
	Brochures	0.001(0.002)	0.001(0.002)	0.001(0.002)
	Field days	0.002(0.004)	0.002(0.004)	0.002(0.004)
	Radio	0.013(0.015)	0.013(0.027)	0.013(0.018)
	Personal communication	0.001(0.02)	-0.003(0.03)	-0.003(0.022)
	N	2111	2111	2111

Table 18: Effects of exposure to demos and field days on sources of inform on improved seed: Female respondents

		Average treatment effect		
Indicator	Outcome variables	Regression	Double Robust Regression	
		Bootstrapped	Cluster-Robust Standard Error	Robust Standard Error
Sources of Information on Improved seeds	Demonstration plots	0.024(0.009)***	0.026(0.011)**	0.026(0.009)***
	Brochures	0.002(0.002)	0.002(0.002)	0.002(0.002)
	Field days	0.001(0.003)	0.001(0.003)	0.001(0.003)
	Radio	0.004(0.014)	0.002(0.024)	0.002(0.016)
	Personal communication	-0.02(0.02)	-0.022(0.026)	-0.022(0.018)
	N	2665	2665	2665

***, ** and * imply significant at 1%, 5% and 10% respectively

7.4 Average Treatment Effects Using IPW

Tables 17 to 28 show results of effects of exposure based on the two-stage inverse probability weighting (IPW) regression with robust and cluster-robust standard errors, and a bootstrapped regression without weighting. The results are changes which occurred post-treatment, between the baseline and the endline. The coefficient (direction and magnitude of effects), the standard error, level of significance, and the sample size are all provided. For household level results, season 2 refers to the cropping season August – January, while season 1 refers to period March – September. The overall results refers to changes for the whole year.

Table 17 and 18 above provide the effect of exposure on farmers' source of information on improved seed. Next we provide results for awareness and attitude towards improved seed, and perception and knowledge of the improved varieties, and these are at individual level for male and female respondents[5] (Tables 19 - 23). Thereafter results showing use of the improved varieties (proportion of households using improved seed) and demand (acreage allocated) for the two varieties being promoted and other improved seed are provided. Finally results for change in yield, and production are presented. The household level results are provided in Tables 24 - 28. Tables 21 – 24 show means of differences in outcomes (between

[5] Mainly man and wife but other male or female adults were interviewed if either one was unavailable

endline and baseline) for the control sample. Additional tables containing descriptives are in a separate folder (docs). The findings are organized according to the research hypothesis.

Research Hypothesis I: Boosting radio messages by establishing demonstration plots and holding field days to create awareness and promote new improved varieties would induces a greater change in the farmers' adoption behavior (awareness, perception and knowledge) in areas where the demos have been established.

Effect of exposure to demos and field days on farmers' awareness of improved seed

The effect of exposure among male respondents on awareness was positive and statistically significant (1%) for improved seed, improved maize seed, PH5052 and K131 (Table 19). For female respondents, exposure to demos and field days significantly increased awareness of PH5052, K131 and K132 (Table 20). The difference in increase in awareness of improved maize between males and females is not surprising since maize tends to be more of a male crop as it contributes significantly to household income.

There was no significant effect of exposure on NABE15, the new beans variety promoted by the seed company. Instead, awareness improved significantly on older varieties such as K131, K132 among female spouses and K131 for male spouses. The non-significant effect of exposure NABE15 is explainable. The company did not stock seed of the new varieties with the agro-dealers and the distance to agro-dealers was large, which increased the cost of accessing the new seed. Besides, field days were conducted during the harvesting period for maize from the demo plots when the bean crop had already been harvested. Usually, beans are harvested before maize and the resources available were not sufficient to hold separate field days for the maize and bean varieties being promoted.

These results are consistent with findings from the qualitative survey which show the awareness was very high especially the treatment areas and lower awareness in sub-counties where the promotion campaign was not successfully implemented.

Table 19: Effects of exposure to demos and field days on awareness of improved seed: Male respondents

		Average treatment effects	
Indicator	Outcome variables	Regression	Double Robust Regression

		bootstrap	Cluster-Robust Standard Error	Robust Standard Error
Awareness of improved seed	Awareness of improved seed	0.031(0.01)***	0.028(0.017)*	0.028(0.012)***
	N	2111	2111	2111
	Awareness of maize improved seed	0.031(0.014)**	0.03(0.019)	0.03(0.014)**
	Awareness of bean improved seed	-0.018(0.025)	-0.017(0.024)	-0.017(0.021)
	N	2040	2040	2040
Awareness of maize improved seed	Aware of PH5052	0.009(0.004)**	0.009(0.004)**	0.009(0.004)**
	Aware of Longe5	0.012(0.023)	0.01(0.029)	0.01(0.022)
	Aware of Longe6	0.015(0.012)	0.013(0.015)	0.013(0.011)
	Aware of Longe4	-0.019(0.016)	-0.021(0.017)	-0.021(0.013)
	N	2111	2111	2111
Awareness of bean improved seed	Aware of NABE15	0.003(0.003)	0.003(0.004)	0.003(0.004)
	Aware of K131	0.059(0.018)***	0.059(0.03)**	0.059(0.02)***
	Aware of K132	0.008(0.017)	0.009(0.018)	0.009(0.016)
	Aware of Kanyebwa	-0.01(0.013)	-0.009(0.016)	-0.009(0.013)
	N	2111	2111	2111

Table 20: Effects of exposure to demos and field days on awareness of improved seed: Female respondents

		Average treatment effects		
Indicator	Outcome variables	Regression	Double Robust Regression	
		Bootstrap	Cluster-Robust Standard Error	Robust Standard Error
Awareness of improved seed	Awareness of improved seed	-0.011(0.01)	-0.011(0.018)	-0.011(0.013)
	N	2665	2665	2665
	Awareness of maize improved seed	-0.022(0.016)	-0.023(0.024)	-0.023(0.016)
	Awareness of bean improved seed	-0.018(0.02)	-0.018(0.021)	-0.018(0.019)
	N	2546	2546	2546
Awareness of maize improved seed	Aware of PH5052	0.005(0.002)**	0.005(0.003)*	0.005(0.002)**
	Aware of Longe5	0.02(0.019)	0.02(0.026)	0.02(0.019)
	Aware of Longe6	0.012(0.011)	0.013(0.014)	0.013(0.01)
	Aware of Longe4	-0.016(0.011)	-0.015(0.014)	-0.015(0.011)

	N	2665	2665	2665
Awareness of bean improved seed	Aware of NABE15	-0.001(0.003)	-0.001(0.004)	-0.001(0.003)
	Aware of K131	0.033(0.018)*	0.032(0.027)	0.032(0.017)*
	Aware of K132	0.028(0.015)*	0.03(0.016)*	0.03(0.014)**
	Aware of Kanyebwa	-0.001(0.016)	0.001(0.017)	0.001(0.014)
	N	2665	2665	2665

***, ** and * imply significant at 1%, 5% and 10% respectively

Effect of exposure on attitudes and perception of improved seed

Tables 21 – 22 show the effects of exposure on attitude, perception and knowledge of male and female respondents. Exposure had a statistically significant and positive effect on attitude of males towards improved varieties of beans and a positive effect on the attitude of females towards improved varieties of maize. The non-significance of the effect of exposure on attitude of males towards improved maize seed and females towards improved bean seed probably implies that the attitude was already high pre-exposure for males towards maize seed and for female towards bean seed.

Exposure improved male farmers' perception of the improved bean variety being promoted and the female farmers' perception of the improved maize variety being promoted. Further, there was statistically significant improvement in knowledge about PH5052 and NABE15 among male farmers but not among the female farmers. Results from the combined sample (male and female) show that exposure significantly improved farmers: attitude towards improved maize and bean varieties; perception and knowledge about the improved maize variety being promoted (PH5052), but no change in farmers perception or knowledge about the bean variety being promoted - NABE15 (Table 23).

Findings from the qualitative study show that participants had both positive and negative perceptions about PH5052 and NABE15. Participants had a positive perception towards PH5052 because; the yields are high; it is drought resistant; the grains are big; has white bright colour which is attractive hence, marketable; and is early maturing/maturity period compared with varieties grown in area. However, participants felt that there was a downside of PH5052. Participants who planted the variety faced several constraints such as high costs because it requires fertilizer application and pesticides, they do not have enough resources for proper and timely weeding, and the variety is easily attacked by fall army worms and weevils. One has to sell the maize grain in the shortest time possible to avoid incurring the losses in storage. Moreover, the indicated that the seeds are not available or accessible because one has to travel for long distances to the major towns to buy the seed. The seed is also not always in stock at the agro dealer shop.

On the bean variety NABE15, participants said that it is short maturing; has high yields under good environmental conditions; it can resist pests and diseases, and its soup is thick and tasty and thick. However, the flowers are delicate and fall during heavy rains; and does not tolerate long dry spells. They also indicated that the seed is not commonly available (means always when farmer wants to buy it). Participant's preference was for other bean seed types because they are marketable and NABE15 is not as expressed in this statement "*NABE15 is high yielding but there is no market. Even I tried to sell to my neighbours but no one wanted to buy'.* Another farmer said '*I eat all the beans produced with my family*". Probably because the bean takes too long to cook and change colour if not dried properly.

The seed supply was poor because participants observed that even when "the demand for PH5052 and NABE15 went up, the seed company could not supply the seeds'. This was confirmed by and agro-dealers who indicated there was 'there was late delivery of the seed though the demand was high'.

Table 21: Effects of exposure to demos and field days on attitudes and perception of improved seed: Male respondent

		Average treatment effects		
Indicator	Outcome variables	Regression	Double Robust Regression	
		Bootstrap	Cluster-Robust Standard Error	Robust Standard Error
Attitude towards improved maize and beans	Attitude towards maize improved seed	0.008(0.012)	0.009(0.015)	0.009(0.012)
	N	1956	1956	1956
	Attitude towards bean improved seed	0.023(0.011)**	0.024(0.014)*	0.024(0.013)*
	N	1896	1896	1896
Perception	Perception towards maize improved varieties	0.139(0.111)	0.145(0.101)	0.145(0.095)
	N	153	153	153
	Perception towards beans improved varieties	0.226(0.132)*	0.23(0.132)*	0.23(0.125)*
		100	100	100
Knowledge	Knowledge about PH5052	0.116(0.058)***	0.12(0.049)**	0.12(0.049)**
	N	140	140	140
	Knowledge about NABE15	0.133(0.05)***	0.138(0.048)***	0.138(0.045)***
	N	93	93	93

Table 22: Effects of exposure to demos and field days on attitudes and perception of improved seed: Female respondents

		Regression model (ATE)		
Indicator	Outcome variables	Regression	Double Robust Regression	
		Bootstrap	Cluster-Robust Standard Error	Robust Standard Error
Attitude towards improved maize and beans	Attitude towards maize improved seed	0.024(0.011)**	0.024(0.014)*	0.024(0.012)**
	N	2335	2335	2335
	Attitude towards bean improved seed	0.009(0.009)	0.009(0.013)	0.009(0.011)
	N	2376	2376	2376
Perception	Perception towards maize improved varieties	0.224(0.122)*	0.214(0.132)	0.214(0.118)*
	N	115	115	115
	Perception towards beans improved varieties	-0.222(0.291)	-0.252(0.205)	-0.252(0.203)
		62	62	62
Knowledge	Knowledge about PH5052	0.053(0.05)	0.054(0.056)	0.054(0.048)
	N	108	108	108
	Knowledge about NABE15	0.015(0.124)	0.006(0.064)	0.006(0.067)
	N	56	56	56

***, ** and * imply significant at 1%, 5% and 10% respectively

Table 23: Effects of exposure to demos and field days on attitudes and perception of improved seed: combined responses from male and female respondents

		Average treatment effects		
Indicator	Outcome variables	Regression	Double Robust Regression	
		Bootstrap	Cluster-Robust Standard Error	Robust Standard Error
Attitude towards improved maize and beans	Attitude towards maize improved seed	0.018(0.008)**	0.017(0.027)	0.017(0.008)**
	N	4291	4291	4291
	Attitude towards bean improved seed	0.015(0.007)**	0.015(0.018)	0.015(0.008)*

	N	4272	4272	4272
Perception	Perception towards maize improved varieties	0.177(0.067)***	0.168(0.082)*	0.168(0.071)**
	N	268	268	268
	Perception towards beans improved varieties	0.038(0.127)	0.026(0.071)	0.026(0.113)
		162	162	162
Knowledge	Knowledge about PH5052	0.085(0.034)**	0.086(0.047)*	0.086(0.031)***
	N	248	248	248
	Knowledge about NABE15	0.067(0.045)	0.064(0.036)*	0.064(0.037)*
	N	149	149	149

Effect of exposure on households' use and demand for improved seed

Research Hypothesis II: Establishment of demonstration plots and field days to showcase new improved varieties will lead to a greater adoption of the new improved varieties being promoted in areas where the demos have been established.

Exposure to demos positively affected the acreage planted with PH052 but not NABE15 (Table 24). This result is consistent with the individual level results that revealed greater awareness about improved varieties in general and about PH5052, a positive attitude towards improved maize and bean varieties in general, and an improvement in perception and knowledge about PH5052. The effect on PH5052 acreage was significant for season 1 but not season 2. During the policy influence meetings, representatives from the local seed companies attributed this to late delivery of improved seed by the seed companies in season 2 due to an overlap of the harvesting and planting periods.

Table 24: Effects of exposure to demos and field days on acreage under new improved seed

		Average treatment effects		
Indicator	Outcome variables	Regression	Double Robust Regression	
		Bootstrap	Cluster-Robust Standard Error	Robust Standard Error
	Acres under PH5052 season 1	0.004(0.002)*	0.004(0.002)*	0.004(0.002)*
	Acres under PH5052 season 2	0.001(0.001)	0.001(0.001)	0.001(0.001)

		Average treatment effects		
Indicator	Outcome variables	Regression	Double Robust Regression	
		Bootstrap	Cluster-Robust Standard Error	Robust Standard Error
Acreage Under PH5052	Acres under PH5052 all seasons	0.004(0.002)*	0.004(0.002)	0.004(0.002)
	N	3901	3901	3901
Acreage Under NABE15	Acres under NABE15 season 1	-0.001(0.002)	-0.001(0.002)	-0.001(0.002)
	Acres under NABE15 season 2	0.001(0.001)	0.001(0.002)	0.001(0.002)
	Acres under NABE15 all season	0(0.003)	0(0.002)	0(0.002)
	N	3901	3901	3901

***, ** and * imply significant at 1%, 5% and 10% respectively

Household level results further show that exposure had a positive and statistically significant effect of the proportion of households that planted PH052 in season 1 but not season 2 (Table 25). There was however no effect on proportion planting NABE15 probably because the field days were held at the time of harvesting maize when the bean crop had already been harvested. This may have affected the information flow from field days and hence the effect of exposure on adoption improved bean seed.

The exposure also increased the proportion of farmers who purchased improved maize in general in the first season but not the second season. From the qualitative survey, it was found out that improved seed in the second season is delivered late because the planting coincides with seed harvesting, and that seed companies do not have enough quantities during the short time difference between planting and seed harvesting. There was no effect on proportion planting improved bean varieties which is consistent with findings from the qualitative study showing that farmers do not see a difference between improved seed and their own farm-saved seed.

The low magnitude of effects can be explained by observations made by participants during the qualitative study that the seeds were not accessible since they had to travel for long distances to major towns to purchase them. Moreover, the seeds were not available all the time which was in concurrence with what the agro-dealer had said. The delivery of the seed was particularly late during the second season, which may have led to purchases of other improved seed (effects on the proportion of farmers who planted unrecycled improved seed is much higher the proportion who planted PH5052.

Table 25: Effects of exposure to demos and field days on proportion of households that planted new seed varieties

		Average treatment effect		
Indicator	Outcome variables	Regression	Double Robust Regression	
		Bootstrap	Cluster-Robust Standard Error	Robust Standard Error
Proportion that planted PH5052	Proportion that planted PH5052 season1	0.002(0.001)**	0.002(0.001)**	0.002(0.001)**
	Proportion that planted PH5052 season2	0.001(0.001)	0.001(0.001)	0.001(0.001)
Proportion that planted NABE15	Proportion that planted NABE15 season1	0(0.002)	0(0.002)	0(0.002)
	Proportion that planted NABE15 season2	0(0.001)	0(0.001)	0(0.001)
Proportion that purchased improved maize seed	Proportion that purchased improved maize seed season 1	0.028(0.013)**	0.027(0.024)	0.027(0.015)*
	Proportion that purchased improved maize seed season 2	0.001(0.015)	0(0.02)	0(0.013)
Proportion that purchased improved bean seed	Proportion that purchased improved bean seed season 1	-0.001(0.012)	-0.001(0.016)	-0.001(0.013)
	Proportion that purchased improved bean seed season 2	-0.007(0.012)	-0.007(0.014)	-0.007(0.011)
	N	3901	3901	3901

***, ** and * imply significant at 1%, 5% and 10% respectively

The results of the effects of exposure on acreage planted to different types of maize seed are presented in Table 26. The exposure resulted to a statistically significant increase in the acreage planted with unrecycled (new) improved maize seed. Though not statistically significant, exposure also caused a reduction in the acreage planted to recycled (retained) improved maize seed in the same season 1; an

increase in the acreage under mixed seed and un-recycled improved maize seed, implying that exposure to demos and field days reduces acreage planted to local and recycled maize seed in favour of pure (un-recycled) improved seed. In the second season exposure had no statistically significant effect on acreage planted to un-recycled improved seed. These results are consistent with the results obtained for proportion of households that purchased un-recycled seed in the second season, confirming the assertion that improved seed in the second season is less accessible because of lack of capacity of seed companies to produce the seed in the short period before planting. Like in the first season, exposure had a negative impact on acreage planted to recycled seed.

The overall results for the year show exposure had a positive and statistically significant effect on the acreage planted with unrecycled improved seed, and a reduction in acreage planted with recycled improved maize seed. The findings are consistent with findings from the qualitative survey where participants listed benefits of planting improved maize seed as: high yields, early maturing; heavier (weighs more) than the local seed; resistant to drought and pests; and marketable because the grains are big.

Table 26: Effects of exposure to demos and field days on acreage under different maize seed types.

	Average treatment effects		
Outcome variables	Regression	Double Robust Regression	
	Bootstrap	Cluster-Robust Standard Error	Robust Standard Error
Acres un-recycled improved maize season 1	0.056(0.046)	0.054(0.067)	0.054(0.045)
Acres recycled improved maize season 1	-0.045(0.021)**	-0.043(0.028)	-0.043(0.022)**
Acres local maize season 1	-0.019(0.017)	-0.02(0.018)	-0.02(0.016)
Acres mixed maize season 1	0.013(0.024)	0.011(0.025)	0.011(0.021)
Acres un-recycled improved maize season 2	0.038(0.031)	0.033(0.044)	0.033(0.031)
Acres recycle improved maize season 2	-0.036(0.023)	-0.036(0.027)	-0.036(0.022)*
Acres local maize season 2	-0.007(0.013)	-0.008(0.015)	-0.008(0.014)
Acres mixed maize season 2	0.011(0.02)	0.011(0.022)	0.011(0.019)

Acres un-recycled improved maize season all	0.078(0.045)*	0.073(0.063)	0.073(0.04)*
Acres recycle improved maize season all	-0.051(0.029)*	-0.051(0.042)	-0.051(0.03)*
Acres local maize season all	0.006(0.035)	0.003(0.048)	0.003(0.036)
Acres mixed maize season all	-0.013(0.011)	-0.013(0.011)	-0.013(0.009)
N	3901	3901	3901

***, ** and * imply significant at 1%, 5% and 10% respectively

The effect of exposure on acreage of recycled (retained) improved beans seed was negative and statistically significant for the first season but this was not clearly in favour of un-recycled improved bean seed (Table 27). The results are different with those for improved maize where there was a negative effect on recycled (retained) improved seed and maize farmers did this in favour of the un-recycled improved seed which is statistically significant.

From the qualitative survey, participants indicated their rejection of improved bean seed was because there is no difference when compared to their home saved seed, and the prices of the improved bean seeds are very high such that farmers cannot afford. The other reasons given were that improved seeds are not available and accessible because they could only be found in major towns. The agro-dealers do not stock much of the improved bean seed because the farmers do not plant it. "I do not stock a lot of improved bean seed because farmers in this area do not use them. The bean improved seed can stay for long in the shop without being bought' one of the agro-dealers said.

Table 27: Effects of exposure to demos and field days on acreage under different beans seed types.

	Average treatment effect		
Outcome variables	Regression	Double Robust Regression	
	Bootstrap	Cluster-Robust Standard Error	Robust Standard Error
Acres un-recycled improved bean season 1	0.008(0.018)	0.008(0.018)	0.008(0.017)
Acres recycle improved bean season 1	-0.03(0.014)**	-0.031(0.016)**	-0.031(0.014)**
Acres local bean season 1	-0.024(0.02)	-0.024(0.023)	-0.024(0.02)
Acres mixed bean season 1	-0.015(0.018)	-0.015(0.02)	-0.015(0.017)
Acres un-recycled improved bean season 2	0.004(0.01)	0.003(0.009)	0.003(0.008)
Acres recycle improved bean season 2	-0.01(0.012)	-0.01(0.011)	-0.01(0.012)

Acres local beans season 2	-0.004(0.01)	-0.007(0.014)	-0.007(0.011)
Acres mixed bean season 2	0(0.006)	0.001(0.009)	0.001(0.008)
Acres un-recycled improved bean season all	0.007(0.019)	0.007(0.02)	0.007(0.018)
Acres recycle improved bean season all	-0.021(0.013)	-0.021(0.018)	-0.021(0.016)
Acres local beans season all	-0.021(0.024)	-0.024(0.028)	-0.024(0.023)
Acres mixed bean season all	-0.012(0.02)	-0.012(0.024)	-0.012(0.02)
N	3901	3901	3901

***, ** and * imply significant at 1%, 5% and 10% respectively

Effect of exposure on maize and bean acreage, production, and yield

Research Hypothesis III: Farmers who adopt the improved varieties being promoted through exposure to the demonstration plots achieve higher yields, higher production and income.

Table 21 in the Appendix shows that in the control group, the acreage of beans declined for seasons 1 and 2. However, the result in Table 28 shows that farmers who were exposed to demos and field days had a smaller decline in acreage under beans in season 1. The same Tables also shows that though the maize yields for the control sample declined by 94kg/acre (Table 1 in the Appendix), exposure resulted to a statistically significantly increase in maize yields of 65 kg/acre, and a resultant increase in maize production of 91 to 102 kgs – though only marginally significant in the bootstrapped regression. This increase in production may be attributed to the significant effect on maize yields, which is consistent with the exposure effect on adoption of PH5052 and unrecycled improved maize seed.

Though not statistically significant, the yields of beans were higher as a result of exposure even though the yields in the control sample declined.

Table 28: Effects of exposure to demos and field days on acreage, production and yield of maize and beans

	Average treatment effect		
Outcome variables	Regression	Double Robust Regression	
	Bootstrap	Cluster-Robust Standard Error	Robust Standard Error
Acreage under maize	-0.062(0.107)	-0.073(0.174)	-0.073(0.098)
Acres under maize season 1	-0.007(0.039)	-0.01(0.062)	-0.01(0.046)
Acres under maize season 2	0.022(0.032)	0.016(0.051)	0.016(0.035)
Acreage under beans	-0.055(0.031)*	-0.051(0.042)	-0.051(0.031)
Acres under bean season 1	-0.055(0.031)*	-0.057(0.032)*	-0.057(0.028)**

Acres under bean season 2	0.038(0.024)	0.038(0.025)	0.038(0.021)*
N	3901	3901	3901
Production of Maize (kg)	102.014(48.404)**	91.297(112.753)	91.297(63.344)
N	3901	3901	3901
Production of beans (kg)	-10.061(26.353)	-9.023(24.654)	-9.023(23.547)
N	3901	3901	3901
Yield of Maize (kg/acre)	65.639(32.676)**	67.902(37.963)*	67.902(35.611)*
N	3602	3602	3602
Yield of beans (kg/acre)	17.271(13.393)	17.238(18.167)	17.238(16.152)
N	3316	3316	3316

***, ** and * imply significant at 1%, 5% and 10% respectively

The lack of exposure effect on bean production and yields is consistent with findings from the qualitative survey which indicates that participants do not see much difference in performance of improved bean seed compared with their own farm saved seed.

VIII. DISCUSSION AND CONCLUSIONS

8.1 Discussion of findings

The findings show that establishment of demonstration plots and holding field days was an effective way of raising awareness and changing the perceptions, knowledge and uptake of improved varieties. It led to: greater awareness and more positive attitude towards improved seed in general; greater awareness and better perception on the maize variety promoted; a reduction in proportion purchasing and acreage planted with recycled (retained) maize and bean seed; an increase in the proportion purchasing and acreage planted with unrecycled maize seed; an increase in maize yield, and as a result, the volume of maize produced. However the magnitude of the effects was small, and mainly for improved maize varieties. Moreover, the effects differed by gender of the farmers, where, attitude of male farmers on improved beans improved while attitude of female farmers on maize improved. Male farmers' perception about the promoted bean variety was more positive while female perception on the promoted maize variety was more positive, though marginally. Male farmers knowledge on the maize and bean varieties promoted increased, but there was no effect on female famers. The overall results (individual level) show better attitude towards improved varieties of both maize and beans; better perception and knowledge about the maize variety being promoted, but not on the bean variety promoted.

Exposure also resulted to an increase in farmers' reliance on demonstration plots as a source of information about/on improved crop varieties, but not their reliance on field days. However, distance to

the demo plots matters as evidenced by the low magnitude of effects on percentage of farmers who were aware (quantitative study), and the high awareness among farmers in close vicinity of the demos (qualitative study).

As a result of better attitude, perception, there was a greater proportion of farmers who purchased and planted the maize variety promoted as well as the acreage planted with the variety. Consequently, the maize yields obtained in exposed group were higher and so was the volume produced, but not for beans. This result can be explained by the low availability and accessibility of the seed by farmers in treated areas who wished to purchase, the high cost of adopting the seed (input and labour costs), but also the negative attributes of the promoted varieties, as reported in the qualitative survey. The marginal significance on production is an indication of the low proportion of farmers who planted the improved seed but it also suggests that production should be viewed as an intermediate or longer term outcome that is unlikely to be achieved within period covered by the impact study. The small effects on yields and production also suggest there could be other factors which are constraining production in the areas of study, and is consistent with views of many previous studies that the impact of improved crop varieties is conditioned on use of accompanying inputs, the correct cultural practices and the condition of the soil.

Exposure also caused other positive changes in farmers' behavior. It led to an increase in farmers' use of unrecycled improved maize seed, and a reduction in the use of recycled (retained) improved seed for both maize and beans. It also increased awareness and use of other improved varieties which had already been introduced to farmers earlier, implying that demos and field days tend to instill confidence among farmers in the improved varieties in general, and varieties that they are already exposed to but probably lacked adequate information.

The results from the qualitative study are supportive and help to explain results from the quantitative study by providing more insights about the attributes of the varieties promoted and other constraints affecting farmers' uptake of the varieties. The qualitative study was undertaken after the endline household survey, in villages where demo plots had been established.

As had been found at the midline, demos mainly reach farmers residing in their vicinity. The farmers who were drawn from these areas were highly aware, however, this increase in awareness only resulted to a marginal uptake of the promoted varieties. Farmers had a positive perception towards PH5052 because it had positive attributes which made it marketable. However the negative attributes contributed to the low uptake. Though the bean variety NABE15 had some positive attributes, the fact that it could not sell due to some negative attributes deterred uptake of the variety. These findings have an implication on demos and other promotion campaigns, that though they reach the farmers (mainly those in the vicinity of the

demo and less of those further away), the promotion does not convince farmers to buy the seed if attributes which are important to farmers and consumers make the variety unmarketable.

Apart for the varietal attributes, there were other issues which affected use of the improved seed. From the qualitative survey we found that though farmers became aware, those who planted the variety faced several constraints, especially high costs because it requires fertilizer application and pesticides. They also indicated that the prices of the improved bean seeds are very high such that farmers cannot afford and they do not have enough resources for proper and timely weeding as recommended. The important point which helps explain farmers' sentiments on cost of seed adoption and affordability is contained in the reason behind their rejection of improved bean seed. They explained that there is no difference when compared to their home saved seed. If farmers do not seed the benefits in an improved variety they will not adopt it.

The other reasons given for not planting the seed were that improved seeds are not available and accessible because they could only be found in major towns. Farmers who wished to plant the seed and were ready to travel to major towns to get it indicated the seed was not commonly found (that means like others..). The agro-dealers on their part indicated two problems: one, the seed is normally supplied late, particularly in the second season, and two, they prefer not to stock much of the improved bean seed because the farmers do not plant it. A cyclical problem without end in sight. Non-availability of the seed in agro-dealer shops in shopping centres nearest to farmers would have likely affected uptake, particularly because travelling cost and time are important constraints for the farmers. The seed company indicated it delivers its seed to agro-dealers in major towns who in turn distribute to agro shops in smaller town centres. This model was said to have failed because of lack of credit for last mile agro-dealers. It also emerged that there was lack of trust between the two levels within the seed supply chain.

Generally, the seed company indicated that it had not had much demand for the seed in the areas of study and this could have been affected by several factors. One, is lack of its own intelligence to gauge demand for its seed in the market. The company relies on agro-dealers who make their orders, allegedly based on farmers demand. Two, insights from stakeholder meetings suggest that the timing for the field days (field days are held at maturity of the crop) is inappropriate because at crop maturity farmers are normally more concerned about sale outlets for their harvested crop, and less about the seed which they would be planting the following season.

The findings suggest that demonstration plots can be effective in creating awareness and promoting improved crop varieties, the results suggest that seed companies and other players in the seed industry need to factor in the limited reach of demonstration plots/field days when planning their promotion

campaigns. The prohibitive cost associated with establishing many demos points to the need for more efficient but equally effective methods for raising awareness about new improved crop varieties, to more farmers more speedily, for widespread changes amongst smallholder farmers.

Some in the agriculture sector have suggested that the evaluation was conducted too early into the promotion campaign. This explanation may be plausible because the two varieties were new and little known in the study areas. The lack of a critical mass of farmers who are aware and have grown the varieties can affect diffusion of information from demos and field days which is mainly through farmer to farmer communication and observations made in fields of neighbouring farmers'.

Constraints during the promotion campaign, such as drought, the late onset of rains and crop damage by domestic animals in some instances, and failure to establish demos in some of the sites due to late delivery of the seed to the demo hosts affected the performance of the crop in the demo, and subsequently, the magnitude of the effect. Factors such as drought and the late onset of rains also affected the crops performance in farms of farmers who used the seed.

8.2 Internal validity

The results from balance tests showed that weighting the observations using the inverse probability score significantly reduced the selection bias. The IPW estimator therefore gives valid inferences about the treatment effects. Other threats to internal validity were contamination through exposure of farmers in the control group to the treatment, and failure to account for spillovers due to diffusion, which would lead to under estimation of the true effect of the promotion campaign. The first problem was minimized (and data shows) by setting up demos to serve a sub-county comprising several villages, whereby, farmers residing in the sub-county where demos were established were considered to be treated. Spillovers through diffusion would occur through 'interpersonal communication' between farmers who have the information and others, as well as through observation of farms planted with the new varieties. Over time the diffusion would occur beyond the treatment areas. The interaction between farmers in the treated and control groups was hindered by distance, though not completely eliminated. Descriptive analysis showed that there were no farmers from control group who visited the demos or attended field days organized by the implementing agency which shows there was no contamination. Spillovers into control areas would also be negligible if any because the number of farmers with information about the new varieties was negligible.

Attrition of the households in original sample was low at eight (8) and nine (9) percent for the treated and control groups respectively. The attrition rates for individual respondents was higher and warranted

further analysis to test for attrition effects on outcomes. Tests for attrition bias were conducted using the IPW approach (for both household and individual level). The conclusion from the results that the attrition would not cause a bias in estimates of the treatment effects, an indication that the endline sample represents the baseline sample and any inference can be generalized for the original population.

John Henry (when control group behaving differently after knowing about the treatment)

That farmers are likely to behave differently when they become aware that they are in either treatment or control group. In this study these effects were minimized because the treatment was assigned at the sub-County level rather at the farmer level. This made it unlikely that farmers in the treated or control group were aware that they belonged to an experiment or in either of the two groups.

Hawthorne Effects (when farmers behave differently when under observation

It unlikely that farmers in the treated group to know they were under observation because no direct selection of farmers was made, rather the intervention was at the sub-county level. In addition, selection of participants for the household survey was done randomly from lists of all households drawn by local leaders in the treatment and control areas. These two arrangements minimized the possibility that farmers in treated group would have a perception that they were being observed in a treatment

8.3 Specific findings for policy and management

Generally, so as to attain high productivity in smallholder farms through crop improvement, the seed industry needs to identify and invest in promotion approaches which are more effective in creating awareness and knowledge about new improved crop varieties among smallholder farmers. Investment in knowing what the client (farmer and consumer) wants in terms of seed attributes, and reduce costs of seed to commensurate with the benefits and the level of small holder agricultural development in their region or countries. Specific recommendations:

For seed companies:

1. Farmers are very discerning so ensure pricing of seed is commensurate with benefits, and is competitive vis a vis the price of competing varieties
2. Partner with researchers to pilot seed promotion methods before investing in a full blown promotion of new seed varieties.
3. Experiment by holding field days during different periods during the growing season rather than at the end of the season. And partnering with researchers to gauge whether timing of field day influences farmer response with respect to demand for seed.

4. Having your own market intelligence to complement your other sources for demand for your seed

For AGRA and agencies with a similar mandate:

1. Continued funding or support for agro-dealer development is important since farmers access to agro-dealers is still a problem
2. Support market intelligence for local seed companies for better projection of demand for their seed
3. Support distribution of new improved varieties is still required
4. Ensure released varieties that are given to seed companies for commercialization (production and distribution) have superior attributes than competing varieties, and the attributes should be important from the farmers point of view
5. Breeding programmes need to seriously consider their clients preference (client is the farmer), developing varieties that have least preferred attributes may erode farmers confidence in improved varieties.

For policy makers:

1. The important implication from the findings is that they should not expect quick changes in crop productivity or in adaptation to climate change if farmers' uptake barely changed after four seasons of a promotion campaign.
2. The government needs to invest in promotion of newly released varieties (in order to have a critical mass of farmers growing the improved seed). Public investment (government and non-governmental organisations) in the intial-stage promotion of newly released varieties is essential so as to create a critical mass of farmers with awareness and knowledge/experience of the new varieties. This will trigger faster diffusion of information about the new varieties.
3. The government and other industry players need to address non-availability of seed of new improved crop varieties in shopping centres nearest to farmers (last mile agro shops). One way would be by making credit more readily available to small agro-dealers.
4. Further to the above recommendations, for greater efficiency in raising awareness and knowledge about improved varieties, seed companies need to be furnished with more evidence on the efficacy of the commonly used promotion methods. Further evidence is needed to inform management decisions such as: how many demos are enough; and when is the best timing and

location for their demos: are effects influenced by the seed variety promoted or the specific implementing agency?

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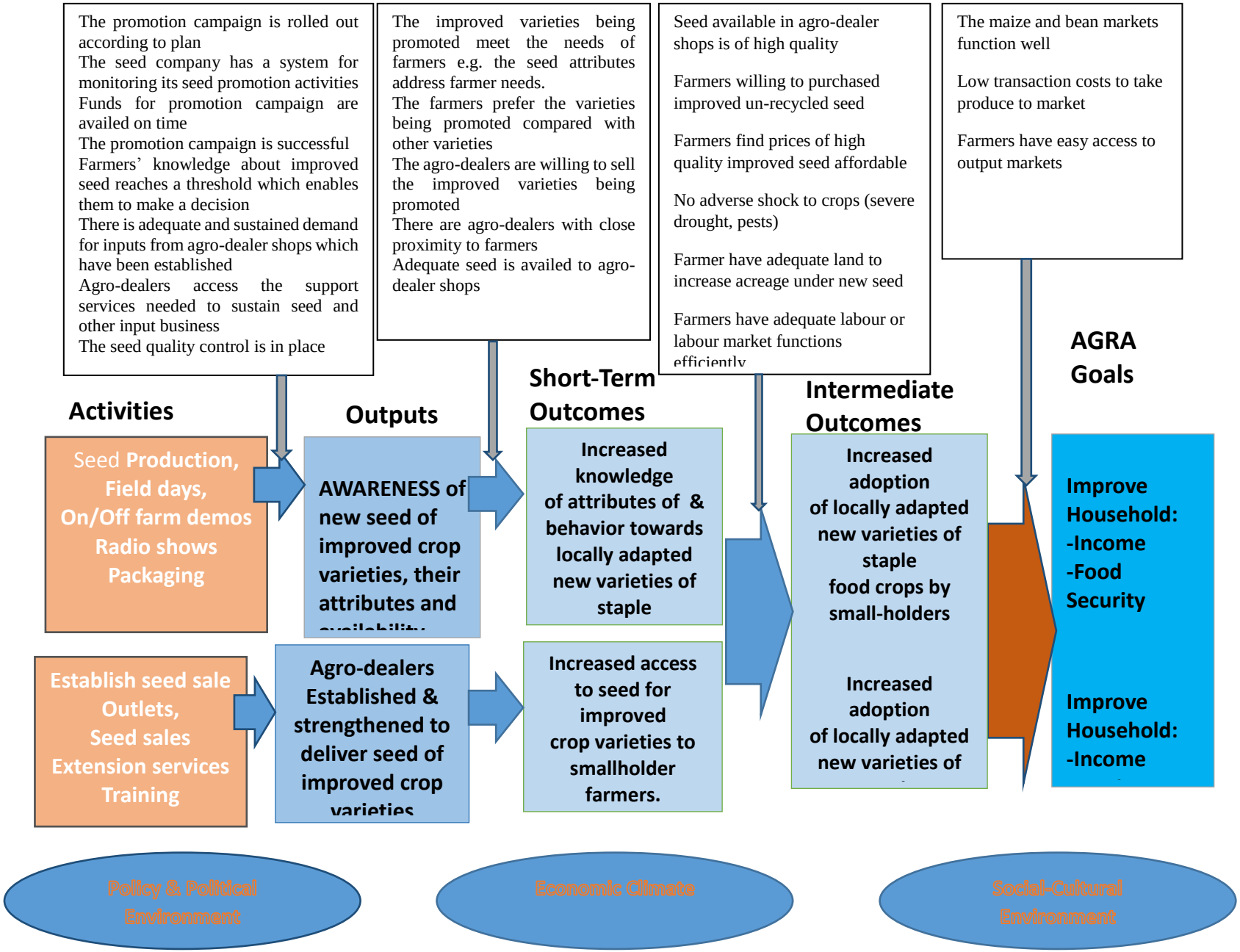
APPENDICES

A1 THEORY OF CHANGE – with assumptions and context

Appendix Figure 1: Adapted from AGRA's PASS Program Logic Model



Appendix Table 1: Bias test results (5 blocks) individual household - block 1and block 2

	Block1 (U)			Block1 (M)			Block2 (U)			Block2 (M)		
	Mean			Mean			Mean			Mean		
Variable	Treated	Control	%bias	Treated	Control	%bias	Treated	Control	%bias	Treated	Control	%bias
Distance to major produce market	12.63	14.17	-14.5	12.63	13.19	-5.3	6.95	7.06	-2.1	6.95	6.98	-0.5
Distance to the nearest improved seed seller	15.45	14.62	8.4	15.45	14.01	14.5	9.57	9.69	-2.1	9.57	9.61	-0.7
Log of asset value	13.95	14.23	-18.9	13.95	14.12	-11.6	13.81	13.76	3.9	13.81	13.74	5.2
Adult Equivalent	4.97	5.21	-10.3	4.97	5.08	-4.8	4.91	4.7	9.6	4.91	4.69	9.9
Single	0.056	0.043	6.1	0.056	0.044	5.6	0.012	0.023	-8.2	0.012	0.022	-8.1
Married	0.864	0.874	-3.1	0.864	0.86	1.3	0.887	0.849	11.4	0.887	0.846	12.1
Banana Acreage	0.496	0.611	-12.4	0.496	0.504	-0.9	0.381	0.357	4.5	0.381	0.356	4.6
Sorghum Acreage	0.11	0.06	12.2	0.11	0.065	10.9	0.11	0.086	7.9	0.11	0.085	8
Sweet potatoes Acreage	0.33	0.386	-10	0.33	0.35	-3.7	0.274	0.279	-1.3	0.274	0.276	-0.5
Groundnuts Acreage	0.547	0.563	-2.2	0.547	0.557	-1.3	0.436	0.495	-8.5	0.436	0.494	-8.4
Other crops Acreage	3.631	4.767	-15.4	3.631	3.863	-3.2	2.937	2.572	11.3	2.937	2.546	12.1
Salaried	0.07	0.091	-7.9	0.07	0.087	-6.2	0.042	0.043	-0.7	0.042	0.043	-0.7
Gender	0.882	0.907	-8.2	0.882	0.892	-3.5	0.884	0.858	7.9	0.884	0.855	8.6
Education level of the household head/respondent	2.495	2.528	-3.7	2.495	2.496	-0.2	2.27	2.318	-6	2.27	2.31	-4.9
Age of the household head/respondent	46	45	6.3	46	45	9	46	46	-0.2	46	46	-0.3
Age Squared	2371	2275	6.1	2371	2238	8.5	2349	2345	0.2	2349	2347	0.1
Age tripled	130000	130000	5	130000	120000	7	130000	130000	0	130000	130000	0
Log of farmsize	1.937	2.047	-13.8	1.937	1.959	-2.7	1.748	1.718	4.3	1.748	1.711	5.2

Appendix Table 2: Bias test results (5 blocks) individual household- block 3 and block 4

	Block3 (U)			Block3 (M)			Block4 (U)			Block4 (M)		
	Mean			Mean			Mean			Mean		
Variable	Treated	Control	%bias	Treated	Control	%bias	Treated	Control	%bias	Treated	Control	%bias
Distance to major produce market	5.38	4.95	11.1	5.38	4.93	11.6	4	4.07	-2.3	4	4.07	-2.2
Distance to the nearest improved seed seller	6.23	7.3	-23.1	6.23	7.25	-22	4.35	4.85	-14.8	4.35	4.84	-14.5
Log of asset value	13.62	13.66	-2.9	13.62	13.66	-2.7	13.59	13.45	12.7	13.59	13.45	12.7
Adult Equivalent	4.89	4.95	-2.4	4.89	4.94	-2.2	5.33	5.38	-2.6	5.33	5.39	-2.8
Single	0.01	0.01	0.1	0.01	0.011	-0.3	0.004	0	9.4	0.004	0	9.4
Married	0.822	0.842	-5.3	0.822	0.841	-5	0.851	0.842	2.6	0.851	0.842	2.5
Banana Acreage	0.3	0.298	0.5	0.3	0.295	1.2	0.272	0.294	-6.3	0.272	0.294	-6.4
Sorghum Acreage	0.079	0.105	-9.5	0.079	0.104	-9.3	0.088	0.102	-5.2	0.088	0.102	-5
Sweet potatoes Acreage	0.302	0.287	3.6	0.302	0.287	3.6	0.343	0.33	2.8	0.343	0.331	2.7
Groundnuts Acreage	0.409	0.38	5.2	0.409	0.377	5.6	0.355	0.291	13.5	0.355	0.291	13.6
Other crops Acreage	2.247	2.301	-2.1	2.247	2.285	-1.5	2.112	2.072	1.7	2.112	2.073	1.6
Salaried	0.057	0.048	3.7	0.057	0.049	3.5	0.04	0.024	8.8	0.04	0.024	8.8
Gender	0.861	0.872	-3.4	0.861	0.871	-3.1	0.869	0.863	1.7	0.869	0.864	1.5
Education level of the household head/respondent	2.363	2.324	4.6	2.363	2.324	4.6	2.255	2.216	4.8	2.255	2.217	4.7
Age of the household head/respondent	47	48	-7.3	47	48	-7.3	50	49	2.1	50	49	2.2
Age Squared	2394	2511	-7.4	2394	2509	-7.3	2666	2626	2.6	2666	2624	2.7
Age tripled	130000	140000	-7	130000	140000	-7	150000	150000	3	150000	150000	3
Log of farmsize	1.606	1.596	1.5	1.606	1.592	1.9	1.554	1.568	-2	1.554	1.566	-1.8

Appendix Table 3: Bias test results (5 blocks) individual household - block 5

	Block5 (U)			Block5 (M)		
Variable	Mean Treated	Control	%bias	Mean Treated	Control	%bias
Distance to major produce market	2.73	2.99	-11.3	2.73	3.05	-13.7
Distance to the nearest improved seed seller	3.04	2.99	1.9	3.04	3.05	-0.2
Log of asset value	13.36	13.34	1.9	13.36	13.36	0.5
Adult Equivalent	6.37	6.48	-4.5	6.37	6.4	-1
Single	0.002	0.007	-7.4	0.002	0.008	-8.2
Married	0.846	0.878	-9.3	0.846	0.873	-7.9
Banana Acreage	0.238	0.251	-4	0.238	0.25	-3.5
Sorghum Acreage	0.05	0.072	-10.3	0.05	0.07	-9.5
Sweet potatoes Acreage	0.431	0.439	-1.2	0.431	0.418	2.2
Groundnuts Acreage	0.223	0.237	-3	0.223	0.24	-3.7
Other crops Acreage	1.706	1.926	-11.1	1.706	1.91	-10.3
Salaried	0.018	0.024	-4.2	0.018	0.023	-3.6
Gender	0.897	0.909	-4.3	0.897	0.905	-2.8
Education level of the household head/respondent	2.302	2.345	-5.1	2.302	2.339	-4.4
Age of the household head/respondent	49	50	-7.2	49	50	-7.2
Age Squared	2569	2660	-6.7	2569	2659	-6.6
Age tripled	140000	150000	-6	140000	150000	-6
Log of farmsize	1.254	1.268	-2	1.254	1.286	-4.7

Appendix Table 4: Bias test results (5 blocks) male respondent - block 1and block 2

	Block1 (U)			Block1 (M)			Block2 (U)			Block2 (M)		
	Mean			Mean			Mean			Mean		
Variable	Treated	Control	%bias	Treated	Control	%bias	Treated	Control	%bias	Treated	Control	%bias
Distance to major produce market	13.229	13.88	-6	13.229	12.471	7	7.069	7.479	-7	7.069	7.357	-5
Distance to the nearest improved seed seller	14.198	13.047	11.1	14.198	12.804	13.5	9.13	10.318	-17.1	9.13	10.221	-15.7
Log of asset value	14.348	14.625	-20.9	14.348	14.539	-14.4	14.283	14.125	14.7	14.283	14.115	15.6
Adult Equivalent	5.093	5.346	-10.4	5.093	5.234	-5.8	5.16	4.941	9.5	5.16	4.926	10.1
Single	0.039	0.063	-11.2	0.039	0.054	-6.8	0.02	0	20	0.02	0	20
Married	0.942	0.925	6.6	0.942	0.932	4.1	0.961	0.982	-12.6	0.961	0.983	-13.7
Banana Acreage	0.49	0.592	-10.8	0.49	0.448	4.5	0.343	0.358	-2.7	0.343	0.357	-2.7
Sorghum Acreage	0.071	0.049	8.2	0.071	0.058	4.9	0.054	0.067	-5	0.054	0.067	-5.2
Sweet potatoes Acreage	0.314	0.386	-14.4	0.314	0.351	-7.3	0.284	0.33	-10.3	0.284	0.329	-10.2
Groundnuts Acreage	0.448	0.601	-21	0.448	0.57	-16.7	0.399	0.425	-4.2	0.399	0.425	-4.2
Other crops Acreage	3.638	5.06	-16.7	3.638	3.594	0.5	2.753	2.79	-1	2.753	2.763	-0.3
Salaried	0.09	0.116	-8.3	0.09	0.113	-7.3	0.025	0.014	8	0.025	0.012	9.1
Education level of the household head/respondent	8.929	9.537	-11.5	8.929	9.344	-7.8	7.424	6.744	15.5	7.424	6.742	15.6
Age of the household head/respondent	46	46	0.3	46	46	-0.6	47	46	4.5	47	46	5.2
Age Squared	2414	2394	1.2	2414	2379	2.2	2438	2389	3.1	2438	2377	3.9
Age tripled	140000	130000	2.1	140000	130000	3.6	140000	130000	2.1	140000	130000	2.9
Log of farmsize	1.869	2.123	-31.9	1.869	2.013	-18.1	1.81	1.707	15.2	1.81	1.697	16.7

Appendix Table 5: Bias test results (5 blocks) male respondent - block 3 and block 4

	Block3 (U)			Block3 (M)			Block4 (U)			Block4 (M)		
	Mean			Mean			Mean			Mean		
Variable	Treated	Control	%bias	Treated	Control	%bias	Treated	Control	%bias	Treated	Control	%bias
Distance to major produce market	5.324	5.342	-0.4	5.324	5.331	-0.2	3.613	4.151	-18.6	3.613	4.153	-18.6
Distance to the nearest improved seed seller	7.531	7.201	5.7	7.531	7.203	5.7	5.577	5.922	-6.3	5.577	5.915	-6.2
Log of asset value	13.719	13.889	-16	13.719	13.881	-15.3	13.541	13.357	17.7	13.541	13.353	18.1
Adult Equivalent	5.235	5.341	-4.5	5.235	5.342	-4.6	5.967	5.714	11.3	5.967	5.717	11.2
Single	0	0.005	-9.9	0	0.005	-9.4	0	0	.	0	0	.
Married	0.977	0.966	6.7	0.977	0.966	6.6	0.964	0.931	14.9	0.964	0.93	15
Banana Acreage	0.339	0.309	6.7	0.339	0.308	7	0.333	0.313	5	0.333	0.313	5
Sorghum Acreage	0.066	0.09	-9.7	0.066	0.09	-10	0.117	0.119	-0.5	0.117	0.12	-0.6
Sweet potatoes Acreage	0.316	0.297	4.9	0.316	0.299	4.2	0.355	0.323	6.5	0.355	0.323	6.5
Groundnuts Acreage	0.411	0.404	1.1	0.411	0.408	0.6	0.388	0.267	24.2	0.388	0.267	24.1
Other crops Acreage	2.648	2.674	-0.9	2.648	2.671	-0.8	2.636	2.197	16.8	2.636	2.198	16.7
Salaried	0	0	.	0	0	.	0.012	0.006	6.7	0.012	0.006	6.7
Education level of the household head/respondent	6.512	6.366	3.5	6.512	6.366	3.5	6.486	6.717	-5.3	6.486	6.713	-5.2
Age of the household head/respondent	48	49	-4.4	48	49	-4.7	47	48	-2.8	47	48	-2.7
Age Squared	2542	2625	-5	2542	2630	-5.3	2407	2471	-4.3	2407	2469	-4.2
Age tripled	150000	150000	-5.6	150000	150000	-5.9	130000	140000	-5.5	130000	140000	-5.3
Log of farmsize	1.638	1.68	-6.5	1.638	1.677	-6.1	1.608	1.472	19.4	1.608	1.472	19.4

Appendix Table 6: Bias test results (5 blocks) male respondent - block 5

	Block5 (U)			Block5(M)		
Variable	Mean Treated	Control	%bias	Mean Treated	Control	%bias
Distance to major produce market	3.204	3.219	-0.6	3.204	3.217	-0.5
Distance to the nearest improved seed seller	4.395	4.991	-11.9	4.395	4.992	-11.9
Log of asset value	12.885	12.952	-6.1	12.885	12.952	-6.1
Adult Equivalent	5.986	6.278	-11.6	5.986	6.284	-11.8
Single	0	0	.	0	0	.
Married	0.633	0.711	-16.5	0.633	0.709	-16.1
Banana Acreage	0.243	0.327	-21.2	0.243	0.326	-21
Sorghum Acreage	0.097	0.07	10	0.097	0.07	10
Sweet potatoes Acreage	0.445	0.415	4.8	0.445	0.418	4.4
Groundnuts Acreage	0.281	0.278	0.5	0.281	0.278	0.6
Other crops Acreage	1.892	2.335	-18.5	1.892	2.326	-18.1
Salaried	0	0	.	0	0	.
Education level of the household head/respondent	5.678	6.118	-11.2	5.678	6.11	-11
Age of the household head/respondent	47	47	1.7	47	47	1.6
Age Squared	2364	2301	5	2364	2303	4.9
Age tripled	130000	120000	7.3	130000	120000	7.2
Log of farmsize	1.365	1.47	-13	1.365	1.466	-12.6

Appendix Table 7: Bias test results (5 blocks) Female respondent - block 1and block 2

	Block1 (U)			Block1 (M)			Block2 (U)			Block2 (M)		
	Mean			Mean			Mean			Mean		
Variable	Treated	Control	%bias	Treated	Control	%bias	Treated	Control	%bias	Treated	Control	%bias
Distance to major produce market	12.41	13.81	-13.1	12.41	12.34	0.6	6.97	7.48	-8.2	6.97	7.37	-6.5
Distance to the nearest improved seed seller	14.61	13.89	7.7	14.61	13.09	16.3	9.02	8.79	3.7	9.02	8.72	4.9
Log of asset value	13.85	14.01	-12.1	13.85	13.97	-8.4	13.71	13.79	-6.3	13.71	13.79	-6.2
Adult Equivalent	4.74	5.13	-17.7	4.74	5.03	-13	4.99	4.87	5.4	4.99	4.88	4.9
Single	0.017	0.006	10.8	0.017	0.007	9.8	0.023	0.01	10.2	0.023	0.01	10
Married	0.739	0.717	4.8	0.739	0.69	10.9	0.743	0.717	5.9	0.743	0.719	5.5
Banana Acreage	0.485	0.575	-10.3	0.485	0.491	-0.7	0.386	0.365	4	0.386	0.362	4.6
Sorghum Acreage	0.107	0.071	9.6	0.107	0.073	9	0.12	0.085	10.1	0.12	0.086	9.8
Sweet potatoes Acreage	0.31	0.348	-7.2	0.31	0.318	-1.4	0.27	0.345	-18.8	0.27	0.343	-18.3
Groundnuts Acreage	0.472	0.516	-6.9	0.472	0.51	-6	0.418	0.442	-3.9	0.418	0.443	-3.9
Other crops Acreage	3.519	4.679	-16.4	3.519	3.784	-3.7	3.038	2.721	9.8	3.038	2.692	10.7
Salaried	0.04	0.05	-5.1	0.04	0.05	-4.7	0.045	0.032	6.7	0.045	0.032	6.8
Education level of the household head/respondent	6	7	-10.4	6	7	-9.6	7	6	10.2	7	6	10.4
Age of the household head/respondent	39	38	2.4	39	38	3.4	41	41	2.6	41	41	2.3
Age Squared	1686	1634	4.5	1686	1624	5.3	1892	1861	2.4	1892	1864	2.1
Age tripled	82045	76693	6.5	82045	76238	7.1	96178	94470	1.7	96178	94617	1.6
Log of farmsize	1.964	2.052	-12	1.964	1.978	-2	1.745	1.718	3.9	1.745	1.712	4.9

Appendix Table 8: Bias test results (5 blocks) Female respondent - block 3 and block 4

	Block3 (U)			Block3 (M)			Block4 (U)			Block4 (M)		
	Mean			Mean			Mean			Mean		
Variable	Treated	Control	%bias	Treated	Control	%bias	Treated	Control	%bias	Treated	Control	%bias
Distance to major produce market	5.36	5.24	2.9	5.36	5.23	3	4.45	4.21	6.2	4.45	4.19	6.7
Distance to the nearest improved seed seller	5.71	5.91	-4.7	5.71	5.87	-3.7	4.15	4.95	-21.1	4.15	4.93	-20.7
Log of asset value	13.72	13.56	12.2	13.72	13.57	11.9	13.56	13.42	11.6	13.56	13.42	11.7
Adult Equivalent	5.1	5.07	1.3	5.1	5.09	0.6	5.53	5.42	5	5.53	5.43	4.9
Single	0	0.024	-22.1	0	0.022	-20.6	0.014	0.013	0.9	0.014	0.012	1
Married	0.77	0.76	2.4	0.77	0.761	2.2	0.793	0.82	-7	0.793	0.821	-7.1
Banana Acreage	0.346	0.319	6.1	0.346	0.317	6.5	0.257	0.267	-2.7	0.257	0.268	-2.7
Sorghum Acreage	0.084	0.116	-10.4	0.084	0.117	-10.8	0.108	0.117	-2.9	0.108	0.116	-2.5
Sweet potatoes Acreage	0.373	0.291	18.8	0.373	0.293	18.4	0.395	0.392	0.7	0.395	0.39	1
Groundnuts Acreage	0.429	0.424	0.8	0.429	0.418	1.7	0.37	0.32	9.6	0.37	0.318	9.9
Other crops Acreage	2.48	2.112	14.5	2.48	2.118	14.2	1.997	2.169	-7	1.997	2.17	-7.1
Salaried	0.035	0.032	1.8	0.035	0.032	1.6	0.041	0.038	1.6	0.041	0.037	2
Education level of the household head/respondent	7	6	3.4	7	6	3.6	7	7	1.6	7	7	1.5
Age of the household head/respondent	40	41	-6.9	40	41	-7.3	43	43	-0.8	43	43	-1.3
Age Squared	1802	1895	-7.1	1802	1898	-7.4	2050	2064	-15	2050	2072	-1.6
Age tripled	89708	96258	-6.5	89708	96403	-6.7	110000	1	-1.5	110000	1	-2.5
Log of farmsize	1.625	1.691	-9.7	1.625	1.691	-9.7	1.52	1.526	-0.9	1.52	1.525	-0.7

Appendix Table 9: Bias test results (5 blocks) Female respondent - block 5

	Block5 (U)			Block5(M)		
Variable	Mean Treated	Control	%bias	Mean Treated	Control	%bias
Distance to major produce market	3.27	3.32	-1.6	3.27	3.37	-3.2
Distance to the nearest improved seed seller	3.18	3.76	-19.3	3.18	3.8	-20.5
Log of asset value	13.28	13.39	-8.8	13.28	13.39	-8.8
Adult Equivalent	6.44	6.46	-0.8	6.44	6.43	0.5
Single	0.027	0.026	0.5	0.027	0.024	1.4
Married	0.853	0.907	-16.9	0.853	0.911	-18.1
Banana Acreage	0.237	0.277	-11.5	0.237	0.271	-9.6
Sorghum Acreage	0.056	0.077	-9.6	0.056	0.077	-9.6
Sweet potatoes Acreage	0.501	0.494	1.1	0.501	0.477	3.7
Groundnuts Acreage	0.281	0.27	2.1	0.281	0.264	3.3
Other crops Acreage	1.764	2.001	-11.6	1.764	1.96	-9.6
Salaried	0.086	0.098	-4.3	0.086	0.098	-4.1
Education level of the household head/respondent	8	8	-5.8	8	8	-5.2
Age of the household head/respondent	46	45	3.8	46	45	6.7
Age Squared	2291	2240	3.4	2291	2192	6.5
Age tripled	130000	1	5	130000	1	5
Log of farmsize	1.242	1.193	6.6	1.242	1.204	5.1

Appendix Table 10: Treatment effects with and without attrition weights (male respondents)

	Without Attrition	With Attrition
Demonstration plots	0.033(0.026)	0.033(0.025)
Brochures	0.001(0.002)	0(0.002)
Field days	0(0.005)	0(0.005)
Radio	0.006(0.067)	0.004(0.067)
Personal communication	0.003(0.046)	0.007(0.046)
Awareness of improved seed	0.028(0.035)	0.028(0.035)
N	2118	2118
Awareness of maize improved seed	0.028(0.055)	0.028(0.055)
Awareness of bean improved seed	-0.01(0.039)	-0.01(0.039)
N	2046	2046
Aware of PH5052	0.009 (0.004) **	0.009(0.004) **
Aware of Longe5	0.001(0.056)	-0.001(0.057)
Aware of Longe6	0.007(0.04)	0.005(0.04)
Aware of Longe4	-0.032(0.037)	-0.034(0.038)
Aware of NABE15	0.003(0.004)	0.002(0.004)
Aware of K131	0.055(0.108)	0.057(0.108)
Aware of K132	0.013(0.027)	0.012(0.027)
Aware of Kanyebwa	-0.002(0.048)	-0.004(0.047)
N	2118	2118
Attitude towards maize improved seed	-0.003(0.03)	-0.034(0.038)
N	1961	1961
Attitude towards bean improved seed	0.023(0.018)	0.057(0.108)
N	1899	1899
Perception towards maize improved varieties	0.073(0.073)	-0.004(0.047)
N	153	153
Perception towards beans improved varieties	0.116(0.124)	-0.003(0.031)
	100	100
Knowledge about PH5052	0.086(0.076)	0.022(0.018)

N	140	140
Knowledge about NABE15	0.083(0.066)	0.066(0.074)
	93	93

Notes for Table 11, 12 and 13 on attrition: To calculate the attrition weights we have used the characteristics of the respondents only because these variables were not collected for households that dropped out after the baseline. This occurred because at the baseline the gender disaggregated survey which collected information at the individual level was not carried out at the same time as the household interviews where most household characteristics were collected. Consequently, information on household characteristics for individuals who dropped out after the baseline was not collected.

Appendix Table 11: Treatment effects with and without attrition weights (female respondents)

	Without attrition	With Attrition
Demonstration plots	0.024(0.022)	0.024(0.022)
Brochures	0.001(0.003)	0.001(0.003)
Field days	-0.001(0.004)	0(0.004)
Radio	0.001(0.069)	0.001(0.07)
Personal communication	-0.008(0.053)	-0.008(0.054)
Awareness of improved seed	-0.003(0.037)	-0.004(0.038)
N	2668	2668
Awareness of maize improved seed	-0.016(0.072)	-0.016(0.072)
Awareness of bean improved seed	-0.002(0.039)	-0.003(0.039)
N	2549	2549
Aware of PH5052	0.005 (0.003) *	0.005(0.003) *
Aware of Longe5	0.027(0.064)	0.026(0.065)
Aware of Longe6	0.009(0.041)	0.007(0.041)
Aware of Longe4	-0.021(0.035)	-0.022(0.036)
Aware of NABE15	-0.001(0.005)	-0.001(0.005)
Aware of K131	0.027(0.114)	0.027(0.114)
Aware of K132	0.039(0.03)	0.039(0.03)

Aware of Kanyebwa	0.017(0.057)	0.016(0.056)
N	2668	2668
Attitude towards maize improved seed	0.025(0.033)	0.024(0.033)
N	2338	2338
Attitude towards bean improved seed	0.018(0.021)	0.018(0.02)
N	2378	2378
Perception towards maize improved varieties	0.205(0.131)	0.211(0.131)
N	115	115
Perception towards beans improved varieties	-0.228 (0.111) *	-0.223(0.112) *
	62	62
Knowledge about PH5052	0.047(0.046)	0.047(0.045)
N	108	108
Knowledge about NABE15	-0.051(0.047)	-0.049(0.046)
	56	56

Appendix Table 12: Means for outcome variables at baseline : Household level

Variables	All sample	Treatment	Control	p-value
Acres under PH5052 season 1	0.001(0.001)	0.001(0.001)	0()	0.158
Acres under PH5052 season 2	0.001(0.001)	0.002(0.002)	0.001(0.001)	0.412
Acres under PH5052 all seasons	0.002(0.001)	0.004(0.002)	0.001(0.001)	0.121
Acres under NABE15 season 1	0.001(0.001)	0.002(0.001)	0.001(0.001)	0.345
Acres under NABE15 season 2	0.002(0.002)	0.004(0.004)	0()	0.281
Acres under NABE15 all season	0.003(0.002)	0.006(0.004)	0.001(0.001)	0.196
Acres un-recycled improved maize season 1	0.434(0.048)	0.413(0.039)	0.454(0.087)	0.812
Acres recycled improved maize season 1	0.218(0.017)	0.215(0.021)	0.221(0.026)	0.933
Acres local maize season 1	0.033(0.006)	0.023(0.006)	0.043(0.01)	0.066
Acres mixed maize season 1	0.457(0.024)	0.457(0.04)	0.458(0.027)	0.782
Acres un-recycled improved maize season 2	0.333(0.025)	0.348(0.04)	0.318(0.029)	0.373
Acres recycle improved maize season 2	0.16(0.018)	0.171(0.03)	0.149(0.022)	0.623
Acres local maize season 2	0.023(0.004)	0.023(0.005)	0.024(0.007)	0.279
Acres mixed maize season 2	0.373(0.022)	0.359(0.033)	0.386(0.029)	0.636
Acres un-recycled improved maize season all	0.551(0.033)	0.562(0.05)	0.539(0.044)	0.551
Acres recycle improved maize season all	0.377(0.028)	0.385(0.041)	0.37(0.038)	0.812

Acres local maize season all	0.83(0.038)	0.815(0.059)	0.844(0.049)	0.655
Acres mixed maize season all	0.054(0.009)	0.044(0.01)	0.065(0.014)	0.099
Acres un-recycled improved bean season 1	0.149(0.014)	0.148(0.023)	0.15(0.017)	0.964
Acres recycle improved bean season 1	0.077(0.008)	0.09(0.012)	0.065(0.01)	0.067
Acres local bean season 1	0.174(0.021)	0.146(0.013)	0.201(0.04)	0.192
Acres mixed bean season 1	0.34(0.016)	0.309(0.019)	0.371(0.025)	0.264
Acres un-recycled improved bean season 2	0.025(0.004)	0.029(0.007)	0.021(0.004)	0.409
Acres recycle improved bean season 2	0.015(0.004)	0.027(0.008)	0.004(0.003)	0.003
Acres local beans season 2	0.112(0.008)	0.097(0.01)	0.126(0.014)	0.167
Acres mixed bean season 2	0.103(0.008)	0.105(0.011)	0.101(0.012)	0.911
Acres un-recycled improved bean season all	0.174(0.015)	0.178(0.024)	0.17(0.018)	0.866
Acres recycle improved bean season all	0.093(0.009)	0.118(0.016)	0.069(0.011)	0.006
Acres local beans season all	0.284(0.025)	0.24(0.019)	0.327(0.046)	0.098
Acres mixed bean season all	0.443(0.019)	0.414(0.024)	0.471(0.03)	0.367
Acreage under maize	2.493(0.07)	2.415(0.089)	2.569(0.108)	0.148
Production of Maize (kg)	1152(50)	1145(64)	1159(77)	0.624
Yield of Maize (kg/acre)	432(8)	446(12)	417(11)	0.112
Acreage under beans	1.116(0.023)	1.114(0.031)	1.117(0.033)	0.371
Production of beans (kg)	184(6)	181(9)	188(9)	0.302
Yield of beans (kg/acre)	187(5)	188(7)	186(7)	0.6
Acres under maize season 1	1.15(0.052)	1.104(0.051)	1.195(0.089)	0.4
Acres under maize season 2	0.906(0.034)	0.921(0.054)	0.89(0.042)	0.634
Acres under bean season 1	0.735(0.027)	0.684(0.028)	0.785(0.046)	0.199
Acres under bean season 2	0.548(0.021)	0.58(0.035)	0.517(0.023)	0.054
Proportion that planted PH5052 season1	0.001(0.001)	0.001(0.001)	0()	0.158
Proportion that planted PH5052 season2	0.002(0.001)	0.003(0.002)	0.001(0.001)	0.565
Proportion that planted NABE15 season1	0.003(0.001)	0.005(0.003)	0.001(0.001)	0.18
Proportion that planted NABE15 season2	0.001(0.001)	0.003(0.002)	0()	0.158
Proportion that purchased improved maize seed season 1	0.281(0.011)	0.289(0.016)	0.273(0.016)	0.437
Proportion that purchased improved maize seed season 2	0.23(0.011)	0.235(0.015)	0.226(0.015)	0.771
Proportion that purchased improved bean seed season 1	0.177(0.01)	0.193(0.014)	0.162(0.013)	0.463
Proportion that purchased improved bean seed season 2	0.119(0.008)	0.129(0.012)	0.11(0.011)	0.547
N	1953	983	970	

Appendix Table 13: Means for outcome variables at baseline : Male respondents

Variables	All sample	Treatment	Control	p-value
Demonstration plots	0.058(0.007)	0.078(0.011)	0.036(0.008)	0.003
Brochures	0.003(0.002)	0.004(0.003)	0.002(0.002)	0.607
Field days	0.008(0.003)	0.011(0.004)	0.004(0.003)	0.189
Radio	0.33(0.014)	0.346(0.02)	0.312(0.021)	0.186
Personal communication	0.587(0.015)	0.601(0.021)	0.571(0.022)	0.23
Awareness of improved seed	0.911(0.009)	0.931(0.011)	0.889(0.014)	0.004
Awareness of maize improved seed	0.862(0.011)	0.882(0.014)	0.841(0.016)	0.058
Awareness of bean improved seed	0.45(0.015)	0.466(0.021)	0.433(0.022)	0.272
Aware of PH5052	0.007(0.003)	0.013(0.005)	0	0
Aware of Longe5	0.515(0.015)	0.53(0.021)	0.498(0.022)	0.218
Aware of Longe6	0.071(0.008)	0.075(0.011)	0.067(0.011)	0.612
Aware of Longe4	0.144(0.011)	0.131(0.014)	0.159(0.016)	0.233
Aware of NABE15	0.007(0.003)	0.011(0.004)	0.002(0.002)	0.072
Aware of K131	0.284(0.014)	0.317(0.02)	0.248(0.019)	0.009
Aware of K132	0.097(0.009)	0.097(0.013)	0.097(0.013)	0.98
Aware of Kanyebwa	0.006(0.002)	0.011(0.004)	0	0
Attitude towards maize improved seed	0.873(0.062)	0.911(0.048)	0.7(0.3)	0.557
Attitude towards bean improved seed	0.727(0.086)	0.733(0.094)	0.7(0.3)	0.246
Perception towards maize improved varieties	0.145(0.165)	0.167(0.199)	0.05(0.25)	0.887
Perception towards beans improved varieties	0.064(0.126)	0.067(0.15)	0.05(0.25)	0.117
Knowledge about PH5052	0.465(0.088)	0.503(0.102)	0.294(0.118)	0.067
Knowledge about NABE15	0.332(0.062)	0.373(0.068)	0.147(0.029)	0.126
N	1442	730	712	

Appendix Table 14: Means for outcome variables at baseline: Female respondents

Variables	All sample	Treatment	Control	p-value
Demonstration plots	0.038(0.005)	0.05(0.009)	0.025(0.006)	0.016
Brochures	0.007(0.002)	0.008(0.003)	0.006(0.003)	0.706
Field days	0.005(0.002)	0.008(0.003)	0.001(0.001)	0.095
Radio	0.252(0.012)	0.253(0.017)	0.25(0.017)	0.813
Personal communication	0.54(0.014)	0.531(0.019)	0.549(0.019)	0.709
Awareness of improved seed	0.834(0.01)	0.819(0.015)	0.849(0.014)	0.374
Awareness of maize improved seed	0.755(0.012)	0.747(0.017)	0.762(0.017)	0.546
Awareness of bean improved seed	0.388(0.013)	0.397(0.019)	0.379(0.019)	0.503
Aware of PH5052	0.002(0.001)	0.005(0.003)	0()	0.079
Aware of Longe5	0.393(0.013)	0.394(0.019)	0.391(0.019)	0.761

Aware of Longe6	0.053(0.006)	0.055(0.009)	0.051(0.009)	0.713
Aware of Longe4	0.079(0.007)	0.073(0.01)	0.085(0.011)	0.446
Aware of NABE15	0.006(0.002)	0.008(0.003)	0.004(0.003)	0.454
Aware of K131	0.225(0.011)	0.222(0.016)	0.228(0.016)	0.908
Aware of K132	0.069(0.007)	0.075(0.01)	0.064(0.01)	0.43
Aware of Kanyebwa	0.004(0.002)	0()	0.007(0.003)	0.027
Attitude towards maize improved seed	0.867(0.067)	0.85(0.096)	0.9(0.1)	0.392
Attitude towards bean improved seed	0.7(0.113)	0.7(0.129)	0.7(0.3)	0.291
Perception towards maize improved varieties	-0.2(0.345)	-0.225(0.193)	-0.15(1.25)	0.66
Perception towards beans improved varieties	-0.2(0.345)	-0.225(0.193)	-0.15(1.25)	0.876
Knowledge about PH5052	0.216(0.06)	0.147(0.061)	0.353(0.059)	0.817
Knowledge about NABE15	0.108(0.032)	0.088(0.029)	0.147(0.088)	0.173
N	1648	819	829	

Appendix 3: Description of Household and Individual Respondents in the Original Sample

Appendix Table 15: Distribution of households interviewed at the baseline by sample, gender of household head and district

	Baseline								
	Treatment			Control			Total		
	Female	Male	Total	Female	Male	Total	Female	Male	Total
Hoima	36	245	281	32	241	273	68	486	554
Masindi	34	207	241	28	217	245	62	424	486
Tororo	36	243	279	37	238	275	73	481	554
Iganga	25	242	267	19	253	272	44	495	539
Total	131	937	1068	116	949	1065	247	1886	2133

Appendix Table 16: Distribution of respondents interviewed at the baseline by sample, gender of respondent and district

	Treatment			Control			Total		
	Female	Male	Total	Female	Male	Total	Female	Male	Total
Hoima	181	209	390	183	184	367	364	393	757
Masindi	172	187	359	169	185	354	341	372	713
Tororo	231	172	403	231	158	389	462	330	792
Iganga	235	162	397	246	185	431	481	347	828
Total	819	730	1549	829	712	1541	1648	1442	3090

Appendix Table 17: Distribution of households interviewed at the midline by sample, gender of household head and district

	Treatment			Control			Total		
	Female	Male	Total	Female	Male	Total	Female	Male	Total
Hoima	32	241	273	36	229	265	68	470	538
Masindi	31	231	262	39	209	248	70	440	510
Tororo	42	228	270	41	227	268	83	455	538
Iganga	33	240	273	26	248	274	59	488	547
Total	138	940	1078	142	913	1055	280	1853	2133

Appendix Table 18: Distribution of respondents interviewed at the midline by sample, gender of respondent and district

	Treatment			Control			Total		
	Female	Male	Total	Female	Male	Total	Female	Male	Total
Hoima	249	219	468	248	200	448	497	419	916
Masindi	203	184	387	206	168	374	409	352	761
Tororo	252	215	467	256	204	460	508	419	927
Iganga	252	208	460	245	204	449	497	412	909
Total	956	826	1782	955	776	1731	1911	1602	3513

Appendix Table 19: Distribution of households interviewed at the endline by sample, gender of household head and district

	Treatment			Control			Total		
	Female	Male	Total	Female	Male	Total	Female	Male	Total
Hoima	30	231	261	37	215	252	67	446	513
Masindi	33	197	230	35	201	236	68	398	466
Tororo	41	226	267	41	226	267	82	452	534
Iganga	31	233	264	24	234	258	55	467	522
Total	135	887	1022	137	876	1013	272	1763	2035

Appendix Table 20: Distribution of respondents interviewed at the endline by sample, gender of respondent and district

	Treatment			Control			Total		
	Female	Male	Total	Female	Male	Total	Female	Male	Total
Hoima	227	187	414	230	171	401	457	358	815
Masindi	196	163	359	207	180	387	403	343	746
Tororo	230	190	420	237	181	418	467	371	838
Iganga	244	201	445	236	203	439	480	404	884
Total	897	741	1638	910	735	1645	1807	1476	3283

Appendix Table 21: Means of outcome variables differences (endline and baseline) in control sample: household level

Variables	Mean(SE)
Acres under PH5052 season 1	0
Acres under PH5052 season 2	-0.001(0.001)
Acres under PH5052 all seasons	-0.001(0.001)
Acres under NABE15 season 1	0.006(0.005)
Acres under NABE15 season 2	0.002(0.002)
Acres under NABE15 all season	0.007(0.005)
Acres un-recycled improved maize season 1	0.074(0.106)
Acres recycled improved maize season 1	0.183(0.044)
Acres local maize season 1	0.288(0.027)
Acres mixed maize season 1	-0.481(0.032)
Acres un-recycled improved maize season 2	0.075(0.051)
Acres recycle improved maize season 2	0.306(0.039)
Acres local maize season 2	0.247(0.023)
Acres mixed maize season 2	-0.408(0.035)
Acres un-recycled improved maize season all	0.12(0.063)
Acres recycle improved maize season all	0.272(0.055)
Acres local maize season all	-0.466(0.061)
Acres mixed maize season all	-0.052(0.017)
Acres un-recycled improved bean season 1	0.014(0.026)
Acres recycle improved bean season 1	0.333(0.028)
Acres local bean season 1	-0.035(0.053)
Acres mixed bean season 1	-0.358(0.029)
Acres un-recycled improved bean season 2	0.073(0.014)
Acres recycle improved bean season 2	0.314(0.021)
Acres local beans season 2	-0.003(0.022)
Acres mixed bean season 2	-0.088(0.014)

Variables	Mean(SE)
Acres un-recycled improved bean season all	0.056(0.028)
Acres recycle improved bean season all	0.469(0.031)
Acres local beans season all	-0.121(0.059)
Acres mixed bean season all	-0.45(0.035)
Acreage under maize	1.38(0.15)
Production of Maize (kg)	85.6(95.8)
Yield of Maize (kg/acre)	-94(27)
Acreage under beans	0.177(0.048)
Production of beans (kg)	45.7(57)
Yield of beans (kg/acre)	-7.6(18)
Acres under maize season 1	-0.201(0.109)
Acres under maize season 2	0.012(0.055)
Acres under bean season 1	-0.121(0.059)
Acres under bean season 2	-0.036(0.032)
Proportion that planted PH5052 season1	0()
Proportion that planted PH5052 season2	-0.001(0.001)
Proportion that planted NABE15 season1	0.003(0.002)
Proportion that planted NABE15 season2	0.001(0.001)
Proportion that purchased improved maize seed season 1	0.052(0.018)
Proportion that purchased improved maize seed season 2	0.016(0.017)
Proportion that purchased improved bean seed season 1	0.088(0.019)
Proportion that purchased improved bean seed season 2	0.046(0.016)

Appendix Table 22: Means of outcome variables differences (endline and baseline) in control sample: Male respondent

Variables	
Demonstration plots	0.017(0.013)
Brochures	0(0.003)
Field days	0.008(0.006)
Radio	-0.151(0.024)
Personal communication	0.153(0.031)
Awareness of improved seed	0.096(0.014)
Awareness of maize improved seed	0.92(0.012)
Awareness of bean improved seed	0.895(0.014)
Aware of PH5052	0()
Aware of Longe5	0.426(0.023)
Aware of Longe6	0.086(0.013)
Aware of Longe4	0.09(0.013)
Aware of NABE15	0.004(0.003)
Aware of K131	0.302(0.021)
Aware of K132	0.205(0.019)
Aware of Kanyebwa	0.216(0.019)

Appendix Table 23: Means of outcome variables differences (endline and baseline) in control sample: Female respondents

Variables	
Demonstration plots	0.036(0.012)
Brochures	-0.002(0.002)
Field days	0.011(0.005)
Radio	-0.042(0.021)
Personal communication	0.375(0.022)
Awareness of improved seed	0.141(0.014)
Awareness of maize improved seed	0.846(0.015)
Awareness of bean improved seed	0.887(0.013)
Aware of PH5052	0.002(0.002)
Aware of Longe5	0.524(0.02)
Aware of Longe6	0.099(0.012)
Aware of Longe4	0.118(0.013)
Aware of NABE15	0.011(0.004)
Aware of K131	0.338(0.019)
Aware of K132	0.241(0.017)
Aware of Kanyebwa	0.283(0.018)

Appendix Table 24: Means of outcome variables differences (endline and baseline) in control sample: all respondent

Variables	
Attitude towards maize improved seed	-0.017(0.012)
Attitude towards bean improved seed	0.148(0.012)
Perception towards maize improved varieties	0.05(0.025)
Perception towards beans improved varieties	0.525(0.360)
Knowledge about PH5052	0.05(0.0)
Knowledge about NABE15	0.176(0.059)

Observations for perception (2 for maize and 4 for beans) and 2 observations for knowledge for PH5052 and NABE15

Appendix 5: Questionnaire used in data collection

EGERTON UNIVERSITY - TEGEMEO INSTITUTE

IMPROVING FOOD SECURITY THROUGH THE INTRODUCTION OF NEW SEED

ASSESSING WHICH MODALITIES ARE MOST COST-EFFFECTIVE IN PROMOTING USE OF NEW SEED VARIETIES

SECTION 1

IDENTIFIERS

Household Name HH Name_____

Respondent(s) Name (s): (Instruction: Record the member ID (D0A) of the Respondent from the Demography table after the survey is completed.)

First visit Respondent Name: Respondent Name _____ D0B_____ SURDATE (dd-mm-yy) _____

Household phone number (s) *(Ask for Head's and Spouse's)* PHONE1_____ PHONE2_____

Region	(1=Eastern, 2=Western)	REG _____
District	(1=Hoima, 2=Masindi, 3=Tororo, 4=Iganga)	DIST _____
Sub-county		SCOUNT _____
Parish		PAR_____
Village		VILL _____
SAMPLE	(1=Treatment 2=Control)	SAMPLE _____
Supervisor		SUP _____
Enumerator		ENUM _____

Consent Reasons for non-consent CONS _____

(*Reasons:* 1=Refused, 2=Family commitments-weddings/burial/other household commitments etc, 3= Sickness, 4=Other , specify)

"We are part of a team at Egerton University, who are studying maize and bean farming for purposes of informing policy formulation. Your participation in answering these questions is very much appreciated. Your participation is completely voluntary, and you do not need to answer any questions you do not want to. Your responses will be COMPLETELY CONFIDENTIAL. If you choose to participate you may refuse to answer certain questions or you may stop participating at any time. Your responses will be added to those of 2160 other households in Uganda and analyzed together. If you have any questions or comments about this survey, you may contact the Director, Tegemeo Institute, Egerton University, P.O. Box 20498, Nairobi. Kenya''

SECTION 1. DEMOGRAPHIC CHARACTERISTICS OF HOUSEHOLD MEMBERS

Ask these questions for each of the members that have stayed with this Household for a period of <u>at least one month</u> for the last 12 months

Number of members who have been staying in the household for a period of <u>at least one month</u> for the last 12 months [ ]

Demog14 (*Key variables: hhid, D0A*) Reference Period: The Past 12 months – Nov 2013 to Oct 2014

Member ID	Name (Start with the household head)	In which year was this person born?	What is the sex of....? 1=male 2=female	Relationship to current head See code below	Marital Status See codes below	What is the highest level of education completed see codes below	(for persons aged 6 – 18 yrs) Currently in school? 1=yes 2=no	How many months in the past 12 months has this person been living at home?	Is this person currently considered a member of this household? 1=Yes –> 2=No	If this person is not a current member of household, why? See code below	Did this person receive cash from informal /business activity? Include farm kibarua/Lejaleja, dividends Nov 2013 to Oct 2014 1=Yes 2=No	Did this person receive cash or payment in kind from salaried employment, wage activities, remittances or pensions Nov 2013 to Oct 2014 1=Yes 2=No	Main occupation of member (use codes in section 3 B1)	Main Occupation (D15) 1= Salary earner (e.g., teacher, policeman, etc.) 2= Casual wage earner 3= Farm labourer 4=Transportation business 5= Bicycle repair/mechanics 6= Brewing business 7= Brick making 8=Butcher 9=Carpentry 10=Charcoal burning 11=Clothes business (trading) 12=Construction 13=General-kiosk owner 14=Miller 15=Trading farm produce 16=Trading fish 17=Trading livestock 18=Trading firewood 19=Trading non-food
D0	D1A	D2	D3	D4	D5	D6	D7	D10	D11	D12	D13	D14	D15	
1														
2														
3														
4														
5														
6														
7														
8														
9														
10														
11														
12														
13														
14														
15														

Relation to head (D4)		Marital Status (D5)	Education levels (D6)				Reason why not member of HH (D12)	
1= head	8= son/daughter-in-	1 = single	-9=None	0=pre	13=S3	14=S4	1=left to find a job	9=farm worker left
2= spouse	9= grandchild	2 = mononogamous	1=P1	2=P2	15=S5	16=S6	2=left to attend school	10=other specify__
3= own child	10=other relative	3 = polygamous	3=P3	4=P4	17= college 1	18=college		
4= step child	11=unrelated	4 = divorced	5=P5	6=P6	19= college 3	20= college	3=married away	
5= parent	12=brother /sister-in-	5 = widowed	7=P7	8=J1	21=univ 1	22=univ 2		
6= brother /sister	13=parent-in-law	6 = separated	9=J2	10 =J3	23=univ 3		4=deceased	
7= nephew /niece	14=Worker	7= other (specify)	11=S1	12=S2	24=univ 4 & above			

SECTION 2. WAGE, SALARIED EMPLOYMENT, SELF-EMPLOYMENT/BUSINESS & REMITTANCES in the last 12 months (Nov 2013 –Oct 2014)

Enumerator Instruction: Ask this Question for all the members who were listed as having earned an income in the demography table i.e. If D13 and/or D14 on Demog14 = Yes: List names of all members who were engaged in wage, salaried employment (including kibarua), business & remittances. If one is engaged in more than one activity, use more than one row. Offarm14 Key variables hhid

Person name	Person ID	Number of economic activities	Activity name Code *Use Biz Code*	Where does this person conduct the business *Use Place codes*	How much did you invest in this business over the last 12 months	Classify each month's gross earnings/sales as: 0= No Earning/Sales Month 1= Low Gross Earning/Sales Month 2= High Gross Earning/Sales Month 3= Constant Earnings/Sales month												If respondent cannot estimate the gross earnings, record net earnings and fill zero for costs					
																		Low gross earnings/sales month		Constant earning/sales month		High gross earnings/sales month	
						Nov 13	Dec 13	Jan 14	Feb 14	Mar 14	April 14	May 14	June 14	July 14	Aug 14	Sep 14	Oct 14	Gross earning per month	Cost* per month	Gross earning per month	Cost* per month	Gross earning per month	Cost* per month
D1B	D0C		B1	B2	B3	B4A	B4B	B4C	B4D	B4E	B4F	B4G	B4H	B4I	B4J	B4K	B4L	B5	B6	B7	B8	B9	B10

*The average monthly cost, including only operational costs (fuel, goods, hiring labours, etc) but excluding fixed costs or capital.

Biz Code (B1): Place Codes (B2) Source of Business Capital (B2)

1= Salary earner (e.g., teacher, policeman, etc.)	8=Butcher	15=Trading farm produce	1=within Parish	1=Credit

2= Casual wage earner	9=Carpentry	16=Trading fish	2=Rural area outside of parish	2=Savings from farm sales
3= Farm labourer	10=Charcoal burning	17=Trading livestock	3=Urban area outside of parish but not	3=Earnings from off farm activities
4=Transportation business	11=Clothes business (trading	18=Trading firewood	4=Major town	4=Specify _____
5= Bicycle repair/mechanics	12=Construction	19=Trading non-food goods	4=Other_____	
6= Brewing business	13=General-kiosk owner	20=Trading timber		
7= Brick making	14=Miller	21=Tailor		
		22= other (don't specify)		

Indicate the wage rate in <u>this area</u> for the following: *(Enumerator instruction; Ask separately for males and females for area… not HH)*

Type of Work	Male (Hours & UGX)		Female (Hours & UGX)	
	WR1	WR1P	WR2	WR2P
Day's work on-farm, UGX and Hrs worked per day				
Day's work off-farm for unskilled labour, UGX and Hrs worked per day				
Day's work off-farm for skilled labour, UGX and Hrs worked per day				
Monthly pay for salaried farm worker				

Enumerator Instruction: Skilled labour refers to labour activities that require formal training to learn.

SECTION 4. LAND OWNERSHIP AND TENURE OF THE PARCELS Accessible to The Household In 2013/14 Cropping Year

Q4.1. How long has this household lived in this locality?(years)
H1_____

Q4.2. Which Year did you start farming in this area? H2_____

Q4.3. How much land did the household own at the time you started farming (acres)? H3_____

Q4.4. How much land does the household OWN today (acres) H4_____

Q4.5. How many acres do you have under Crop farming: H5A_____ Grassland: H5B _____Forest/Woodlots: H5C_____ Weedy Fallow: H5D _____

Q4.6. What is the price of good quality agricultural land in this area in UGX per Acre? Lower price: H6A_____ Higher price: H6B_____

Q4.7. How many parcels did this household access in 2013/14 cropping year? [ ] H7A

Q4.8. Fill in Table below all parcels the household <u>accessed</u> in 2013/14 cropping year

Tenure14: Key variables hhid, P1

									Renting-out	Renting-in

Parcel Name	Parcel ID	Area of Parcel in acres (As reported by the farmer)	Distance from home to the parcel (km)	Slope of this parcel Use slope Code	How did this household acquire this parcel? Code below	If own land, in which year did this household acquire this parcel? e.g., 1987	If purchased what was the price? UGX	Have you rented-out all or part of it? 1=yes 2=no	If P8=1 For how long have you been renting-out this parcel? (years)	If rented-out what was the lease period in 2013/14? 1=First crop season only 2=Second crop season only 3=Annual 4=2 years 5=Long-term	How much were you paid (for land rent) UGX?	Relation of the Head with tenant Use relation code	Residence of tenant 1=same parish 2=same sub-county 3=Other	If rented-in what is the lease period in 2013/14? 1=First crop season only 2=Second crop season only 3=Annual 4=2 years 5=Long-term	How much in UGX did you pay for the land you rented?	How many years have you been renting-in this parcel 1=First crop season only 2=Second crop season only 3=Annual 4=2 years 5=Long-term	Relation of the head with land owner (Use code below)	Residence of land owner 1=same parish, 2=same sub-county, 3=Other
P0	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17	P18

Slope code (P4): 1=flat; 2=gentle slope; 3=steep slope 4=moderate terraced 5=Steep terraced

Acquisition code (P5) 1= Purchased; 2= Rented-in for fixed payments; 3= Gift or inheritance; 4= Borrowing from relatives/friends; 5= Sharecropping-in; 6= Just walked in; 7= other (specify)

Relationship code (P12 & P17): 1= relative; 2=neighbour; 3=friend; 4=other (specify)

Table 1:

SECTION 5. INVESTMENT ON LAND

(Enumerator Instruction: If a parcel has more than one installation, record each on a different row).

Installation14 Key Variables hhid

Parcel ID As given in Section 4 above	Name of the Parcel (Enumerator, this should be the same name as P0 in section4 above) Parcel Name	Do you have installations on this parcel? (0=No, 1=Yes)	How many installations do you have on this parcel	What installation(s) are on this Parcel?	How many years ago was this installation put?	In the last 1 year (since 2013) did you make any improvements to the installation 1=Yes 0=No *Go to next installation*	In total how much money did you pay to improve on this installation? (UGX)	How did you get financing to make these improvements?
PC1	PC0	PC2	PC2B	PC3	PC4	PC5	PC6	PC7

PC3

1= Cow Shed

2 =Chicken House

3= Goat Pen

4 =Tapped Water

5= Well

6= Posho mill

7= Grain store

8= Fencing or Hedge

9= Cut off Drain

10 =Bench

11= Biogas structure.

12= Other Specify_____

PC7

1=Credit

2=Savings from farm sales

3=Income outside of the farm

									4=Remittances

Table 2:

Table 3:

Table 4:

SECTION 6. CROPPING ACTIVITY

Q6.1. Did this household have any cropping activity during FIRST SEASON (Feb to Jul 2014)? (No=0, 1= Yes) H7_____

If yes, fill the details in table below. Otherwise skip to Question 6.3. *Enumerator Instruction: Get details for all the plots cultivated by the household on all parcels accessed during first season whether on own plots or rented.* (*A plot is a piece of land within a parcel with a uniform crop mixture).*

Crop14 *Key Variables: hhid, season, C1, C2, C3* Season = 1 (FIRST)

Parcel ID As given in Section 4 above	Number of plots in the parcel	Plot ID	Area of plot (acres)	Watering system used 1=Rain fed 2=Irrigated(piped) 3=Irrigation (gravity) 4=other (specify)	Main land preparation method 0=zero tillage 1=hand 2=animal traction 3=tractor 4=slash & burn 5=other specify	No. of crops planted	Which crops did you plant *See crop codes*	Planted Seed Type? 1=Purchased /New improved 2=Recycled improved 3=local 4= Purchased /New improved + local 5=local seedling /cuttings/split 6=improved seedling /cutting /splits	Quantity of seed used and cost, if purchased this season			Did you use fertilizer? (0=No,1=Yes)									Harvest -777=not yet harvested		Sales (if no sales skip to next season)		Price of the largest sale *(Use the sale unit)*
												Quantity of 1st Fertilizer used			Quantity of 2nd Fertilizer used			Quantity of 3rd Fertilizer used								
									Qty	Unit *Use Codes below*	Cost per unit	Type	Qty	Unit *Use Codes below*	Type	Qty	Unit *Use Codes below*	Type	Qty	Unit *Use Codes below*	Qty	Unit *Use Codes below*	Qty	Unit *Use Codes below*	
C1	C2	C2	C4	C5	C6	C3		C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20	C21	C22	C23	C24

Chemical Fertilizer codes: 0=None 1=DAP 2=MAP 3=TSP 4=SSP	10=UREA(46:0:0) 5=NPK (20:20:0) 6=NPK (17:17:0) 7=NPK(25:5:+5S) 8=CAN(26:0:0) 9=ASN(26:0: 0)	11=SA(21:0:0) 14=Foliar feeds 15=NPK(23:23:23) 16=NPK(20:10:10) 19=magmax lime	20=DSP 21=NPK(23:23:0) 22=NPK(17:17:17) 23=NPK(18:14:12) 24=NPK(15:15:15) 25=Mavuno-basal	26=Kero green 27=Rock-phosphate 28=NPK 14:14:20 29=Mijingu 1100 30=Mavuno-top dress. 12=Other (specify)___	Organic Fertilizer codes: 0=None 13=(Dry) manure 32=(Fresh)Animal manure 34=Ash 18=compost	Unit codes: 1 =90 kg bag 11 =50 kg bag 2 =kgs 3 =litter 4=crate 5 =numbers	6=bunch(bananas) 9 =gorogoro 10 =tones 12 =debe 13 =grams 7 = 25 kg bag 8 = 10 kg bag	14 =wheelbarrow 15 =cart 16 =canter 17 =pickup 18 =2kg bag 19 =Donkey load 20 = Donkey cart load	21 = Hand cart load 22 = Head load 23 = Area in acres 24 Other (specify)

First season CONT.....

If yes, fill the details in table below. Otherwise skip to Question 6.3. *Enumerator Instruction: Get details for all the plots cultivated by the household on all parcels accessed during first season whether on own plots or rented. (A plot is a piece of land within a parcel with a uniform crop mixture).*

Crop14 *Key Variables: hhid, season, C1, C2, C3* Season = 1 (FIRST)

Parcel ID As given in Section 4 above	Number of plots in the parcel	Plot ID	Area of plot (acres)	Watering system used 1=Rain fed 2=Irrigated(piped) 3=Irrigation (gravity) 4=other (specify)	Main land preparation method 0=zero tillage 1=hand 2=animal traction 3=tractor 4=slash & burn 5=other specify	No. of crops planted	Which crops did you plant *See crop codes*	Planted Seed Type? 1=Purchased /New improved 2=Recycled improved 3=local 4= Purchased /New improved + local 5=local seedling /cuttings/split 6=improved seedling /cutting /splits	Quantity of seed used and cost, if purchased this season			Did you use fertilizer? (0=No,1=Yes)									Harvest -777=not yet harvested		Sales (if no sales skip to next season)		Price of the largest sale *(Use the sale unit)*
												Quantity of 1st Fertilizer used			Quantity of 2nd Fertilizer used			Quantity of 3rd Fertilizer used								
									Qty	Unit *Use Codes below*	Cost per unit	Type	Qty	Unit *Use Codes below*	Type	Qty	Unit *Use Codes below*	Type	Qty	Unit *Use Codes below*	Qty	Unit *Use Codes below*	Qty	Unit *Use Codes below*	
C1	C2	C2	C4	C5	C6	C3		C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20	C21	C22	C23	C24

Chemical Fertilizer codes: 0=None 1=DAP 2=MAP 3=TSP 4=SSP	10=UREA(46:0:0) 5=NPK (20:20:0) 6=NPK (17:17:0) 7=NPK(25:5:+5S) 8=CAN(26:0:0) 9=ASN(26:0: 0)	11=SA(21:0:0) 14=Foliar feeds 15=NPK(23:23:23) 16=NPK(20:10:10) 19=magmax lime	20=DSP 21=NPK(23:23:0) 22=NPK(17:17:17) 23=NPK(18:14:12) 24=NPK(15:15:15) 25=Mavuno-basal	26=Kero green 27=Rock-phosphate 28=NPK 14:14:20 29=Mijingu 1100 30=Mavuno-top dress. 12=Other (specify)___	Organic Fertilizer codes: 0=None 13=(Dry) manure 32=(Fresh)Animal manure 34=Ash 18=compost	Unit codes: 1 =90 kg bag 11 =50 kg bag 2 =kgs 3 =litter 4=crate 5 =numbers	6=bunch(bananas) 9 =gorogoro 10 =tones 12 =debe 13 =grams 7 = 25 kg bag 8 = 10 kg bag	14 =wheelbarrow 15 =cart 16 =canter 17 =pickup 18 =2kg bag 19 =Donkey load 20 = Donkey cart load	21 = Hand cart load 22 = Head load 23 = Area in acres 24 = Other (specify)

List of crops arranged alphabetically to be used with the crops tables to select a crop code

Amaranthus	140	Dates	192	Mkuyu	196	Soyabeans	160
Apple	119	Dhania	183	Mulberry	220	Spinach	66
Arrowroots	44	Dhania grains	182	Nathi	165	Squash	124
Artemisia	201	Eggplant	71	Njahi	147	Stefali	190
Avocado	97	Flowers	20	Njugu mawe/bambara bean	37	Stinging nettle	206
Avocado (grafted)	50	French beans	25	Okra	77	Strawberries	177
Bananas	10	Garlic onion	138	Onions	96	Sugar beets	187
Bananas (tissue culture)	202	Gourds	62	Oranges	75	Sugarcane	15
Barley	60	Grapes	179	Oranges (grafted)	61	Sugarcane, chewing	170
Beans	7	Green grams	34	Other leaves (bean,njahi)	184	Sukuma wiki	64
Brinjals/biriganya	129	Green peas	167	Passion fruit	137	Sunflower	30
Bulrush millet	169	Groundnuts	33	Passion fruit (grafted)	59	Sweet melon	68
Beetroot	221	Guava	72	Pawpaw	70	Sweet potatoes	43
Cabbage	93	Indigenous vegs	140	Pawpaw (grafted)	58	Tamarind	3
Cammomila	200	Indigenous grains	139	Peaches	166	Tangawizi	189
Capsicum/sweet peppers	67	Irish potatoes	27	Pears	134	Tangerine	136
Carrots	94	Jack fruit	300	Pepper, bell	65	Tea	12
Cashew nuts	24	Karela	210	Pigeon peas	141	Tobacco	29
Cassava	28	Lemons	74	Pineapples	133	Tomatoes	63
Castor oil	146	Lemons (grafted)	84	Plums	121	Tree tomato	162
Cauliflower	175	Lemon grass	207	Pomegranite	178	Trees, commercial	5
Chillie peppers	131	Lettuce	173	Poyo	35	Turnips	161
Coconuts	23	Lugard	118	Pumpkin	76	Vanilla	205
Coconuts, copra	194	Macadamia nuts (grafted)	203	Pumpkin leaves	172	Watermelon	69
Coconuts, green	193	Macadamia nuts	135	Pyrethrum	17	Wheat	13
Coffee, cherries	6	Maize, dry	1	Ravaya	211	White suppoise	163
Coffee, churned	176	Maize, green	2	Rice	31	Wild berries	149
Coffee, mbuni	11	Mangoes (grafted)	204	Runner beans	171	Yams	81
Corn flower	168	Mangoes	73	Saina	36	Yellow passion fruit (mero)	95
Cotton	14	Matomoko	120	Simsim	78	Zambarao	174
Cowpeas	21	Millet	9	Sisal	16		
Cowpeas leave	19	Miraa	148	Snow peas	90		
Cucumber	125	Mkunga	197	Sorghum	8		

Feed stuff		Pasture (other than		Lucerne	32
Napier/ Elephant grass	80	Napier grass)	85		
Other Fodder leaves	22	Oats	83		

Q6.2. Did this household have any cropping activity during SECOND SEASON (Aug 2013 to Jan, 2014)? (0=No, 1= Yes)
H8_____

If yes, fill the details in table below. Otherwise skip to Question 7.1. *Get details for all the plots (see definition above) cultivated by the household on all parcels accessed during second season whether on own plots or rented.*

Crop14 *Key Variables: hhid, season, C1, C2, C3* Season = 2 (SECOND)

Parcel ID As given in Section 4 above	Parcel name	Number of plots in the parcel	Plot ID	Area of plot (acres)	Watering system used 1=Rain fed 2=Irrigated(piped) 3=Irrigation (gravity) 4=other (specify)	Main land preparation method 0=zero tillage 1=hand 2=animal traction 3=tractor 4=slash & burn 5=other specify	No. of crops planted	Which crops did you plant *See crop codes*	Planted Seed Type? 1=Purchased /New improved 2=Recycled improved 3=local 4= Purchased /New improved + local 5=local seedling /cuttings/split 6=improved seedling /cutting /splits	Quantity of seed used and cost, if purchased this season			Did you use fertilizer? (0=No,1=Yes)									Harvest -777=not yet harvested		Sales (if no sales skip to next season)		Price of the largest sale *(Use the sale unit)*
													Quantity of 1st Fertilizer used			Quantity of 2nd Fertilizer used			Quantity of 3rd Fertilizer used							
										Qty	Unit *Use Codes below*	Cost per unit	Type	Qty	Unit *Use Codes below*	Type	Qty	Unit *Use Codes below*	Type	Qty	Unit *Use Codes below*	Qty	Unit *Use Codes below*	Qty	Unit *Use Codes below*	
C1	C0	C2	C2	C4	C5	C6	C3		C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20	C21	C22	C23	C24

Chemical Fertilizer codes: 0=None 1=DAP 2=MAP 3=TSP 4=SSP	10=UREA(46:0:0) 5=NPK (20:20:0) 6=NPK (17:17:0) 7=NPK(25:5:+5S) 8=CAN(26:0:0) 9=ASN(26:0: 0)	11=SA(21:0:0) 14=Foliar feeds 15=NPK(23:23:23) 16=NPK(20:10:10) 19=magmax lime	20=DSP 21=NPK(23:23:0) 22=NPK(17:17:17) 23=NPK(18:14:12) 24=NPK(15:15:15) 25=Mavuno-basal	26=Kero green 27=Rock-phosphate 28=NPK 14:14:20 29=Mijingu 1100 30=Mavuno-top dress. 12=Other (specify)___	Organic Fertilizer codes: 0=None 13=(Dry) manure 32=(Fresh)Animal manure 34=Ash 18=compost	Unit codes: 1 =90 kg bag 11 =50 kg bag 2 =kgs 3 =litter 4=crate 5 =numbers	6=bunch(bananas) 9 =gorogoro 10 =tones 12 =debe 13 =grams 7 = 25 kg bag 8 = 10 kg bag	14 =wheelbarrow 15 =cart 16 =canter 17 =pickup 18 =2kg bag 19 =Donkey load 20 = Donkey cart load	21 = Hand cart load 22 = Head load 23 = Area in acres 24= Other (specify)

Second Season CONT.....

If yes, fill the details in table below. Otherwise skip to Question 7.1. *Get details for all the plots (see definition above) cultivated by the household on all parcels accessed during second season whether on own plots or rented.*

Crop14 *Key Variables: hhid, season, C1, C2, C3* Season = 2 (SECOND)

Parcel ID	Parcel	Number of		Area of		Main land preparat	No. of crop	Which crop	Planted Seed Type?	Quantity of seed used and cost, if	Did you use fertilizer? (0=No,1=Yes)	Harvest	Sales	Price of the larges

HHID_______

As given in Section 4 above	name	plots in the parcel	Plot ID	plot (acres)	Watering system used 1=Rain fed 2=Irrigated(piped) 3=Irrigation (gravity) 4=other (specify)	ion method 0=zero tillage 1=hand 2=animal traction 3=tractor 4=slash & burn 5=other specify	s planted	s did you plant *See crop codes*	1=Purchased /New improved 2=Recycled improved 3=local 4= Purchased /New improved + local 5=local seedling /cuttings/split 6=improved seedling /cutting /splits	purchased this season			Quantity of 1st Fertilizer used			Quantity of 2nd Fertilizer used			Quantity of 3rd Fertilizer used			-777=not yet harvested		(if no sales skip to next season)		t sale *(Use the sale unit)*
										Qty	Unit *Use Codes below*	Cost per unit	Type	Qty	Unit *Use Codes below*	Type	Qty	Unit *Use Codes below*	Type	Qty	Unit *Use Codes below*	Qty	Unit *Use Codes below*	Qty	Unit *Use Codes below*	
C1	C0	C2	C2	C4	C5	C6	C3		C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20	C21	C22	C23	C24

Chemical Fertilizer codes: 0=None 1=DAP 2=MAP 3=TSP 4=SSP	10=UREA(46:0:0) 5=NPK (20:20:0) 6=NPK (17:17:0) 7=NPK(25:5:+5S) 8=CAN(26:0:0) 9=ASN(26:0: 0)	11=SA(21:0:0) 14=Foliar feeds 15=NPK(23:23:23) 16=NPK(20:10:10) 19=magmax lime	20=DSP 21=NPK(23:23:0) 22=NPK(17:17:17) 23=NPK(18:14:12) 24=NPK(15:15:15) 25=Mavuno-basal	26=Kero green 27=Rock-phosphate 28=NPK 14:14:20 29=Mijingu 1100 30=Mavuno-top dress. 12=Other (specify)___	Organic Fertilizer codes: 0=None 13=(Dry) manure 32=(Fresh)Animal manure 34=Ash 18=compost	Unit codes: 1 =90 kg bag 11 =50 kg bag 2 =kgs 3 =litter 4=crate 5 =numbers	6=bunch(bananas) 9 =gorogoro 10 =tones 12 =debe 13 =grams 7 = 25 kg bag 8 = 10 kg bag	14 =wheelbarrow 15 =cart 16 =canter 17 =pickup 18 =2kg bag 19 =Donkey load 20 = Donkey cart load	21 = Hand cart load 22 = Head load 23 = Area in acres 24= Other (specify)

SECTION 8. MAIZE and BEANS MARKETING

(Indicate in the table below the Maize and beans marketing details marketing details. *2013/14 Cropping Season*

Transfer the information on parcel id, plot No, crop code, season, and quantity sold for maize and beans only both for first and second season.

Sale14 (Key variables: hhid,)

Parcel ID	Plot No.	Crop Sold 1=maize 2=Green maize 7=Beans	Season 1=First season 2=Second season	Quantity Sold		Distance from farm (km) to point of sale	If paid transport to point of sale, how much was paid?	Largest sale			
				Qty	Unit			Mode of transport to point of sale	State of road to point of sale 1=Tarmac 2=All weather 3=Seasonal	Sale Price	Unit of the largest sale
CM1	CM2	CM3	CM3A	CM4	CM5	CM7	CM6	CM8	CM9	CM10	CM11

Unit codes: CM5, CM11	11=50 kg bag	Mode of transport to point of sale CM8
1=90 kg bag	12=debe (18kg tin)	1= vehicle
2=kgs	16 =canter	2= human
5 =numbers	17 =pickup	3= animal (e.g. donkey, oxen)
9=gorogoro (2kg tin)	23 = Area in acres	4= bicycle
10=tonnes		5=boat
		6=motorcycle

SECTION 9: EXPENSES ON PURCHASED INPUTS FOR PRODUCTION OF MAIZE (do beans also): 2014 Crop

Input14 *Key variables hhid*

Season 1=First 2=Second	Crop type 1=Maize 2=Beans	Type of input purchased (use code below)	Input source	Quantity applied Only if bought this season	Unit *(Use unit codes)*	Price of input per unit	Mode of purchase of the input 1=cash 2=credit 3=Subsidy 4=Other specify	Transport cost UGX	Input source E8 1=small trader, 2=Stockist, 3=large company, 4=NGO/CBO, 5=NAADS 6=farmer /neighbour, 7=Other coop, 8=Farmer group, 19=other specify_____ Unit codes: 1 =90 kg bag 11 =50 kg bag
E1	E1A	E2	E8	E3	E4	E5	E6	E7	

Chemical Fertilizer codes: 0=None 1=DAP 2=MAP 3=TSP 4=SSP	10=UREA(46:0:0) 11=SA(21:0:0) 14=Foliar feeds 15=NPK(23:23:23) 16=NPK(20:10:10) 19=magmax lime 20=DSP	23=NPK(18:14:12) 24=NPK(15:15:15) 25=Mavuno-basal 26=Kero green 27=Rock-phosphate 28=NPK 14:14:20 29=Mijingu 1100	Organic Fertilizer codes: 0=None 13=(Dry) manure 56=(Fresh)Animal manure 55=Ash	32=pesticide 33=insecticide 34=herbicide 35=plough 36=sprayer 37= AT equip	40=fungicide 41=water 46=planter cost 47=harvester cost 49=Sheller cost 50=fuel	51=gunny bags 52=ridger cost 53=land rent 54=land preparation cost 12=other specify_____

5=NPK (20:20:0) 6=NPK (17:17:0) 7=NPK(25:5:+5S) 8=CAN(26:0:0) 9=ASN(26:0: 0)	21=NPK(23:23:0) 22=NPK(17:17:17)	31=Mavuno-top dress. 12=Other (specify)___	18=compost	39=technical support

SECTION 10: HIRED LABOUR for CROPPING & MARKETING ACTIVITIES (crops production)

Q9.1. Did you use hired labour (for any cropping activity during the last two seasons: i.e. 2013/2014 season) during the 2013/2014 cropping season?

0= No, *Go To Section 12*, 1=Yes H9_____

Q9.2. If 10.1=Yes, ask about the activity, number or people & time spent on each of the activities. (Only include hired labour over age 15 years*).*

Hlabour14 Key variables hhid

Season 1=first 2=second	Parcel ID	Plot No	Activity *Use codes on the right*	Hired Labour									Type of contract: (HL9) 1=day's work 2= piecework 3=permanent worker (HL11) Unit codes: 1=Acres 3=hours 2=kgs 4=day 1=90 kg bag 11=50 kg bag	Activity codes (HL4) 1=1st Ploughing 2=2nd Ploughing 3=Harrowing 4=Planting 5=1st Weeding 6=Top-dressing 7=2nd Weeding 8=3rd Weeding 9=Spraying crops 10=Pruning 11=Harvesting 12=Threshing 13=Transport from farm 14=Storage
				Gender 1=male 2=female	Number of persons	Number of days worked	Number of hours	Type of contract	If per day indicate amount paid per person	If piecework indicate UNIT of payment	Number of units that must be attained to fulfil contract	Total payment for the contract		
HL1	HL2	HL3	HL4	HL5	HL6	HL7	HL8	HL9	HL10	HL11	HL12	H13		

SECTION 12: EXPENSES ON PURCHASED INPUTS for Production of other Crops (Ask about fertilisers, pesticides and other inputs)

Cropinput14 Key variables hhid,

Did you purchase inputs for other crops (0=No, 1=Yes)	Type of input used (use code below)	Quantity used	Unit codes: 1=90 kg bag 2=kg 3=litre 4=50 kg bag 5=other (specify)__	Price of input per unit	Mode of purchase of the input 1=cash 2=credit 3=Free 4=Subsidized 5=Other specify	Transport cost	Input source	Input source (EC9) 1=small trader, 2=Stockist, 3=large company, 4=NGO/CBO, 5=NAADS 6=farmer /neighbour, 7=Other coop, 8=Farmer group, 9=other specify_____
EC1	EC2	EC3	EC4	EC5	EC6	EC7	EC8	

Chemical Fertilizer codes: 0=None 1=DAP 2=MAP 3=TSP 4=SSP 5=NPK (20:20:0) 6=NPK (17:17:0) 7=NPK(25:5:+5S) 8=CAN(26:0:0) 9=ASN(26:0: 0)	10=UREA(46:0:0) 11=SA(21:0:0) 14=Foliar feeds 15=NPK(23:23:23) 16=NPK(20:10:10) 17=DAP + CAN 19=magmax lime 20=DSP 21=NPK(23:23:0) 22=NPK(17:17:17)	23=NPK(18:14:12) 24=NPK(15:15:15) 25=Mavuno-basal 26=Kero green 27=Rock-phosphate 28=NPK 14:14:20 29=Mijingu 1100 30=UREA+CAN 31=Mavuno-top dress. 12=Other (specify)___	Organic Fertilizer codes: 0=None 13=(Dry) manure 32=(Fresh)Animal manure 34=Ash 18=compost	32=pesticide 33=insecticide 34=herbicide 35=plough 36=sprayer 37= AT equip 39=technical support	40=fungicide 41=water 46=planter cost 47=harvester cost 49=sheller cost 50=fuel	51=gunny bags 52=ridger cost 53=land rent 54=land preparation cost(only on credit) 12=other specify_____

SECTION 16: LIVESTOCK INVENTORY

Q1.1. Has this Household kept any livestock for the last 12 months Nov 2013 –Oct 2014? 1=Yes, 2=No (skip to Assets) H26_____

Q1.2. Did this household keep animals for someone else in Oct 2014? 1=Yes, 2=No H27 _____

Q1.3. Did someone else keep animals for this household in Oct 2014? 1=Yes, 2=No H28_____

Livestock14 Key Variables HHID, LV1

Livestock	Live stock	October 2014					Number Owned in	Since Nov2013 to Oct 2014					Who has the right on sale of
			Total value of	Number of	Number of	Number kept at this household in							

	ID	Number owned include animals kept by others)	owned livestock in UGX	animals keeping for others	animals kept by others	Grazing	Zero or Semi-zero grazing	November 2013	Number born	Number purchased	Number consumed at home	Number sold	Number died or stolen	these livestock? 1=head 2=Spouse 3=Both 4=Son 5=Daughter
LSNAME	LV1	LV2	LV3	LV4	LV5	LV6	LV7	LV8	LV9	LV10	LV11	LV12	LV13	LV14
Local: Cows	1													
Local: Bulls/Oxen	2													
Local: Young bulls	3													
Local: Heifer	4													
Local: Calves	5													
Improved: Cows	6													
Improved: Bulls/	7													
Improved: Young	8													
Improved: Heifer	9													
Improved: Calves	10													
Local: Goats	11													
Improved: Goats	12													
Sheep	13													
Pigs	14													
Improved Chicken	15													
Indigenous Chicken	16													
Other Specify	17													
Rabbits	18													

SECTION 17: LIVESTOCK OUTPUT

Q17.1. Did this household produce any cow milk during the last 12 months? (1=Yes 2=No (Go To SECTION 18) H29_____

Q17.2. How many months over the last past 12 months, *(In terms of production)* were;

a) High Milking Months? H30_____

b) Low Milking Months? H31_____

c) Zero Milking Months? H32_____

Q17.3. Provide information on the fresh milk produced by the household on this table:

Milkprod14 (key variable, hhid, MP1)

Milk			Quantity (in litres) of fresh milk per day			Price (per Litre) for fresh milk	If fresh milk was sold, Ask about the largest buyer			Buyer type of largest sale (MP6) 1=Cooperative societies; 2=UCCCU.; 3=Private processors /traders; 4=Hawker /informal trader; 5=Institutions/Hotels; 6=Consumer /Neighbour /Farmer; 7=other, specify_____ 8=Sameer
			Produced	Consumed at home	Sold as fresh		Buyer type of largest sale (Use buyer code)	Quantity (in litres) sold to this buyer	Distance to the point of sale (km)	
		MP1	MP2	MP3	MP4	MP5	MP6	MP7	MP8	
High milking period	Morning	1								
	Evening	2								
Low milking period	Morning	3								
	Evening	4								

Table 5:

SECTION 18: Other livestock products produced during the last 12 months (Nov 2013 –Oct 2014)

Liveprod14 *(Key variables: hhid, LP1)*

Livestock Product		Average number of animals producing over the year	Number of months of production per year	Average Quantity production/ month	Unit of Production.	Number of months of sales per year	Average quantity sold per month	Price received per Unit (UGX) on the largest sale	Buyer type of largest sale	LP5 2=Kgs 3=litres 22=Trays 5=Numbers 1=90kg bag 14=wheelbarrow
	LP1	LP2	LP3	LP4	LP5	LP6	LP7	LP8	LP9	
Goat milk	1									

Honey	2									LP9
Eggs	3									1=Cooperative societies;
Hides and skin	4									2=UCCCU;
Fish (if have fish	5									3=Private processors
Wool	6									/traders; 4=Hawker
Manure (Only if Sold)	7									/informal trader;
Other,	8									5=Institutions/Hotels;

SECTION 11: HIRED LABOUR for Livestock ACTIVITIES (Production & Marketing)

Did you use hired labor (for any Livestock activity during the 2013/2014 season? (0=No, 1=Yes) H9A

(if 0=No, skip to section 18A)

Activity code	Hired Labour									HL14
	Gender 1=male 2=female	Number of persons	Number of days worked	Number of hours	Type of contract (Use codes)	If per day indicate amount paid per person	If piecework indicate UNIT of payment	Number of units that must be attained to fulfil contract	Payment for the contract	1=Grazing 2=Gathering fodder 3=Milking 4=Milk Delivery 5=Spraying livestock 6=Cleaning sheds 7=All livestock activities
HL14	HL15	HL16	HL17	HL18	HL19	HL20	HL21	HL22	HL23	
										Type of contract 1=day's work 2= piecework 3=permanent worker

SECTION 18 A

Q18.1. In total over the last 12 months, how much money did you spend on the following services for your livestock?
Livescost14 (Key variables: hhid, LE1)

Animal Species		Purchased feeds cost	Vet serv+Vaccinations	Tick control	De-worming	AI service cost	Natural Insemination
LE1		LE2	LE3	LE4	LE5	LE6	LE7
Cattle	1						
Goats	2						
Sheep	3						
Pigs	4						
Improved chicken	5						
Fish	6						

SECTION 19: HOUSEHOLD ASSETS (NOV 2013 –OCT 2014)
Asset 14 Key Variables hhid, A0

Asset		Number of items currently owned	At what price would you buy item	How many did you own 1 years ago?	Number of items purchased in the last 12 months (Nov 2013 – Oct 2014)	Purchase price per unit	Asset		Number of items currently owned	At what price would you buy	How many did you own 1 years ago?	Number of items purchased in the last 12 months (Nov 2013 – Oct 2014)	Purchase price per unit
ITEM	A0	A1	A3	A2	A4	A5	ITEM	A0	A1	A3	A2	A4	A5
Tractors	1						Water tanks	15					
Trailers	2						Grinders	16					
Vehicles	3						Beehives	17					
Carts	4						Motorcycle	18					
Donkeys	5						Bicycle	19					
Wheelbarrow	6						Radio/ Tape	20					
Ploughs	7						Batteries	21					
Borehole	8						TV	22					
Well	9						Mobile Phones	23					
Sickle	10						Furniture	24					
Hand hoe	11						Mosquito nets	25					
Chaff cutter	12						Solar Panels	26					
Spray pumps	13						Milking churns	27					
Diesel pumps	14												

SECTION 19A

ASK MALE SPOUSE

Q19.1. If you do not own a radio, do you have access to one (that you can listen to)? (1=Yes) (2=No) H33M_____

Q19.2. If yes, from whom do you access the radio? (1=neighbour 2= relative 3=Other, specify_____) H34M_____

Q19.3. How far do you go to access the radio (Km) H35M_____

Q19.4. How much do you pay to listen? (UGX) H36M_____

Q19.5. What specific times do you listen to the radio? (record three distinct times) H37AM_____ H37BM_____ H37CM_____

Q19.6. If you do not own a phone, do you have access to one (that you can use)? (1=Yes) (2=No) H38M_____

Q19.7. If Q23=yes, from whom do you access the phone? (1=neighbour 2= relative 3=Other, specify_____) H39M_____

Q19.8. How far do you go to access the phone? (Km) H40M_____

Q19.9. How much do you pay to use the phone? (UGX) H41M _____

ASK FEMALE SPOUSE

Q20.1. If you do not own a radio, do you have access to one (that you can listen to)? (1=Yes) (2=No) H33F_____

Q20.2. If yes, from whom do you access the radio? (1=neighbour 2= relative 3=Other, specify_____) H34F_____

Q20.3. How far do you go to access the radio (Km) H35F_____

Q20.4. How much do you pay to listen? (UGX) H36F_____

Q20.5. What specific times do you listen to the radio? (record three distinct times) H37AF_____ H37BF_____ H37CF_____

Q20.6. If you do not own a phone, do you have access to one (that you can use)? (1=Yes) (2=No) H38F_____

Q20.7. If Q23=yes, from whom do you access the phone? (1=neighbour 2= relative 3=Other, specify_____) H39F_____

Q20.8. How far do you go to access the phone? (Km) H40F_____

Q20.9. How much do you pay to use the phone? (UGX) H41F _____

SECTION 20: ACCESS TO CREDIT

Q21.1. Did any member of this household apply for credit (either cash or in kind) over the last 1 years i.e. since 2013?

1 = yes →go to 21.3 2 = no →give reason 3 = not sure →skip to section 22 H42_____

Q21.2. If Q21.1 = 2 what were the reasons for not applying H43_____

1=no security 2=had outstanding loan 3= did not require credit 4= Don't Know 5=no means to repay 6= other (specify) _____

Q21.3. Did any member of this household receive the credit in cash applied for? 1= Yes 2=No H44_____

Q21.4. If No, what was the reason for being denied the cash credit? H45_____

1=no security 2=had outstanding loan 3= Credit received in kind 4= Don't Know 5= other (specify) _____

If Q21.1=yes, fill details of credit in table below

Credit14: Key variables hhid, CD2 (Reference period: last 1 year)

Year received credit	Purpose of the credit	What was the source of credit:	Who applied &received the cash credit (D0A from the demography)	How much Cash was received (UGX)	What security/collateral was demanded?	Would you have desired a bigger Amount? 1=yes 2=no	What was the duration of the loan? (1, 2, 3… In months)	What was the repayment monthly instalment? (UGX)	Have you been able to pay back the loan: 1= Paid in full 2= Unable to pay 3= Still paying 4= Not yet due 5 = Other (specify_____	Purpose of the credit(CR2) 1=Coffee Farming 2=Dairy keeping, 3=Horticulture farming, 4= Maize farming 5=Bee-keeping, 6=School fees, 7=medical, 8=business, 9=other (specify)_____ What was the source of credit(CR3) 1= neighbour 2=farmer group 3=SACCO (specify) _____	Collateral(CR6) 1=Land 2=Other permanent assets 3=Movable assets 4=Investment shares 5=Guarantors 6=other specify
CR1	CR2	CR3	CR4	CR5	CR6	CR7	CR8	CR9	CR10		

										4=commercial bank _____ 5=relative/friend 6=NGO/MFI (specify)_____ 7=AFC 8= group (ROSCA) 9=Coffee Coop 10=Dairy Coop 11=other (specify) _____	

SECTION 22: INFRASTRUCTURE *Distance should be recorded in kilometres, Km* (-7= Service not available)

Q23. Road type codes *1=tarmac 2=murram /all weather 3=dry weather 4=foot path.*

a) What is the distance from your homestead to extension advice? H57 _____

b) What is the distance from your homestead to veterinary help? H58_____

c) What is the distance from your homestead to A.I. service? H59_____

d) What is the distance from your homestead to the nearest animal feed seller? H60_____

e) What is the distance from your homestead to nearest agro-dealer? H56_____

f) What is the distance from your homestead to seller of improved seed? H67_____

g) What is the distance from your homestead to seller of inorganic fertiliser? H68_____

h) What is the distance from your homestead to the nearest MAJOR market place for farm produce? H61_____

i) What is the type of the road from your homestead to the farm produce market? (Use codes above) H62_____

j) What is the distance from your home stead to the nearest electricity supply point(Tap able) H63_____

k) What is the distance from your homestead to the nearest milk dairy? H64_____

l) What is the distance from your homestead to the nearest livestock market place? H65_____

m) What is the distance to the nearest public telephone?(landline, and public mobile phones,) H66_____

Table 6:

SECTION 24: FAMILY'S ECONOMIC SITUATION Household staple food & expenditures

Q24.1. In the last 12 months, for how many months did the household have adequate food staples from own production? H75____

Q24.2. If the household did not have adequate staples from own production in the entire last 12 months, how did it meet the shortfall in staples?

Give three sources H76A_____ H76B_____ H76C_____

(List in order of importance) 1=Purchases 2=Donations 3=Relief 4=other (specify) _____

Q24.3. How many months did you consume own produced maize? H78 _____

Q24.4. In total how much maize did you consume at home? H79_____

Q24.5. Did you produce enough maize to sell? *(1=yes, 2=No)* H80_____

Q24.6. How much maize did you sell? H81_____

Q24.7. Did you purchase maize for home consumption? *(1=yes, 2=No)* H82_____

Q24.8. In total how much did you purchase? H83_____

Q24.9. How many months did you consume own produced beans? H86 _____

Q24.10. In total how much beans did you consume at home? H87 _____

Q24.11. Did you produce enough beans to sell? *(1=yes, 2=No)* H88 _____

Q24.12. How much beans did you sell? H89 _____

Q24.13. Did you purchase beans for home consumption? *(1=yes, 2=No)* H90 _____

Q24.14. In total how much did you purchase? H91_____

SECTION 25: WELFARE INDICATORS (Enumerator: Observe/ask about the following)

Q25.1. Have you made any improvements in your main house over the last 1 year? 1=YES 2=NO H93_____

Q25.2. If 25.1= yes what was the total cost of the improvements made? H94_____

Q25.3. What is the roofing material of the main house? H95_____

(1=grass /makuti 2=iron sheet 3=tiles 4=other, (specify_____)

Q25.4. What is the wall material of the main house? H96_____

(1=mud 2=bricks/stones 3=iron sheet 4=wood 5=plastered 6=other, (specify_____)

Q25.5. What is the floor material of the main house? H97_____

(1= earth 2=cement 3=wood 4=tiles 5=other, (specify_____

Q25.6. What is the mode of ownership of the main house? H98_____

(1= owned 2= rented 3= owned by relative 4=other, (specify_____)

Q25.7. What type of toilet do you use? H99_____

(1=Improved pit latrine 2=Traditional pit latrine 3= bush 4= flush toilet 5= other, (specify_____)

Q25.8. What is the main source of water for domestic use during dry seasons? H100_____

(1=Pond 2=dam /sand dam 3=lake 4=stream/river 5=unprotected spring 6=protected spring 7=well 8=borehole 9=piped into compound 10=piped outside compound 11=water tankers 12=roof catchments 13=water hawkers-cart / bicycle transporters 14= other, specify_____)

Q25.9. What is the distance (in km) to main source of water for domestic use during dry Seasons? H101_____

Q25.10. What is the main source of water for domestic use during wet seasons? H102_____

(1=Pond 2=dam /sand dam 3=lake 4=stream/river 5=unprotected spring 6=protected spring 7=well 8=borehole 9=piped into compound 10=piped outside compound 11=water tankers 12=roof catchments 13=water hawkers-cart / bicycle transporters 14= other, specify_____)

Q25.11. What is the distance (in km) to main source of water for domestic use during wet seasons? H103_____

Q25.12. What is the main source of water for irrigation? H104_____

(0=Does not irrigate 1=Pond 2=dam /sand dam 3=lake 4=stream/river 5=unprotected spring 6=protected spring 7=well 8=borehole 9=piped 10=water tankers 11=roof catchments 12=water hawkers-cart / bicycle transporters 13= other, specify_____)

Q25.13. What is your main cooking fuel? H105_____

(1=electricity 2=paraffin 3=firewood 4=gas 5=charcoal 6=solar power 7=other, specify_____)

Q25.14. What is your main type of lighting? H106_____

(1=electricity 2=pressure lamp 3=tin lamp 4=fuel wood 5=lantern 6=solar power 7=other, specify_____)

Thank you