The state of the commercial maize seed sector in Uganda

A report based on survey data collected from smallholder farmers and agro-input dealers

Bjorn Van Campenhout, Richard M. Ariong, Frank Kagoda, Caroline Miehe, Leocardia Nabwire

SEPTEMBER 1, 2021

International Food Policy Research Institute (IFPRI)

Kampala, Uganda

THE AUTHORS

1. Bjorn Van Campenhout (PhD)
   Principal Investigator, Seed Systems Development Project
   International Food Policy Research Institute and LICOS Centre for Institutions and Economic Performance- KU Leuven
   Waaistraat 6 - bus 3511 - B-3000 Leuven - Belgium
   Tel No: +32 488 147073
   E-mail Address: B.VanCampenhout@cgiar.org

2. Richard M. Ariong (MSc)
   Research Analyst
   International Food Policy Research Institute
   Tel No: +256 751 798111
   Email: R.Ariong@cgiar.org

3. Frank Kagoda (PhD)
   Senior Scientist/Program Leader - Crops and Natural Resources Program
   Buginyanya Zonal Agricultural Research and Development Institute (NARO)
   Tel No: +256 703 745929
   Email: fkagoda@gmail.com

4. Caroline Miehe (MSc)
   Phd Student
   LICOS Centre for Institutions and Economic Performance- KU Leuven
   Tel No: +32 487 805586
   Email: caroline.miehe@kuleuven.be

5. Leocardia Nabwire (MSc)
   Research Analyst
   International Food Policy Research Institute
   Tel No: +256 782 644412
   Email: L.Nabwire@cgiar.org

ACKNOWLEDGEMENT

This report was prepared as part of a larger project on Seed Systems Development, funded by the Netherlands-CGIAR/NWO Research programme.. The study was implemented in Uganda by International Food Policy Research Institute in collaboration with Wageningen University of Research, National Agricultural Research Organisation (NARO)- Uganda, and Integrated Seed Sector Development Programme (ISSD). The implementing partners appreciate all the farmers and agro-input dealers that participated in the study.

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ABSTRACT

Smallholder farmers in Uganda predominantly rely on informal seed systems. As a result, maize yields remain low and may even reduce over time as the quality of the seed stock in informal systems reduces. There are various reasons why smallholder farmers may refrain from obtaining seed through the formal sector. This includes economic factors (such as lack of money and competing expenditures, risk related to the use of an unfamiliar type of seed, etc.) as well as behavioural biases (such as inability to commit, anchoring of seed price to the price of grain, etc). As part of a larger field experiment designed to answer questions related to the role of seed quality as a barrier to the development of the sector, baseline data was collected among a sample of about 350 agro-input dealers towards the end of 2020 and among a sample of about 3,500 smallholder farmers in the beginning of 2021. This report provides a description of this data.

We find that at baseline, already about half of the farmers were using improved seed on at least one field, which they typically buy from agro-input shops in the neighbourhood. Farmers that adopt quality seed do this because they perceive commercial seed to be of good quality and reasonably priced. However, farmers that do not adopt are of the opinion that seed is too expensive, and quality is low. This underscores the importance of perceptions in the decision to adopt.

Farmers distrust agro-input dealers, as many believe agro-input dealers often sell fake seed. At the same time, farmers also indicate that the reason why they buy seed at a particular agro-input dealer is because they get good quality. This seems to suggest that farmers only trust agro-input dealers they have interacted with. The fact that farmers are loyal and distrust competing agro-input dealers may hamper the development of a competitive seed system.

When looking at the seeds that farmers actually use, farmers that use improved seed, especially hybrid, are happy with their seed. Improved seed outperform landraces on almost all areas, both judged by farmer perceptions as by more objective indicators such as yield and price. For example, farmers who reported to have used quality seed had yields that were 27 percent higher than that for the farmers who reported not to have used quality seed. At the same time, it is observed that few farmers give feedback on seed performance even if they feel quality was less that what was promised. This could be due to a lack of clear feedback mechanism(s) between the agro-input dealers and their clients or extension agents, and this may call for some intervention that makes it easier to provide feedback on the quality of services and seed in particular. NGOs provide best seed in terms of yield, followed by seed obtained from agro-input dealers.

Farmers do not seem to use a lot of complementary inputs. They do, however, seem to understand the importance of early and frequent weed control. Of farmers who do report to be using inputs, mostly DAP inorganic fertilizer, also record higher yields.

Agro-input dealers are generally run by well educated youth, many of them trained on the importance of seed quality. The average shop had 2 hybrid maize seed varieties and one hybrid variety in stock.

Longe10H is the most popular hyrbid while Longe5 is the most popular OPV. Agro-input dealers take a price mark-up of about 20 percent, and the markup is slightly higher for OPVs. Agro-input

dealers often experience stock-outs, especially for hybrid seed. This may point to credit constraints and poor planning at the level of the agro-input dealer, or bottlenecks at the level of the seed producers and wholesalers.

With respect to seed storage and handling, we find lots of room for improvement. Agro-input dealers have seed storage facilities that are likely to expose seed to moisture and cannot keep seed in a condition with relatively uniform temperature leading to seed quality issues. A large majority of agro-input dealers report problems with pests.

Agro-input dealers generally give discounts for large quantities, but rarely provide seed on credit. Some agro-input dealers deliver to farmers, but only for large quantities. More than half of the agro-input dealers report that they repackage seed, which indicates that quantities are generally too big. This is in line with the finding that the most popular packaging size by far is 1 kg.

Despite relatively high levels of education, store management seem to be lacking in knowledge. Many agro-input dealers lack knowledge about best ways to store and handle seed. They also often seem to be unaware of key properties of the seed varieties they sell.

Agro-input dealers do not have equipment to test for moisture content. We do find that shelf life is a strong predictor of moisture content. We find that already after 3 months of seed storage, the limit for acceptable moisture content is often exceeded.

1.0 INTRODUCTION

1.1 Background

One of the most effective ways to increase agricultural productivity is through the use of improved agricultural technologies and practices. These include mechanization, but the Green Revolution has demonstrated that large gains can also be expected from improved inputs such as inorganic fertilizers and high yielding cultivars. Technology adoption remains lower than projected, particularly among the poor in sub-Saharan Africa (Gollin, Morris, & Byerlee, 2005). As a result, differences in yields between sub-Saharan Africa and areas that experienced a green revolution have nearly doubled since 1961 (Magruder, 2018). To reduce this yield gap, it is important to identify the drivers of, and constraints to, technology adoption.

In line with the general trend in economics, the drivers of, and constraints to agricultural technology have increasingly been studied using field experiments (De Janvry et al., 2016; De Janvry et al., 2017). For instance, the Agricultural Technology Adoption Initiative (ATAI), a collaboration between MIT's Abdul Latif Jameel Poverty Action Lab (J-PAL) and UC Berkeley's Center for Effective Global Action (CEGA) has funded a series of field experiments to illuminate what helps and hinders technology adoption among smallholder farmers. Key constraints identified include poor access to information (Ashraf, Giné, & Karlan, 2009), procrastination and time-inconsistent preferences (Duflo, Kremer, & Robinson, 2011), heterogeneity in the net benefits to the technology due to high transaction costs (Suri, 2011), the lack of access to insurance (Karlan et al., 2014), and learning failures (Hanna, Mullainathan, & Schwartzstein, 2014).

1.2 The seed study

This report is part of a larger study that was designed to addresses quality considerations about the technology (improved seed) as a particular constraint to adoption, a topic that has received considerable attention recently (Bold et al., 2017; Michelson etal., 2021). In that study, we specifically explore (perceived) quality of improved maize seed as a constraint to its adoption among a sample of smallholder maize farmers in Uganda. Maize is an important crop in Uganda, both for home consumption and as a source of income. Yet, the uptake of improved maize seed by smallholder farmers to improve its yields remains persistently low, despite their higher yield potential compared to traditional seed varieties. Studies have advanced several factors explaining smallholder's limited adoption of improved inputs in Uganda, and of improved maize seed. These have included farmers' beliefs that the inputs are of poor quality - counterfeited, adulterated, or otherwise non-performant (Bold et al., 2017; Ashour et al., 2019; Barriga & Fiala, 2020). Our study will test interventions aimed at identifying the relative importance of potential sources of these (perceived) quality issues at different levels for agricultural technology adoption. It will bring to light the cognitive, economic, and behavioral aspects that underlie under-adoption of these technologies.

The study takes the form of a field experiment, where research hypotheses are tested through interventions that are randomly assigned to some participants, but not to others. Random assignment is key here, as it guarantees that any differences that emerge between the two groups (like for instance

higher yields in the group that was exposed to the treatment) can be attributed to the treatment. Due to randomization, all other characteristics are "balanced" between the two groups.

It is common for field experiments to carry out a baseline survey before the interventions are implemented. There are various reasons why baseline data is collected. A first reason is to test for balance. Most papers that report on field experiments will show a table that compares averages on a range of baseline characteristics between treatment and control (for example, age of household head, number of children in the household). The idea is then to test if these averages are the same in both the group that was assigned to the treatment and the group that was not (the control). In other words, it tests if the randomization was successful. A second important reason is that statistical power can be increase by controlling for outcomes at baseline, either in a simple analysis of covariance or in a difference-in-difference regression framework. Finally, pre-treatment data is needed to test for heterogeneous treatment effects. For instance, it may be that a treatment only works for a certain type of people (eg only for richer farmers).

The field experiments tests three hypothesis, as issues related to seed quality may arise at different stages in the seed supply chain. Poor seed quality may occur because of input dealer practices. This may be unintentional, for example poor handling and storage practices, or intentional, for instance by mixing poor quality seed with good quality seed to cut costs. The problem may also be situated at the level of the smallholder farmer. For instance, a farmer may lack confidence in the input dealer or his/her products, and the nature of the input may make it impossible for the farmer to assess the quality. It may also be that the farmer wrongly attributes poor outcomes caused by factors other than seed quality to seed quality. We test interventions at different stages in the seed supply chain to assess the relative importance of each potential cause for low demand for improved seed. The first intervention targets the input dealer, the second targets the interaction between the input dealer and the farmer, while the last targets the farmer. Regardless of who is targeted by the intervention, we will assess changes in outcomes at both the input dealer level and at the level of the farmer

We thus collect baseline data at both farmer and agro-input dealer level. In particular, September and October 2020, we collected baseline data from about 350 agro-input dealers in 13 districts in eastern Uganda. In April 2021, we randomly sampled 10 small-holder farmers each catchment area of these agro-input dealers, leading to a sample of 3,500 households. As such, this report has two parts. The first part describes the data that was collected at the farmer level, the second describes characteristics of the agro-input dealers.

3.0 RESULTS

PART I: FARMERS

3.1 Household demographics

We start with some general household characteristics in Table 1. Most households are male headed (78%) and the age of a household head on average is about 47 years. We also see that many of the farmers/respondents (88.4%) were married. In terms of education level, most respondents (41%) had attained some primary schooling, but only 15 percent had finished it. For secondary education, we see that about 26 percent had reached secondary schooling, but only 4 percent had finished it. This finding is reassuringly close to the results of a recent household survey by UBOS (2021) which shows that, in our study site of the Busoga sub-region, 38 percent had some primary schooling while 29 percent completed secondary education We also find that, on average, the household size of farming households in our study area is nine people, which seems somewhat higher than the national average. This may be due to a relatively high incidence of polygamy in the area. Average land size among the sampled farming households is 3.3 acres

Table 1: Household head and farmer characteristics

Variable	**Pooled sample of respondents (N=3470)**			
	Mean	SD	Min.	Max.
Male headed households	0.777	0.416	0	1
Marital status of HH head				
Married	0.884	0.320	0	1
Widowed	0.077	0.266	0	1
Divorced	0.006	0.076	0	1
Separated	0.023	0.150	0	1
Single	0.010	0.101	0	1
Highest education level (Proportion)				
No formal education	0.078	0.268	0	1
Some primary schooling	0.410	0.492	0	1
Finished primary schooling	0.153	0.360	0	1
Some secondary school	0.262	0.440	0	1
Finished secondary schooling	0.040	0.195	0	1
Attained post-secondary education	0.048	0.214	0	1
Other schooling	0.009	0.097	0	1
Belong to a group (proportion)	0.126	0.332	0	1
Household size (Number)	8.695	3.979	01	25
Age of household head (Years)	48.617	13.385	18	97
Farming experience of farmer/respondent (Years)	23.085	13.144	00	82
Household land access for crop production (acres)	3.348	4.348	0.185	100
Female headed household (acres)	2.696	3.458	0.185	050
Male headed household (acres)	3.533	4.519	0.250	100

Additionally, we examined the characteristics of the material of the roof and number of rooms of the main house of farmers in the study area as an objectively verifiable indicator of household level welfare. We find that 92 percent of the households have houses with iron sheets as the roof material and most of the houses (56%) comprise of three to four rooms (Fig. 1). We find that the prevalence of iron sheet houses is substantially higher than the national estimate of 66 percent. This suggests households in our sample are reasonably well off, which is in line with regional poverty estimates.

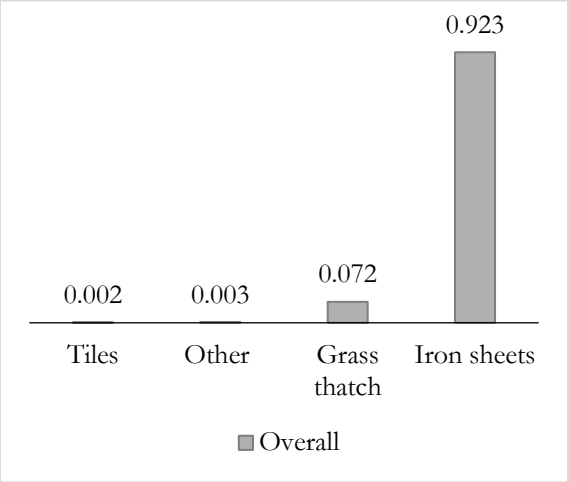

Figure 1: Material of roof of main house

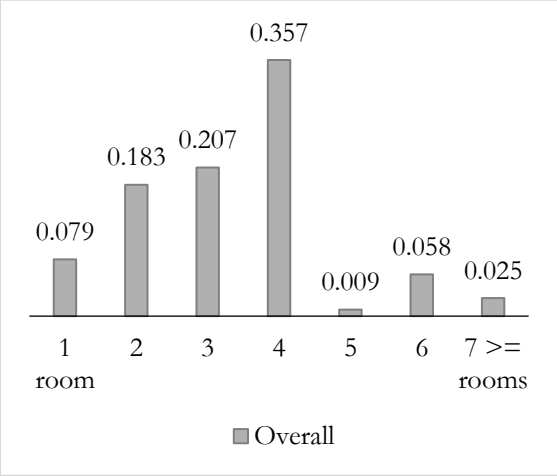

Figure 2: Number of rooms of main house

3.2 Distance to agro-input shop

Maize seed is the most commercialized grain seed in Uganda with some farmers occasionally buying seed and thus. Accessibility in terms of distance to a seed source is one of the traditional challenges that has been found to hinder adoption of improved seed. Busoga sub-region is a key maize production hub in Uganda with the largest area under cultivation. According to the Uganda Bureau of Statistics annual abstract (2020), Iganga district is the leading maize producer in Uganda which makes this region key in maize seed trade. Results in Table 2 show that there are at least two input dealer shops in a village and that the average distance to an input shop is about 4 kilometres. 31 percent of the farmers had an input shop within a one kilometre radius. This indicates that commercial seed is within reasonable reach for most farmers in the area.

Table 2: Distance to farm inputs

Variable	Obs.	Overall mean	SD	Min.	Max.
Number of agro-input dealer shops in the village	3263	2.163	2.346	0	25
Distance to nearest service (KM)					
Tarmac	3302	9.390	10.810	0	100
Village HQ/ Local council	3436	0.745	0.903	0	15
Agro-input dealer shop	3339	3.779	4.789	0	52
Neighbour	3463	0.114	0.183	0	02
Input shop is within 1 KM radius (proportion)	3470	0.313	0.464	0	1

Also, while households reported quite short distances to the nearest Local Council (LC) and to their nearest neighbour (< 1 km), distance to the nearest tarmac road is considerable (Table 2). Much as the households reported to have access to an average of two agro-input dealer shops in their villages, the standard and level of stocking of these shops may require further investigation.

3.3 Farmer practices and perceptions on improved seed

3.3.1 Variety selection, and farmer perceptions

Use of quality seed

Technically, attributes of quality seed include: uniformity (98% variety purity and clean in that it is not mixed with foreign matter like stones or dirt, or other seeds); high germination rate (> 85%); desirable moisture (13%); not damaged, broken, shrivelled, mouldy, or insect damaged; not rotten or discoloured faded; and all non-conformity should not exceed 2% (MAAIF, 2020). Few farmers pay attention to all the mentioned attributes, except for the face value assessment on seed uniformity at buying, and germination rates after planting. Limited farmer assessment is confounded by information failures.

In light of the above, we here define quality seed to mean either hybrid or OPV maize seed accessed from the agro-input shops. The figure below shows that about 50 percent of the farmers reported that they did not use quality seed. Adoption of yield enhancing technologies such as improved seed and fertilizers is still low in Uganda and varies depending on the crop. Improved maize seed being one of the most likely to be adopted, we expect its adoption rates to be above 35 percent, which is common with other food security crops.

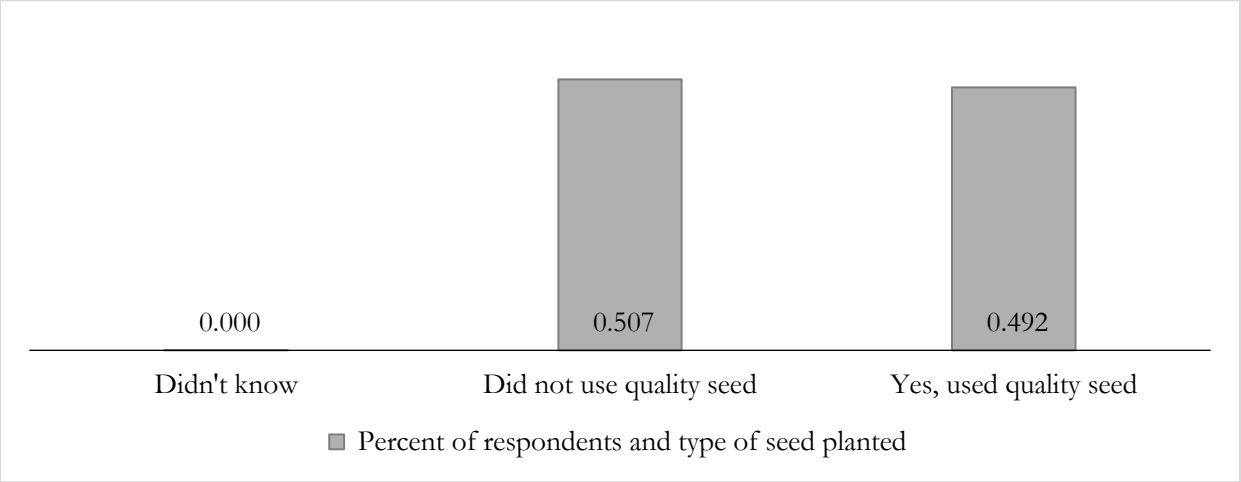

Figure 3: Use of quality seed

Reasons for buying quality seed

Adoption of improved seed in Uganda has been slow among farmers due to several reasons such as accessibility and affordability of inputs. Figure 4 shows, for the subsample of farmers that bought seed at the agro-input shops, reasons why they did so. Among the respondents who admitted to using

improved seed, quality of seed was is found to be the main reason why they do so (Fig. 4). A significant number of farmers also indicated that seed is reasonably priced.

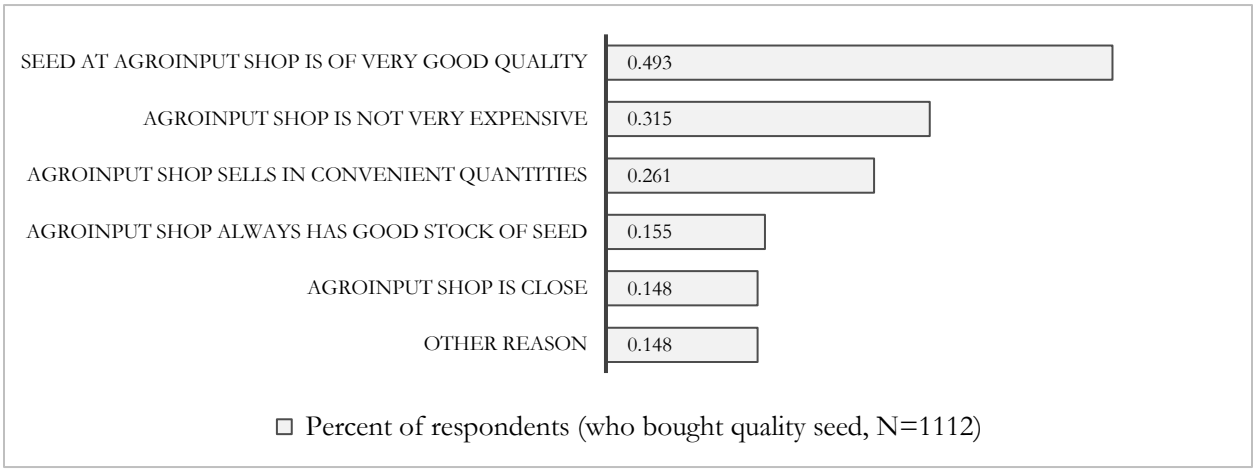

Figure 4: Reasons for accessing quality seed

Results in Figure 5 shows reasons for not using quality seed by non-adopters. Interestingly the very reason why adopters buy quality seed is also the main reason why non-adopters do not adopt: quality. The second most mentioned reason also contrasts with what adopters believe. This illustrates the important role that (wrong) perceptions play in the decision to adopt.

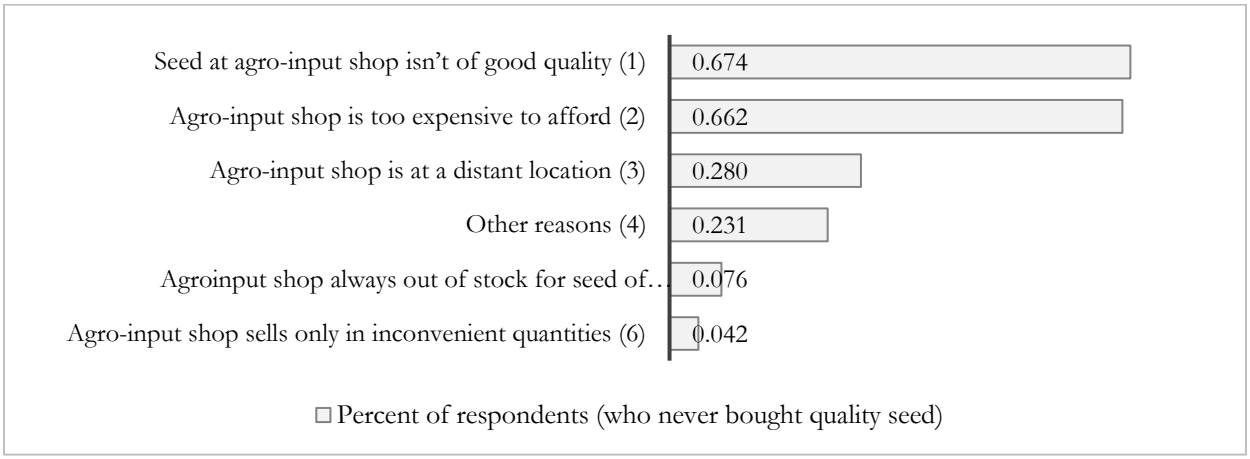

Figure 5: Reasons for not using quality seed

Farmer reason seed is considered not of good quality

In a small sub-sample of farmers that bought seed but indicated they were not happy with the seed, we further inquire why they were not happy. Most farmers seem to indicate issues related to quality.

Table 3: Reasons why farmer was not satisfied

Why is farmer not happy with improved seed	Proportion of respondents (N=159)
Poor varietal purity (many off-types)	0.314

Lower germination rate than expected	0.302
Lower market value than expected	0.252
Requires much more labour (e.g needs lots of weeding)	0.252
Yield is lower than expected	0.239
Less tolerant to pests/disease than expected	0.239
Slower maturing than expected	0.189
Needs more water than expected	0.063
Does not taste as good as expected	0.000
Other	0.503

3.3.2 Farmer awareness of improved maize seed varieties

The first step to adoption is access to information on available technologies in the market. There are over 10 varieties on the Ugandan maize seed market and eleven maize varieties have been developed and released by NARO notably labelled as "Longe" varieties[1]. In the context of farmer awareness of existing maize varieties in the market, we find that generally, the most known varieties include LONGE-5 (66%) and LONGE-10H (51%) while WEMA and PANNAR varieties were the least popular among the varieties mentioned (Table 4). Awareness about improved seed is higher among seed users across all categories, suggesting that lack of knowledge is indeed also an important reason why farmers do not adopt.

Table 4: Farmer awareness of improved maize varieties

Maize variety		**Proportion of respondents aware of the variety**	
		Overall (N=3470)	Users of quality seed (N=1706)
OPV varieties	LONGE-5	0.655	0.754
	LONGE-4	0.157	0.192
	OTHER VARIETY	0.066	0.028
Hybrid varieties	LONGE-10H	0.513	0.639
	LONGE-6H	0.096	0.118
	LONGE-7H	0.087	0.114
	LONGE-7HR	0.076	0.096
	BAZOOKA	0.145	0.222
	KH SERIES	0.075	0.093
	PANNER	0.016	0.020
	WEMA	0.010	0.011
	OTHER HYBRID	0.235	0.269

3.3.3 Farmer perception on agro-input shops and association with counterfeit seed

We saw earlier that many farmers do not buy seed because they think seed sold by agro-input dealers is counterfeit. In line with this, in Fig. 6 we find that a majority of respondents (53%) reported that some agro-input dealer shops may sell counterfeit seed. Somewhat surprisingly, and in contrast to responses of farmers who buy improved seed at an agro input dealer in Figure 4, the proportion of farmers reporting the possibility of counterfeiting was even higher (61%) for the farmers who reported

[1] The varieties released in Uganda can be found on the NAADS website - https://naads.or.ug/maize-varieties/

to have used quality seed. This seems to suggest that farmers only trust agro-input dealers they have interacted with.

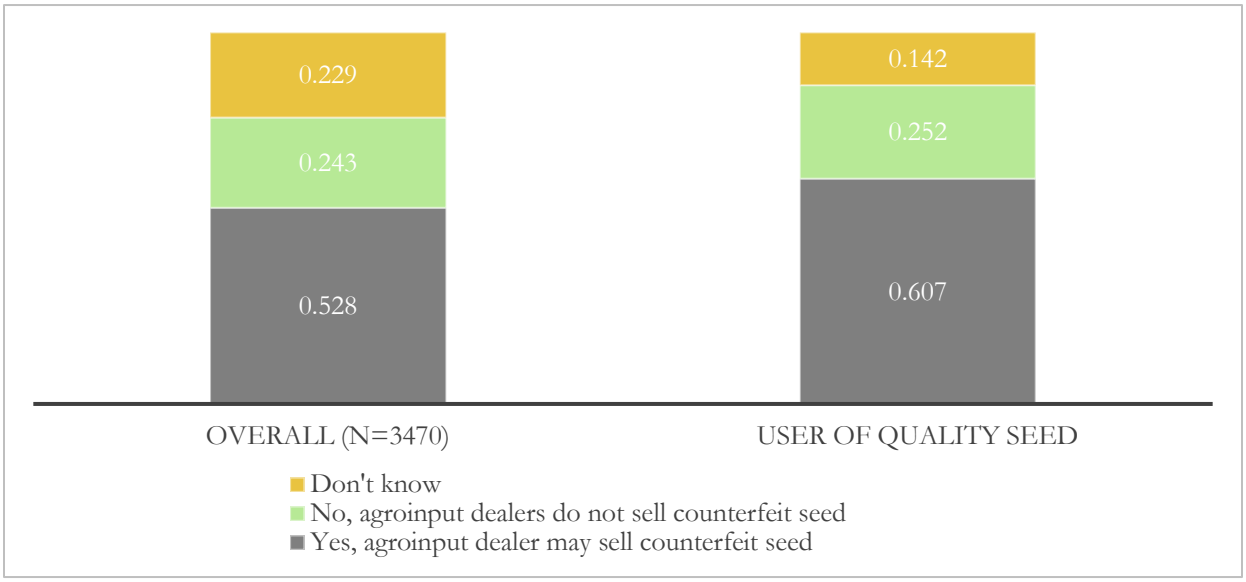

Figure 6: Proportion of farmers who think agro-input shops can have counterfeit seed

3.3.4 Maize varieties and sources of planted seed

In this section, we look at what farmers actually planted in the season prior to the survey (which was the second season of 2020 referred to locally as entoigo). To do so, we randomly selected one plot from all plots that the farmer cultivated and asked detailed questions about this field, including seed use, practices, yield, etc.

Varieties planted in the study area

There are over 12 varieties planted by farmers in Busoga sub-region namely the LONGE series, KH series, BAZOOKA, Panner, and WEMA (Table 5). It is noted that most farmers in the study area grow improved varieties as opposed to landraces (43%) and among the improved varieties, LONGE-5 and LONGE-10H come off as the top two varieties of choice with 62 percent of the users of quality seed growing them vis-a-vis other varieties. However, much as a significant proportion of farmers plant improved varieties, the output from the seed and land productivity from the improved seed may be undermined by other factors including limited use of complementary inputs and seed recycling which impacts on farmer yield and later, contribute to variety dis-adoption.

Table 5: Maize varieties planted

Variable	Proportion of respondents (Yes)	
	Overall (N=3470)	Users of quality seed (N=1706)
LONGE-5	0.215	0.356
LONGE-10H	0.146	0.265
OTHER HYBRID	0.056	0.083
BAZOOKA	0.051	0.097
LONGE-4	0.020	0.035
KH SERIES	0.016	0.029
LONGE-6H	0.008	0.015
LONGE-7R	0.008	0.016
LONGE-7H	0.006	0.012
PANNER	0.001	0.001
WEMA	0.001	0.001
LAND RACES	0.428	0.058
DON'T KNOW	0.044	0.032

Note: A variety denoted with a "H" at the end means that it is a hybrid developed in Uganda

Sources of maize seed

The recommended practice is that farmers plant improved maize varieties from quality assured sources and avoid use of recycled seed but many farmer continue to plant own saved seed or seed obtained from neighbours or relatives, which is usually associated with recycling. Results in Table 6 show that overall, about 50 percent of the surveyed farmers planted own saved seed. Only 33 percent bought seed from an agro-input dealer shop. However, for farmers who reported to have used quality seed, a majority of them (63%) sourced it from an agro-input dealer. Since local seed businesses are just picking up in the study area, only 0.3 percent of farmers reported getting seed from them. None of the farmers reported obtaining seed directly from a seed company or research station. In all, agro-input shops are by far the most important source for farmers that use quality seed.

Table 6: Source of seed

Seed source	Proportion of respondents	
	Overall (N=3470)	Users of quality seed (N=1706)
Own saved seed	0.498	0.157
Agro-input shop	0.327	0.632
Fellow farmer (saved) seed	0.074	0.045
OWC/NAADS	0.038	0.073
NGO	0.029	0.056
Bought in the local market or grain shop	0.018	0.010
Local Seed Business (LSB)	0.003	0.003
Research station	0.000	0.000
Seed company	0.000	0.000
Other	0.012	0.022

3.3.5 Extent of seed recycling

Results show that about 60 percent of the maize farmers/respondents in the study area recycled seed from one to over six times (Table 7). Remarkably, of the farmers that reported to practice seed

recycling, 29 percent were recycling the seed for the sixth or more times compared to two percent who were recycling the seed for the first time. Among the users of quality seed, a majority of them (77%) reported not to be recycling the seed, whereas only five percent reported to be recycling seed for either sixth or more times. This suggests that adopters of quality seed are less likely to recycle seed while the non-adopters are inclined to recycling of maize seed and the frequency goes on for many seasons.

Table 7: Distribution of farmers by frequency of seed recycling

Frequency of recycling	Proportion of respondents	
	Overall (N=3470)	Users of quality seed (N=1706)
0 times (planted newly got seed)	0.397	0.767
1 time (first time recycling)	0.016	0.019
2	0.077	0.070
3	0.072	0.026
4	0.043	0.017
5	0.023	0.010
6 and above	0.286	0.052
98 (Don't know)	0.086	0.039

Note: Farmers denoted by zero recycling are those who bought fresh seed or planted seed sourced from LSB, NAADS, AID shop, NGO, seed company, and Research organization

3.3.6 Farmer ratings on seed quality and performance

Farmer rating on general seed quality

We asked farmers to rate the seed they used on the randomly selected plot on general quality using a 5-point scale ranging from very low to excellent. Results in Figure 7 show that few farmers (12%) considered the seed planted to be excellent while most of them (42%) considered it to be of good quality. On the contrary, 24 percent of the farmers considered the seed planted to be of low to very low quality.

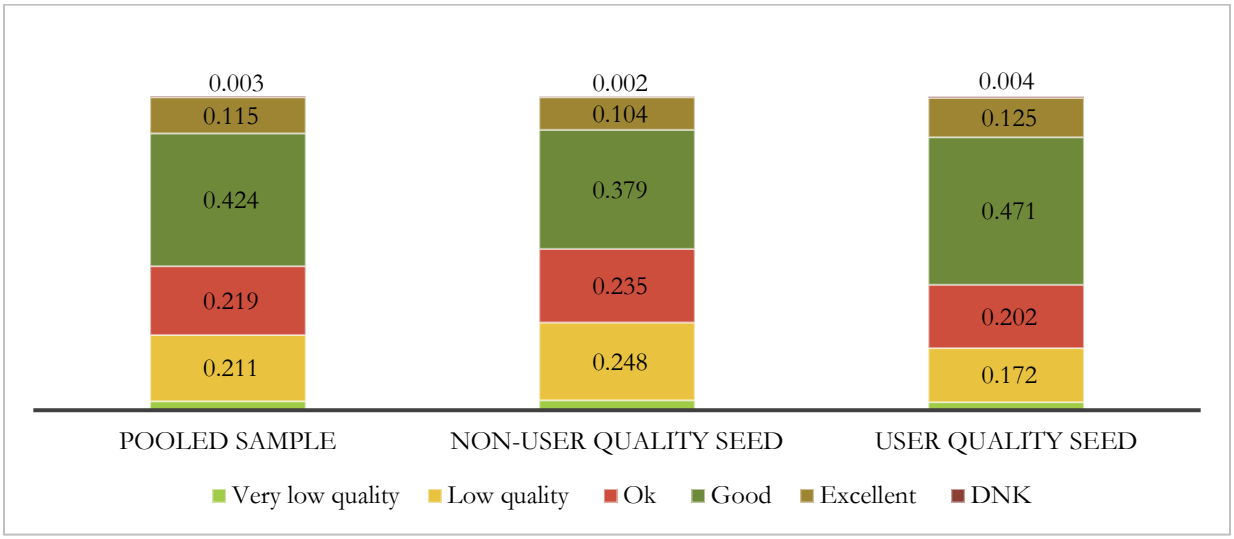

Figure 7: Farmer perception on quality of seed

Farmer ratings on field performance traits of maize seed planted in the second season of 2020

In this section, we look at farmer ratings of the performance of seed in terms of yield, tolerance to drought, pests and diseases, time to maturity, and the germination rate of seed planted in second season of 2020. The results show that 31 percent of farmers rated the maize seed planted to be high yielding and 37 percent gave a rating of low to very low farmer yield (Annex 1). Better grain yields scores were more evident among users of quality seed than the non-users, with 45 percent giving a rating of high to very high grain yield compared to 33 percent giving in the same category rating of the seed they planted in 2020B.

We also see that most farmers reported tolerance to drought to be either merely okay (35%) or very high (19%) while a few farmers (9%), irrespective of whether a farmer was a non-user or user of quality seed, reported very low drought tolerance among the maize varieties grown. On tolerance to pests and diseases, 69 percent of farmers reported a rating of very low to low varietal tolerance and the trend was similar for both the non-users and users of quality seed.

In terms of crop maturity, many farmers (45%) perceived their maize varieties to be early maturing as opposed to only 20 percent who reported their maize varieties to be late maturing. However, for the users of quality seed, only 7 percent of farmers rated their varieties to be late maturing. On germinability, most farmers reported high (40%) or just okay (31%) germination rate as compared to only 12 percent who reported low germination rate. However, more users of quality seed (43%) reported high germination rate as compared to the non-users of quality seed (36.7%).

Overall, the results indicate that only short maturity and germination characterises attained ratings of high to very high by at least 50 percent of the farmers while the other performance traits (drought, pest and disease tolerance and yield) had many farmers giving lower ratings. This suggests that more investigation is needed to evaluate the performance of seed that is used by farmers from the various sources. The farmer ratings may also serve as a guide for more work on breeding for disease tolerance and/or training farmers on both traditional and emerging pests/diseases coupled with integrated pest management.

Farmer ratings on market and consumer performance traits of maize seed planted

On market related aspects of seed, farmers indicate that demand for maize is lower than expected an this is also reflected in the price: 61% generally gave low ratings on marketability regardless of farmer category.

On price of the maize seed, about 41 percent of the farmers rated it to be high to very high. The rating on high prices of seed is largely driven by farmers who use improved seed, as those that do not often get seed for free using recycling. With respect to varietal availability, 38 percent of the surveyed farmers said that the seed is mostly available while 41 percent said seed is almost always available. The majority of the farmers who said seed is available are users of quality seed.

Looking at the consumer trait aspect of taste, a majority of the farmers/respondents (41%) reported the taste of the maize varieties they grow was good and 35 percent commended the varieties for being

very good in taste. These were mainly the non-users of quality seed, and probably majority of these are mainly non-commercial farmers who grow maize mainly for home consumption.

3.3.7 Farmer satisfaction with planted seed and feedback to the source

General satisfaction with planted seed

Figure 8 gives a general perception on farmer satisfaction with the seed planted in season 2020B and it shows that overall, 68 percent of the farmers were satisfied with the seed whiles 32 percent were not satisfied with seed planted in season 2020B. Looking at those who used quality seed vis-a-vis those who did not, we find that 72 percent of the farmers who said they used quality seed were satisfied with the seed they planted compared to about 64 percent of those considered non-user of "quality" seed.

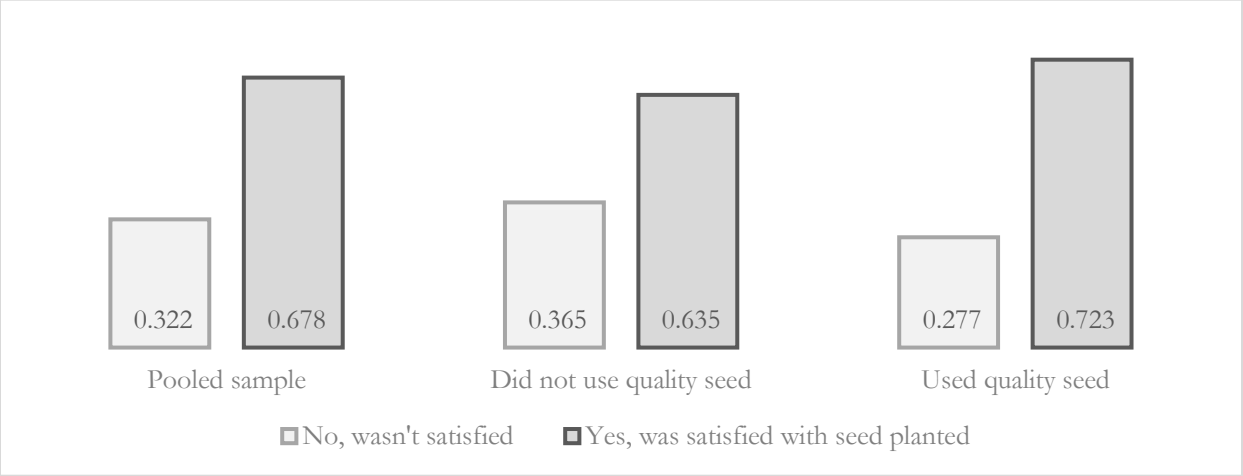

Figure 8: Farmer satisfaction with seed planted in 2020B

Variety planted vis-a-vis farmer satisfaction

Table 8 further shows the association between general farmer satisfaction and the variety planted in season 2020B. The results show that the highest percentage of farmers who reported to be satisfied are those that planted Bazooka (81%) followed by farmers who planted KH series (74%), LONGE-10H (72%) and LONGE-5 (71%). Farmers who planted landraces and unknown varieties were the least satisfied, with only 63 percent and 59 percent satisfaction, respectively.

Table 8: Farmer satisfaction with variety planted

Variable	Overall		Non-user of quality seed		User of quality seed	
	Obs.	Proportion	Obs.	Prop.	Obs.	Prop.
LAND RACES	1486	0.633	1385	0.623	099	0.788
LONGE5	745	0.706	137	0.723	607	0.702
LONGE10H	507	0.724	054	0.704	453	0.726
OTHER HYBRID	194	0.706	052	0.692	142	0.711
BAZOOKA	176	0.807	010	0.800	166	0.807
LONGE4	068	0.647	009	0.444	059	0.678
KH SERIES	057	0.737	007	0.714	050	0.740

LONGE7R	030	0.700	002	0.500	028	0.714
LONGE6H	028	0.893	003	100.0	025	0.880
LONGE7H	023	0.652	003	0.667	020	0.650
PANNER	002	100.0	001	100.0	001	100.0
WEMA	002	100.0	001	100.0	001	100.0
UNKNOWN VARIETY	152	0.586	096	0.594	055	0.564

Note: Only varieties with observations/ a sample size above 20 are discussed (< to be deleted).

Source of seed vis-a-vis farmer satisfaction

Often, issues in seed are associated with the source of the seed and thus, understanding the link between farmer satisfaction and the source of seed may shed some light on grey areas in the seed quality discussions. Reassuringly, Table 9 shows that overall, the highest percentage of satisfied farmers was that of farmers who obtained seed from input dealer shops (74%) closely followed by farmers who obtained seed from the NGOs (72%). The general picture was also mirrored across farmer categories with no significant differences in the patterns. The least percentage of satisfied farmers were those who obtained seed from local market or grain shop (59%) and those using own farmer saved seed (61%).

Table 9: Farmer perception on seed source and seed quality (% is satisfied)

Variable	Overall		Non-user of quality seed		User of quality seed	
	Obs.	Proportion	Obs.	Prop.	Obs.	Prop.
Own saved seed	1728	0.648	267	0.700	1458	0.639
Agro-input shop	1133	0.741	1079	0.741	054	0.759
Fellow farmer (saved) seed	258	0.612	077	0.636	180	0.600
OWC/NAADS	131	0.672	125	0.680	006	0.500
NGO	102	0.716	096	0.719	006	0.667
Local market or grain shop	064	0.594	017	0.765	047	0.532
Local Seed Business (LSB)	011	0.636	006	0.667	005	0.600
Seed company	001	100.0	001	100.0	000	0.000
Research station	001	100.0	001	100.0	000	0.000
Other	041	0.683	037	0.703	004	0.500

Farmer-Supplier feedback on dissatisfaction with seed

For the farmers that were not satisfied with overall seed performance, a majority (72%; N=509) did not relay any feedback to where they got it from vis-a-vi poor performance of the seed (Fig. 9).

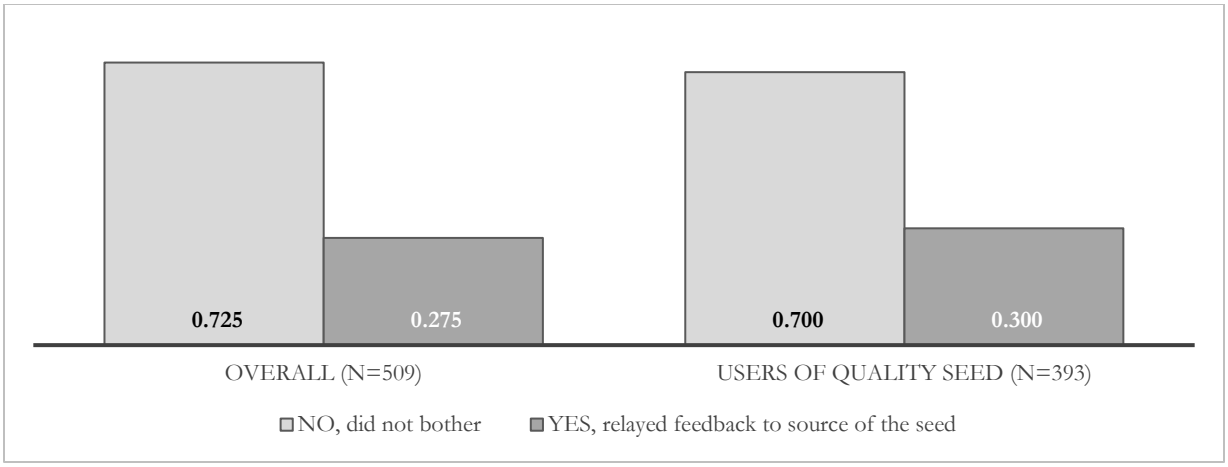

Figure 9: Feedback on seed performance

It is observed that few farmers give feedback on seed performance even if they feel quality was less that what was promised. This could be due to a lack of clear feedback mechanism(s) between the agro-input dealers and their clients or extension agents, and this may call for some intervention that makes it easier to provide feedback on the quality of services and seed in particular.

3.3.8 Long run adoption and disadoption

Plan to use same seed variety in the future

To get insight into longer term adoption, in addition to asking about satisfaction, we also asked if farmers would consider using the same seed variety in the future. In line with overall levels of satisfaction, Fig. 10 shows that 76 percent of the farmers reported that they would re-use the seed planted in season 2020B.

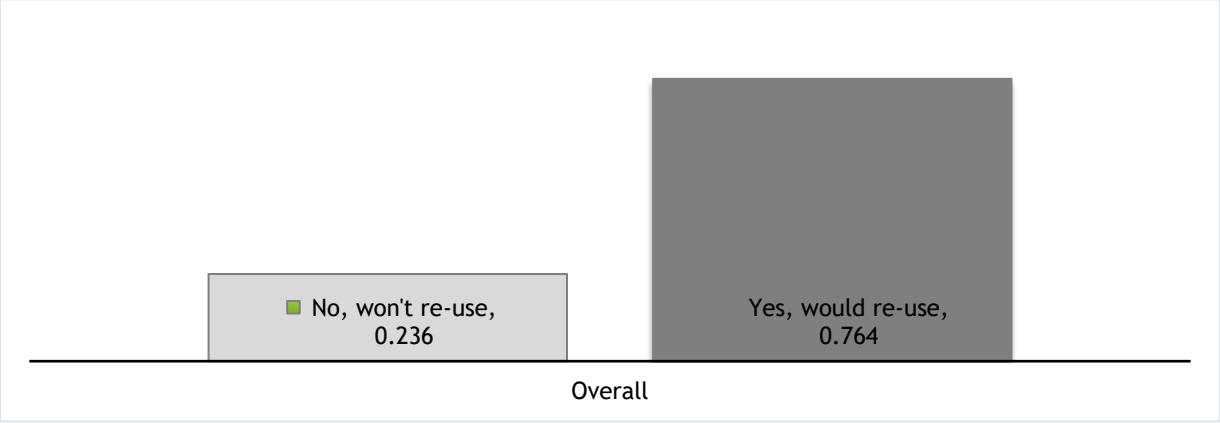

Figure 10: Re-use of seed variety planted in season 2020B

Generally, the results show a high possibility of reselection of all varieties used in season 2020B for the next season with over 60 percent of the respondents across varieties indicating so (Table 10).

Table 10: Use same seed variety in future (% indicates it is likely)

Variable	Overall		Non-user of quality seed		User of quality seed	
	Obs.	Prop. (%Yes)	Obs.	Prop. (%Yes)	Obs.	Prop. (%Yes)
LAND RACES	1486	0.756	1385	0.751	099	0.828
LONGE5	745	0.754	137	0.715	607	0.763
LONGE10H	507	0.795	54	0.778	453	0.797
OTHER HYBRID	194	0.747	052	0.750	142	0.747
BAZOOKA	176	0.807	10	0.900	166	0.801
LONGE4	068	0.809	09	0.778	059	0.814
KH SERIES	057	0.737	07	0.571	050	0.760
LONGE7R	030	0.833	002	100.0	028	0.821
LONGE6H	028	0.821	003	100.0	025	0.800
LONGE7H	023	0.609	003	0.333	020	0.650
PANNER	002	100.0	001	100.0	001	100.0
WEMA	002	100.0	001	100.0	001	100.0
DNK	152	0.737	96	0.719	055	0.764

Plan to use same sources in future

In addition to knowing if farmers would choose the same seed in the future, we also wanted to know if farmers would stick to the source of the seed. In Table 11, we see that 77 percent farmers who used own saved seed (in 2020B) said would reuse seed of same source in the following season and, 77 percent of farmers who bought seed from agro-input shops reported that they would reuse seed from agro-input shops and, this was same across farmer categories (Users and non-users of quality seed). The percentage of farmers who used seed from the local market were the least willing to reselect seed from the same source (67%). Overall, we see that the affinity for a farmer to stick to the same seed source is high for all sources irrespective of farmer category. This poses a challenge in trying to shift farmers from using own-saved and recycled seed to more commercial options.

Table 11: Obtain seed from source in future (% indicates it is likely)

Variable	Overall		Non-user of quality seed		User of quality seed	
	Obs.	Prop. (Yes)	Obs.	Prop. (Yes)	Obs.	Prop. (Yes)
Own saved seed	1728	0.774	1458	0.761	267	0.843
Agro-input shop	1133	0.770	054	0.778	1079	0.769
Fellow farmer (saved) seed	258	0.702	180	0.672	077	0.766
OWC/NAADS	131	0.763	006	0.667	125	0.768
NGO	102	0.784	006	0.667	096	0.792
Local market or grain shop	064	0.672	047	0.617	017	0.824
Other source	041	0.683	004	0.500	037	0.703
Local Seed Business (LSB)	011	0.727	005	0.800	006	0.667
Seed company	001	100.0	000	0.000	001	100.0
Research station	001	100.0	000	0.000	001	100.0

3.4 Production practices and use of complementary inputs

3.4.1 Number of maize fields and farmer scale

Number of maize plots planted in season 2020B

Farmers tend to plant one or more fields of maize for several reasons including risk management and fragmented land holdings. In our sample, 65 percent of farmers reported to have planted one plot in the second season of 2020 (2020B) and about 25 percent had two plots in the same season. Less than 10 percent planted more than two plots of maize (Fig. 11).

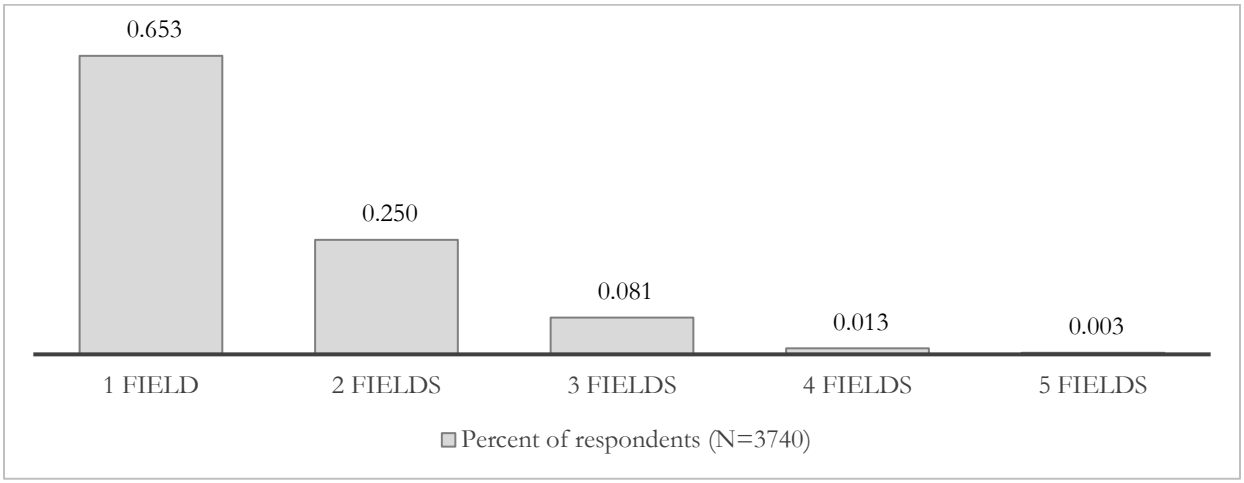

Figure 11: Number of maize fields planted

Maize plot size and scale

According to FAO, a small-scale farmer is one that cultivates less than one hectare while a medium scale farmer plants within 2-4 ha and a large-scale plant an area above four hectares of maize. We therefore categorise farmers based on this criterion and find that 92 percent of the surveyed farmers are small-scale, and a paltry 0.2 percent qualified as large scale (Table 12).

Table 12: Distribution of farmers by scale of production

Farmer type	Obs.	Mean	Std. Dev.	Min	Max
Small scale farmer	3465	0.924	0.264	0	1
Medium scale	3465	0.074	0.262	0	1
Large scale	3465	0.002	0.042	0	1

3.4.2 Intercropping practice

Extent of intercropping practice among farmers

Figure 12 shows that most of the farmers (70%) practice intercropping in the maize fields and there was no significant difference between farmer categories.

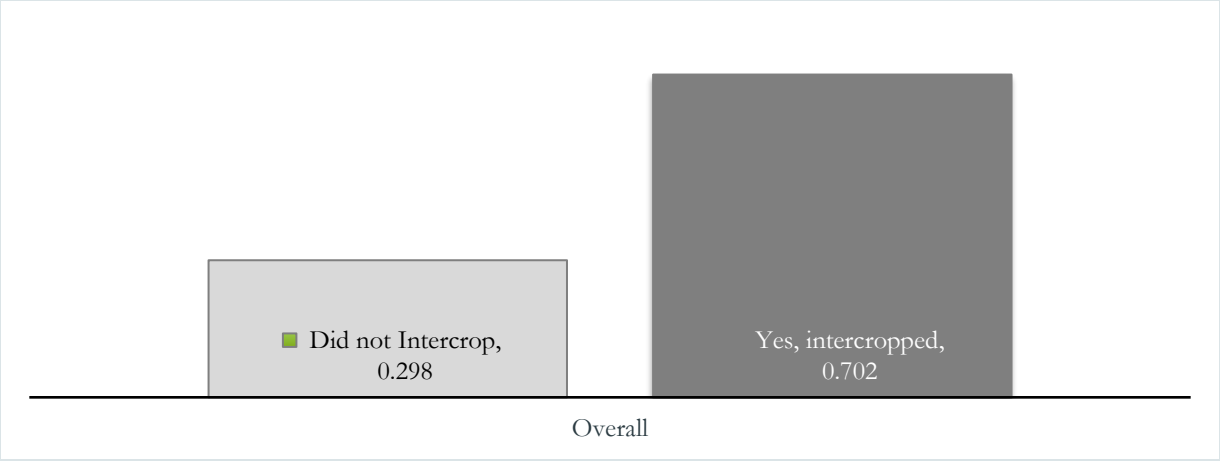

Figure 12: Intercropping practice among farmers

The inter crops

Several crops are often intercropped in maize in the traditional production system practiced by smallholder farmers in Uganda. Figure 13 shows that about 57 percent of farmers reported common bean as the choice of intercrop on maize plots. Other crops frequently used for intercropping include cassava (38%) and groundnuts (15%).

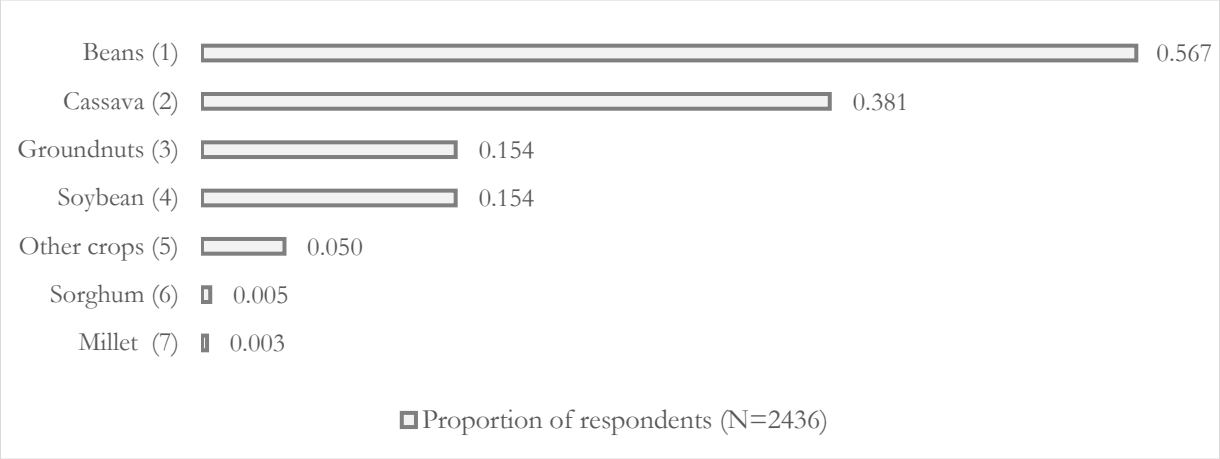

Figure 13: Maize plot inter-crops

3.4.3 Timeliness of maize planting

The FAO crop calendar for maize recommends that farmers in the Busoga farming system should start second season maize planting mid-August. A majority (70%) of farmers planted immediately (within one to three days) after onset of the first rains of season 2020B (Fig. 14). Considering that increasingly, rains have become unpredictability and are reported to be more intense but within a short window, timely planting is very important for farmers if the gains of improved seed are to be harnessed amid the emerging challenge of climate change.

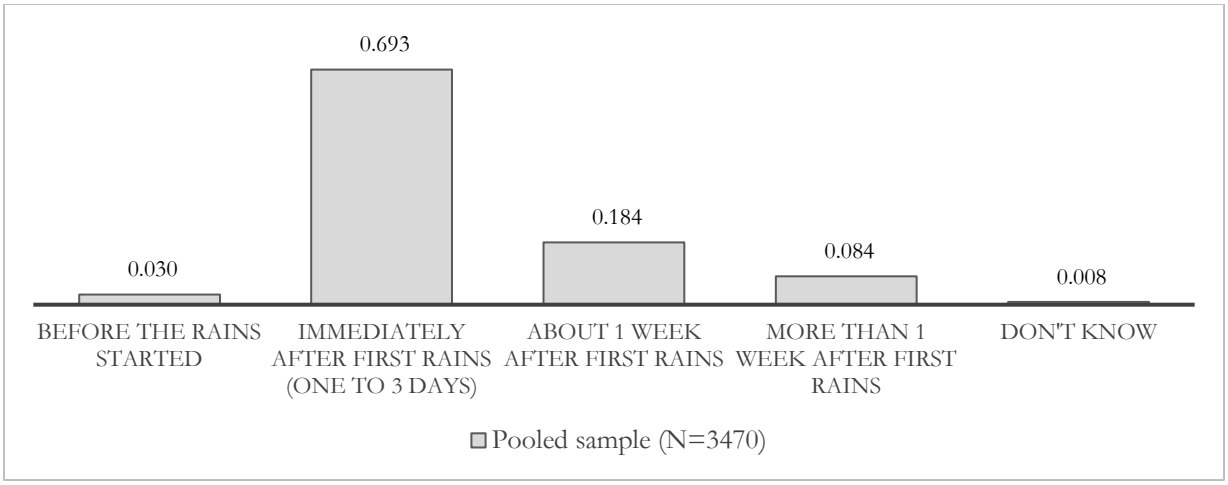

Figure 14: Timeliness of maize planting

3.4.4 Plant spacing

The biggest section of farmers still do not use recommended spacing when planting maize. Figure 15 shows that about 73 percent of the farmers plant maize based on their own convineint spacing methood. The recommended spacing is 2.5X1 feet/75X30 cm for single seed per hill or 2.5X2 feet/ 75X60 cm for two seeds per hill which all requires 10Kgs of seed per acre and leads to an optimal plant population of 21,000. We see that overall, only about 24 percent of the farmers are found to be aware of this spacing and for the users of quality seed, 34 percent were aware compared to 16 percent of the nonusers of quality seed.

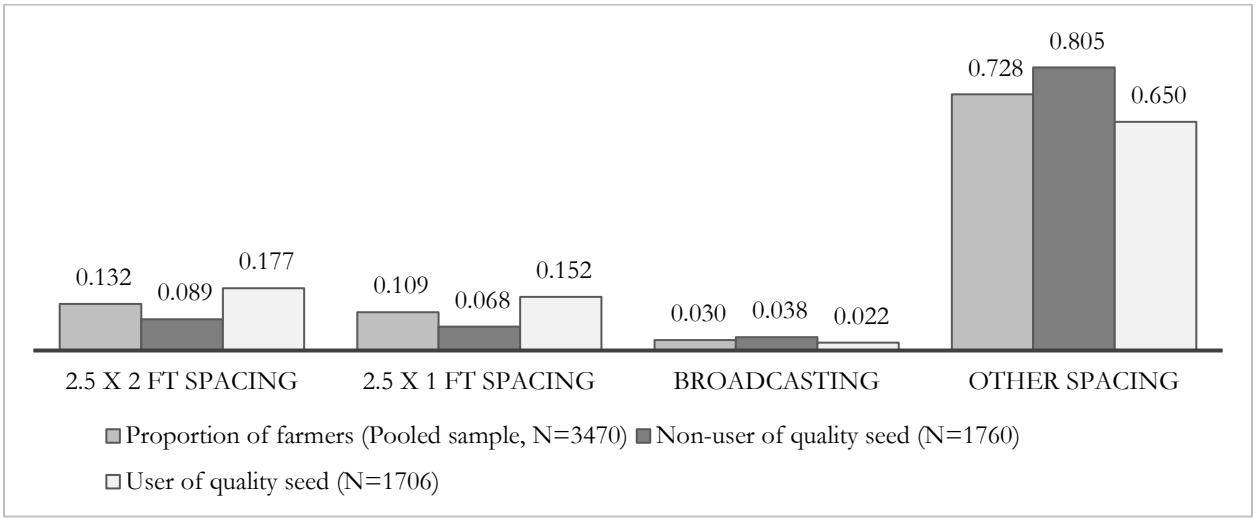

Figure 15: Proportion of farmers by plant spacing

3.4.5 Number of seeds per hill and plant population

From the data, it was revealed that only 24 percent of the farmers plant one to two seeds per hill whereas the majority (76%) plant three or more seeds per hill. Planting more than three seeds per hill is an indicator that either the farmer lacks knowledge on recommended planting practices or there is a lack of trust of the seed and therefore, plant more as an insurance cover for germinability per hill. It may also imply a guard against a risk of pests eating up the seed before it germinates. In Figure 16, we see that even for the farmers that got the spacing right, a majority (53% - 60%) planted three or more seeds per hill which is improper based on the technical requirement. Only about 24 percent of the farmers are found to get it right. Assuming many farmers get time constrained to do thinning in the early stages of maize growth, this means that 5-6 farmers out of 10 farmers are likely to have maize fields with plant population density above the optimum 21,000 hence predisposing the farmer to low yields other factors notwithstanding.

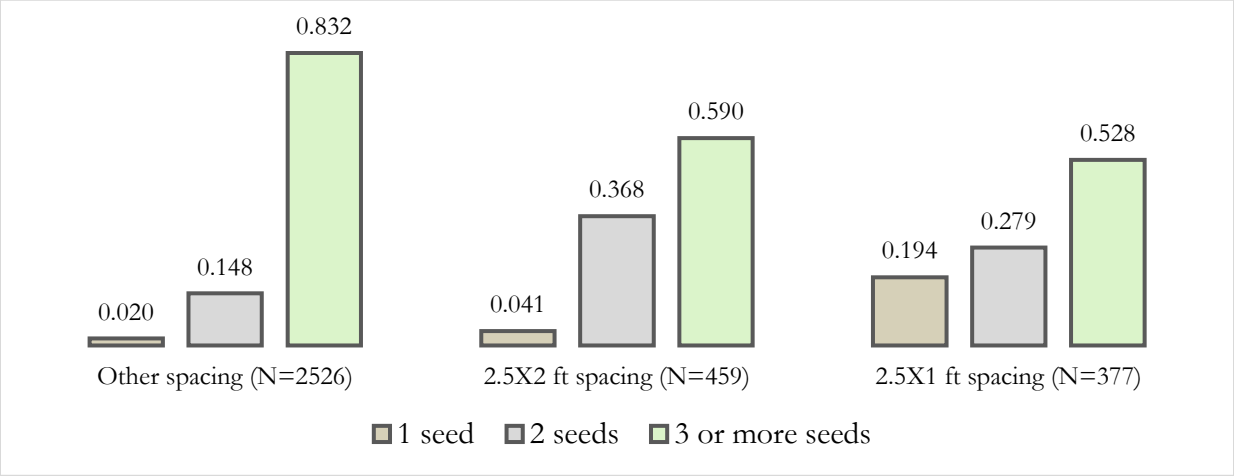

Figure 16: Proportion of farmer per maize spacing and number of seeds planted per hill

3.4.6 Fertilizer application

Application of fertilizers in maize field

In addition to use of quality seed, fertilizer application is the second main productivity enhancing practices in crop enterprise production, but its adoption is still low in Uganda. We find that overall, only about 25 percent of the respondents applied fertilizers to the randomly selected maize field. Due to soil mining, application of fertilizers in maize production is recommended by extension agents to enhance output and returns to farmer production. The fertilizers essential for higher yield include DAP and UREA recommended at particular stages of maize growth. Figure 17 shows that generally, application of organic manure and UREA fertilizer stands at less than two percent while application of DAP/NPK stands at about 25 percent. However, application of DAP/NPK is significantly higher (41%) among users of quality seed as compared to the non-users of quality seed (10%).

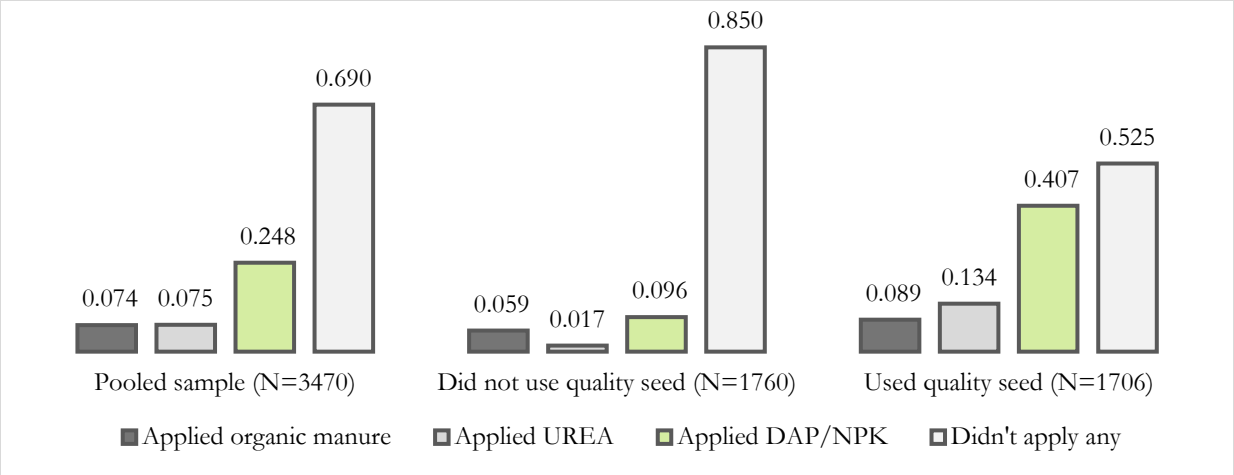

Figure 17: Application of recommended fertilizers in maize production

3.4.7 Quantity of inputs used

The average size of farmer land under maize was 1.2 acres (Table 13). It's also noted that the farmers using quality seed planted a slightly bigger acreage of maize (1.3 acres) compared to their counterparts, those who reported not to use quality seed. The average quantity of seed used is 10 kgs (±0.169) which is only slightly less than what is the technically required under recommended spacing.

Table 13: Quantities of seed and fertilizers applied to maize field

Variable	Obs.	Mean	SD	Min.	Max.
Overall, area planted (acres)	3465	1.181	1.0006	0.075	20.00
Farmers who used quality seed (acres)	1704	1.304	1.1430	0.100	20.00
Farmers who Don't use quality seed (acres)	1757	1.062	0.8235	0.075	14.00
Quantity of seed (Kgs)	3,413	9.616	9.871	0.200	200.00
Quantity of DAP/NPK (Kgs)	845	16.877	20.676	0.100	150.00
Quantity of UREA (Kgs)	251	15.811	19.894	0.500	150.00
Cost of seed (UGX)	3,411	2631.309	2942.094	0.000	14500.00

3.4.8 Weeding of maize field

Weeding frequency

Weeding is a prerequisite for good yield. The majority (92%) of farmers reported to have weeded either three or four times which not only means good awareness of the importance of weeding among the surveyed farmers but also an indication that the weed regeneration and burden is high (Fig. 18).

Figure 18: Application of the weeding practice

Time lag to first weeding

Depending on the soil conditions, maize seed takes 7 – 10 days to emerge after planting under tropical conditions and thus, considering the weed burden, the first weeding should be prompt within second to third week post emergence. It is recommended that timely weeding should be within 2-3 weeks after planting at which stage the maize root system is taking shape. In Table 14, it is shown that 41 percent of farmers did the first weeding two weeks after planting and 36 percent of the farmers reported weeding three weeks after planting. The results show that about 87 percent of the farmers weed at less than 22 days (within three weeks) after planting.

Table 14: Time lag to first weeding

Duration to 1st weeding	**Proportion of respondents**		
(Number of days after planting)	Pooled sample (N=3428)	Non-user of quality seed (N=1742)	User of quality seed (N=1682)
<10 days (1 week)	0.099	0.108	0.090
10 – 14 (2 weeks)	0.411	0.397	0.426
15 – 21 (3 weeks)	0.356	0.366	0.346
22 – 28 (4 weeks)	0.042	0.040	0.044
29 – 36 (5 weeks)	0.084	0.084	0.085
37 – 43 (6 weeks)	0.004	0.003	0.004
44 – 50 (7 weeks)	0.002	0.002	0.002
>50 days (8 weeks)	0.002	0.000	0.003

3.4.9 Resowing practice

One of the parameters for seed quality is the germinability after sowing and depending on the germination rate, resowing may be necessary. Quality seed is expected to have high germination rate (>85%). Fig. 19 shows that overall, about 48 percent of the farms reported resowing their maize fields.

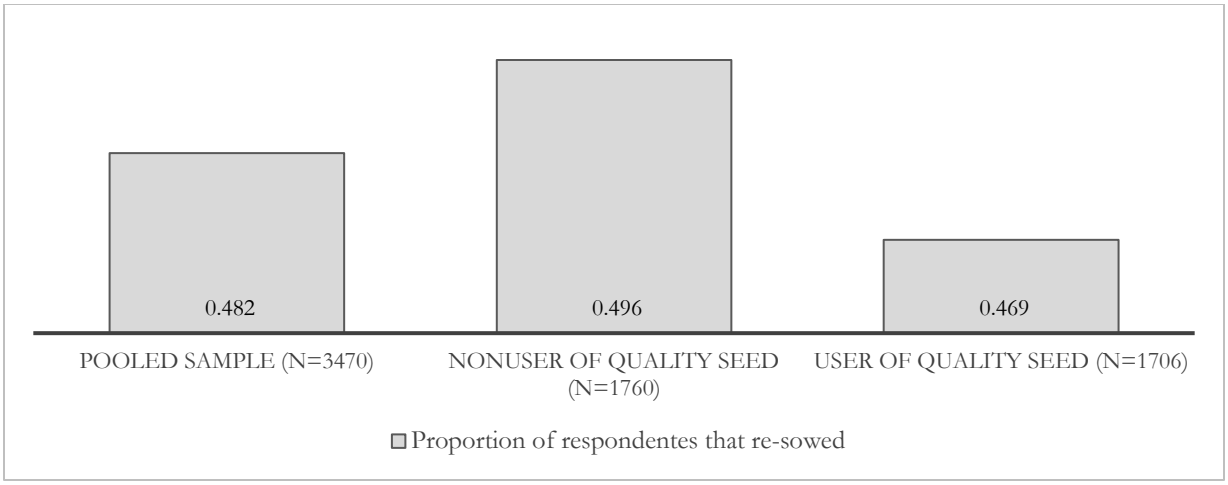

Figure 19: Proportion of farmers that resowed

3.5 Maize output and farmer yield

General farmer yield estimate

Generally, yield of the surveyed farmers stands at about 1180 $Kgha^{-1}$. Farmers who reported to have used quality seed had yields that were 27 percent higher than that for the farmers who reported not to have used quality seed. Additionally, farmer output was significantly lower than the expected for all farmers. We note that in Uganda, the national farmer maize yield is estimated to stand at 2.1 tons/ha and in Table 15, we see that the yield is not only below farmer expectation but also below expectation going by the national average.

Table 15: Farmer output and yield

Variable	Obs.	Mean	SD	Min.	Max.
Overall					
Area planted (ha)	3430	0.479	0.406	0.030	8.094
Output (kgs)	3430	534.547	807.716	4.000	25000
Expected output (kgs)	2551	896.967	1246.255	0.000	28000
Farmer yield ($kgha^{-1}$)	3430	1178.81	1024.723	24.710	10707.52
Non-users of quality seed					
Area planted (ha)	1735	0.431	0.334	0.030	5.666
Output (kgs)	1735	398.596	551.454	4.000	11660
Expected output (kgs)	1259	704.06	883.948	0.000	12100
Farmer yield ($kgha^{-1}$)	1735	1002.476	941.464	24.710	10707.52
Users of quality seed					
Area planted (ha)	1691	0.528	0.463	0.040	8.094
Output (kgs)	1691	674.638	986.356	10.00	25000
Expected output (kgs)	1288	1086.763	1496.658	0.000	28000
Farmer yield ($Kgha^{-1}$)	1691	1360.512	1074.95	24.710	9883.864

Note: estimates were generated by excluding farmers with zero yield

Farmer yield and maize variety

Improved varieties are associated with better yield compared to land races, but they also exhibit yield differences depending on seed source, breeding objectives, and farming practices during the production cycle. Table 16 shows that as expected, most hybrid varieties perform better than the OPV varieties, and significantly better than the land races.

Notably, hybrid variety BAZOOKA is the highest yielding (2.0 tons/ha), closely followed by the KH series. OPVs yielded 50 percent less than the hybrid varieties (about 1.0 tons/ha) while the landraces and varieties that were not specified were the least yielding (<1.0 tons/ha). It is also noted that maize seed that was being recycled returns yield which is about 390 kgs less than fresh seed.

Table 16: Seed variety vis-a-vis estimated yield

Variable (overall)	Obs.	Mean	SD	Min.	Max.
Hybrid varieties					
LONGE10H	506	1388.297	1019.625	0.000	7412.898
OTHER HYBRID	191	1212.021	1032.583	0.000	6819.866
BAZOOKA	175	2034.625	1433.644	123.548	7412.898
KH SERIES	57	1516.201	1108.146	247.097	4941.932
LONGE6H	28	1319.702	1109.415	131.785	4941.932
LONGE7H	23	1157.537	980.796	0.000	3459.353
LONGE7R	30	1977.951	2075.924	247.097	9883.864
PANNER	2	1235.483	698.895	741.290	1729.676
WEMA	2	1482.580	349.447	1235.483	1729.676
OPV varieties					
LONGE4	68	1314.396	853.797	82.366	4941.932
LONGE5	740	1186.361	884.311	0.000	6918.705
LAND RACES	1477	968.152	919.645	0.000	9883.864
UNKNOWN VARIETY	148	882.143	684.930	32.946	4118.277
Recycled seed variety					
Unrecycled maize seed	1365	1413.830	1114.398	24.710	9883.864
Recycled maise seed	2065	1023.458	929.044	24.710	10707.52

Farmer yield and seed source

Table 17 shows yield associated with each seed source. Other undefined sources notwithstanding (which may suffer from small number of observations), we see that the yield of seed from NGO supply is associated with the highest yield level followed by that from agro-input dealers (1.3 tons/ha). The seed source associated with the lowest yield came from the maize grain market (0.937 tons/ha) followed by that from fellow farmer (0.986 tons/ha) and own-saved seed (1.0 tons/ha).

Table 17: Source of seed vis-a-vi estimated yield

Variable	Obs.	Mean	SD	Min.	Max.
Own saved seed	1713	1011.185	893.203	0.000	9883.864
Agro-input shop	1129	1353.821	1024.765	0.000	7412.898
Fellow farmer (saved) seed	257	985.846	952.255	0.000	9883.864
OWC/NAADS	130	1246.200	1053.35	0.000	6177.416
NGO	101	2161.470	1722.712	0.000	9883.864
Bought in the local market or grain shop	63	926.742	746.568	120.325	4447.739
Other source	41	1434.797	1198.763	24.710	4941.932
Local Seed Business (LSB)	11	1228.182	832.356	370.645	2965.159
Seed company	1	2647.464	.	2647.464	2647.464
Research station	1	4941.932	.	4941.932	4941.932

Note: The estimates for seed company and research station had only one observation each and therefore are not discussed.

Farmer yield, and fertilizer application

A link between fertiliser application and yield shows that indeed, farmers who applied fertilisers got significantly (33%) higher yield as compared to farmers that did not apply fertilizers (Table 18). Among the fertilizer adopters, those who applied UREA fertilizer obtained significantly higher yields (2.0 tons/ha) as compared to application of DAP/NPK (1.5 tons/ha) and organic fertilizer (1.3 tons/ha). Application of both DAP/NPK and URE as expected, leads to even higher yield (2.1 tons/ha) as compared to only one fertilizer type.

Table 18: Comparison of framer yield for adopters and non-adopters of fertilizers

Fertilizer application	Applied fertilizer			Did not apply any fertilizer			P stat
	Obs.	Mean	SD	Obs.	Mean	SD	
FERTILIZER ADOPTER	1068	1522.435	1172.314	2376	1011.899	888.536	0.0000
ORGANIC	257	1310.884	1033.262	3186	1158.851	1010.881	0.5034
DAP/NPK	857	1581.058	1196.722	2586	1034.168	904.616	0.0000
UREA	258	2012.080	1519.886	3186	1101.993	927.96	0.0000
Application of DAP & UREA							
Applied none of the two	2554	1113.867	2085.472				
Applied one of the two	687	1401.386	1010.42				
Applied both DAP & UREA	214	2129.279	1544.601				

3.6 Maize disposition

Market participation

The primary objective of smallholder farmer production is food security and sell off whatever is deemed surplus. In this case, 51 percent of the surveyed farmers sold part of the maize that was produced in season 2020B implying that about half of the maize producers in Busoga sub region participated in maize output market and with a pinch of salt, may be categorised as being commercial.

Disposition of harvest

Additionally, Table 19 shows that on average, farmers sold about 5 bags which is about 60 percent of the maize harvested and each bag fetched about UGX 50000 which translates to about UGX 500 per kilogram of maize considering most of the bags had a weight of 100 kgs.

Table 19: Quantity of maize sold

Variable	Obs.	Mean	SD	Min.	Max.
Farmer output	3460	544.031	858.163	0	25000
Market value at time of harvest (per bag)	3400	70248.590	27792.000	20000	145000
Bags sold	1779	5.058	9.383	0.020	250.000
KG equivalent sold	1779	514.617	939.617	2	25000
Proportion of maize (kgs) sold	1779	0.602	0.218	0.006	1.000
Sold >=50% of maize produced	1779	0.754	0.431	0	1
Price per bag	1748	51653.000	17033.980	5000.0	150000

PART II: TRADERS

3.7 Agro-input trader characteristics and practices

3.7.1 Dealer characteristics and input profile

In this study, all surveyed agro-input shops were involved in selling maize seed among other inputs (Table 20). Other common inputs sold in such shops were fertilizers, agro-chemicals, and farm equipment. In terms of education level, a majority of the shop operators had at least attained secondary school education and beyond, and many were youth. At least 53 percent of them had received some training on seed handling and storage in the year 2020 and ISSD was among other organization which had extended training to the agro input dealers. The agro-input dealers also reported having an average of at least three maize varieties stocked in the shop for sale, two of which were hybrids.

Table 20: Agro-input shop characteristics

Variable	Respondents				
	Obs.	Overall	SD	Min.	Max.
Respondent is owner of shop (proportion)	348	0.555	0.498	0	1
Shop is male operated/male respondent (proportion)	348	0.595	0.493	0	1
Shop sells only agro-inputs (proportion)	348	0.741	0.439	0	1
Shop sells maize seed as part of the inputs	348	1.000	0.000	1	1
Other inputs stocked in the shop (proportion)					
Farm machinery	348	0.066	0.249	0	1
Farm equipment	348	0.724	0.448	0	1
Agro-chemicals	348	0.945	0.228	0	1
Fertilizers	348	0.960	0.197	0	1
Other supplies	348	0.144	0.351	0	1
Highest education level (Proportion)					
No formal education	348	0.014			
Some primary schooling	348	0.063			
Finished primary	348	0.063			
Some secondary school	348	0.457			
Finished secondary	348	0.155			
Higher than secondary	348	0.221			
Other schooling	348	0.026			
Belong to a group (proportion)					
Age of household head (Years)	348	32.427	11.492	15	80
Years of shop operation	348	6.339	6.299	1	34
Distance to nearest tarmac road (km)	343	6.556	10.390	0	52
Distance to nearest murram road	348	0.190	0.626	0	9
Est. weekly customers at start of season (number)	346	41.486	46.489	2	300
Est. weekly customers who buy seed at season start	347	21.265	26.796	0	250
Agro-input training on seed storage					
Got training on seed handling & storage	348	0.526	0.500	0	1
Got training last year (2020)	183	0.508	0.501	0	1
Got training from ISSD	086	0.419	0.496	0	1
Picture of the shop (taken)	348	0.876	0.330	0	1
Number of maize varieties sold	348	2.917	1.755	0	10
Number of maize hybrids varieties in stock	348	1.681	1.330	0	8

3.7.2 Stocked maize varieties and seed stockouts

Most stocked varieties

The OPV maize variety that was found in majority of the shops was LONGE-5 (88.5%), followed by the hybrid LONGE-10H (68.4%).

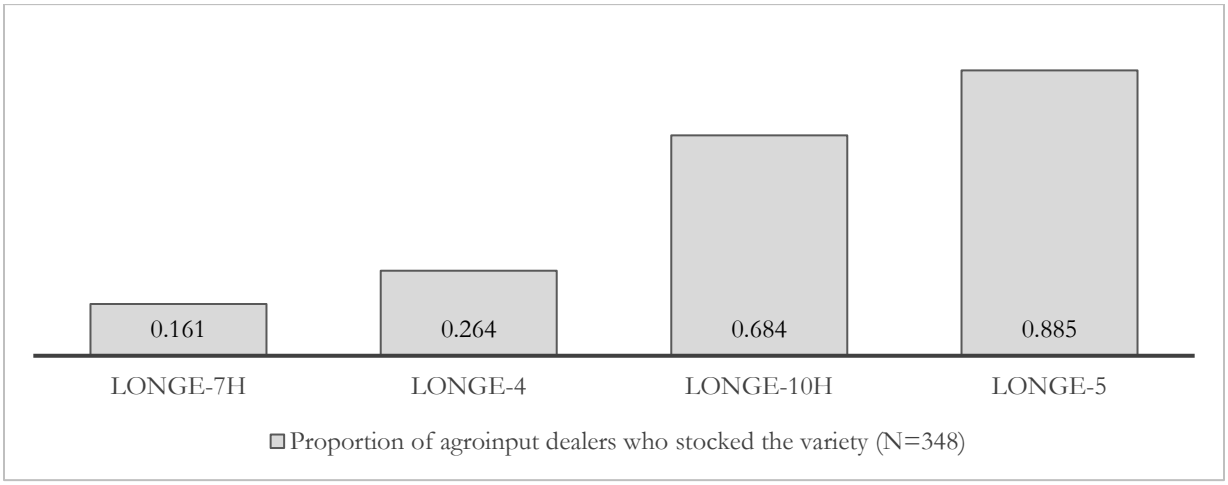

Figure 20: Maize varieties stocked by agro-input dealers

Cost and price markups of most stocked maize varieties

Hybrid maize varieties

In Table 21, we show the quantities of maize seed stocked and unit cost of seed for most common hybrid maize seed, LONGE10H and LONGE7H, which was stocked by 68 percent and 16 percent of the agro-input dealers respectively. It is shown that agro-input dealers' stock about 400 - 500 kgs of seed and for LONGE10H, about 98 percent was sold while for LONGE7H just about 34 percent was sold leaving a small carry of LONGE10H and a somewhat carryover of LONGE7H to the next season. The amounts found to be counted as wasted/lost were very small (<1kg). The unit cost of LONGE10H seed is found to be about UGX 5000 at the seed supplier side and the dealers place a markup on cost of about 19 percent translating to a selling price that averages UGX 6200 per kg. In the case of LONGE7H, the unit cost is found to be about UGX 4000 and with a markup on unit cost of about UGX 1300, the unit selling price goes for about UGX 5500. The average markup on unit cost of LONGE7H is a bit higher (23%) which indicates that some agro-input dealers perhaps sell LONGE7H expensively, at a price that is probably closer to LONGE10H yet the field performance of the two varieties (at least in terms of yield, per Table 16) is significantly different. This may explain the significant carryover of LONGE7H (13%) which is about double that for LONGE10H.

Table 21: Quantity bought, sold and carryover of hybrid maize varieties

Variable	Obs.	Mean	SD	Min.	Max.
LONGE10H					
LONGE10H brought forward from prev. season (Kg)	238	15.731	137.507	0.000	2000
Quantity of LONGE10H bought in 2020B (KG)	234	506.868	1515.380	4.000	15000

Quantity of LONGE10H (bought + carryover) sold	235	498.102	1507.187	0.000	15000
Quantity of LONGE10H not sold in 2020B (KG)	238	26.454	180.309	0.000	2500
Quantity of LONGE10H lost/wasted in 2020B (KG)	072	0.750	3.197	0.000	20.00
Cost of LONGE10H per KG from main source (UGX)	232	5135.560	1032.584	2300	12000
Selling price of LONGE10H per kg in 2020B (UGX)	238	6265.756	1459.370	3000	15000
Price margin	238	1234.479	1254.255	0.000	9200
Markup on cost price (proportion)	235	0.193	0.100	0.000	1.000
Carryover stock to next season (proportion)	225	0.067	0.172	0.000	1.000
LONGE7H					
LONGE7H brought forward from prev. season (Kg)	56	1.786	13.363	0.000	100
Quantity of LONGE7H bought in 2020B (KG)	56	439.054	865.801	5.000	5000
Quantity of LONGE7H (bought + carryover) sold	49	148.224	176.827	2.000	750
Quantity of LONGE7H not sold in 2020B (KG)	56	130.804	638.421	0.000	4001
Quantity of LONGE7H lost/wasted in 2020B (KG)	18	0.556	1.917	0.000	8.00
Cost of LONGE7H per KG from main source (UGX)	53	4339.623	999.296	2200	7500
Selling price of LONGE7H per kg in 2020B (UGX)	56	5473.214	1383.078	3000	12000
Price margin	56	1312.554	1204.819	500	7000
Markup on cost price (proportion)	56	0.229	0.124	0.091	0.714
Carryover stock to next season (proportion)	56	0.125	0.265	0.000	0.933

Note: Unit of measurement for weight is Kgs while the currency is Uganda shilling (UGX)

OPV maize varieties

We further look at the two most common OPV maize varieties, LONGE4 and LONGE5 (Table 22). The results reveal that very small volumes were carried forward from the previous season stocks and significant volumes of LONGE5 is stocked (≈900 kgs) compared to LONGE4 and the hybrids which had stock levels of about half a ton (≈400-500 Kgs). The volume of LONGE5 sold (800kg) in season 2020B was about 50 percent higher than what sold for LONGE4. The unit cost for both LONGE5 and LONGE4 is shown to be same (≈UGX 2500) and is half the unit cost of hybrid maize varieties and thus, OPVs are significantly cheaper. However, the markup on unit cost price of OPV varieties is higher at an average of 26 percent compared to the markup on unit cost of hybrid varieties. Therefore, OPV seed was at a retailing price of about UGX 3000. We also see that the proportion of carryover of OPV seed to the following season was <=12 percent just like in the case of the hybrids though in real terms, the quantities significantly differ due to a wide variance in quantities stocked.

Table 22: Quantity bought, sold and carryover of OPV maize varieties

Variable	Obs.	Mean	SD	Min.	Max.
LONGE5					
LONGE5 carried forward from prev. season (KG)	307	8.423	46.455	0.000	600.00
Quantity of LONGE5 bought in 2020B (KG)	306	902.987	6069.077	0.000	100000
Quantity of LONGE5 (bought + carryover) sold	306	801.954	5402.633	0.000	90000
Quantity of LONGE5 not sold in 2020B (KG)	308	112.016	719.177	0.000	10000
Quantity of LONGE5 lost/wasted in 2020B (KG)	178	6.452	25.660	0.000	200.00
Cost of LONGE5 per KG from main source (UGX)	300	2525.500	487.048	1500	8000
Selling price of LONGE5 per kg in 2020B (UGX)	308	3175.649	645.070	2500	9000
Price margin	300	643.167	329.556	200	2500
Markup on cost price (proportion)	300	0.260	0.136	0.071	1
Carryover stock to next season (proportion)	306	0.117	0.188	0.000	1
LONGE4					
LONGE4 carried forward from prev. season (KG)	92	5.304	24.512	0.000	200
Quantity of LONGE4 bought in 2020B (KG)	91	432.736	933.252	0.000	5000
Quantity of LONGE4 (bought + carryover) sold	91	403.978	899.199	0.000	5000
Quantity of LONGE4 not sold in 2020B (KG)	92	33.750	215.707	0.000	2010
Quantity of LONGE4 lost/wasted in 2020B (KG)	27	0.259	1.023	0.000	5
Cost of LONGE4 per KG from main source (UGX)	89	2501.124	372.185	2000	5000
Selling price of LONGE4 per kg in 2020B (UGX)	92	3143.478	437.853	2500	6000
Price margin	92	669.478	324.283	0.000	2000
Markup on cost price (proportion)	89	0.263	0.147	0.000	0.800
Carryover stock to next season (proportion)	91	0.082	0.203	0.000	1

Source of maize seed stocks

Table 23 shows about 70 percent of agro-input dealers reported that they source maize seed from agro-input wholesale dealer/distributor and 27 percent said they buy the seed from a seed company. The pattern is similar across all the maize varieties procured by the agro-input dealers.

Table 23: Sources of seed stocks

SOURCE OF INPUTS	Proportion of agro-input dealers				
	OVERALL (N=348)	LONGE10H (N=238)	LONGE7H (N=56)	LONGE5 (N=306)	LONGE4 (N=90)
Agro-input wholesaler	0.698	0.677	0.661	0.696	0.744
Seed company	0.267	0.290	0.286	0.268	0.233
Agro-input retailer	0.014	0.013	0.018	0.007	0.011
Other source	0.012	0.008	0.018	0.013	0.000
LSB	0.012	0.013	0.018	0.013	0.011
Individual seed producer	0.003	0.003	0.000	0.003	0.000

Seed stockout experiences

About 64 percent of the agro-input dealers experienced a stockout of LONGE10H while 36 percent did not (Table 24). For those who reported stockouts, 37 percent had two to three stockouts while

about 27 percent had more than three stockouts in season 2020B. The OPV varieties seem to suffer less from stockouts.

Table 24: Proportion of agro-input dealers vis-a-vi stockout frequency

Stockout frequency in season (2020B)	LONGE10H (N=238)	LONGE7H (N=56)	LONGE5 (N=308)	LONGE4 (N=90)
Stockout X0	0.357	0.464	0.523	0.522
X1	0.008	0.000	0.003	0.000
X2	0.156	0.179	0.146	0.076
X3	0.214	0.178	0.159	0.141
X4	0.189	0.125	0.146	0.217
X5	0.059	0.054	0.016	0.033
X6	0.017	0.000	0.007	0.011

Determinants of most stocked varieties

Several factors determine the kind of seed that agro-input dealers choose to stock among which include availability and cost. In Figure 1, farmer demand for the seed/variety came out as the number one reason (72%) that agro-input reported as a determinant of seed procured by the agro-input dealers in Busoga. This was followed by cost of seed (15%) and seed properties (10%).

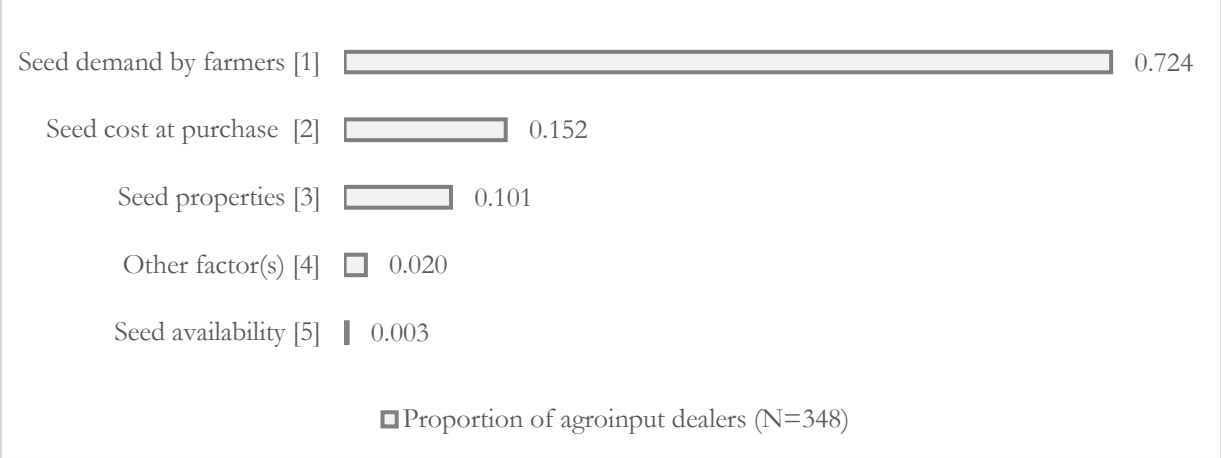

Figure 21: Determinants of stocked seed/varieties

3.7.3 Seed storage practice and storage conditions

Availability of a special seed storage area

Agro-input dealers were also examined on the manner with which they store the seed. We first check if they have a dedicated storage area/facility for seed and then look at the condition of the seed storage facility. We find that many (54%) do not have a dedicated area for seed storage.

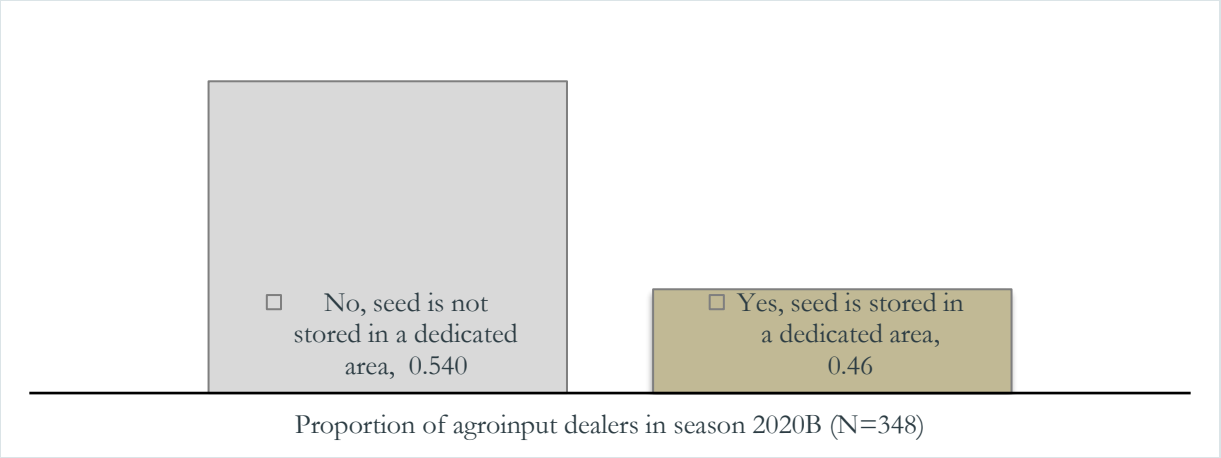

Figure 22: Proportion of farmers with a dedicated seed storage area

Condition of seed storage facility

A standard seed storage facility meets certain criteria which allows for uniform temperature and keeps the grain dry at a moisture content below 13.5 percent, and out of reach of any pest/vermin (Table 25). It is therefore essential for an agro-input dealer to have a proper storage facility and keep track of seed storage conditions. Our results show that much as many did not have problems with the floor and the lighting, 65 percent of the input dealers had a problem with pests, 46 percent had a problem with a leaking roof, and 42 percent had a store roof which was not insulated. This means that some agro-input dealers have seed storage facilities that are likely to expose seed to moisture and cannot keep seed in a condition with relatively uniform temperature leading to seed quality issues.

Table 25: Characteristics of storage facility

Characteristic	Mean (N=348)	Std. Dev.	Min	Max
Had a problem with pests (rats, insects)	0.649	0.478	0	1
Store roof is leakproof	0.537	0.499	0	1
Store roof is insulated	0.580	0.494	0	1
Walls of store are insulated to keep heat out	0.813	0.390	0	1
Store is ventilated	0.793	0.406	0	1
Store walls are plastered	0.920	0.272	0	1
Floor material				
Cement	0.943	0.233	0	1
Mud	0.026	0.159	0	1
Tiles	0.017	0.130	0	1
Other material	0.014	0.119	0	1
Store lighting				
Ambient lighting	0.825	0.381	0	1
Direct sunlight	0.164	0.371	0	1
Dark	0.011	0.107	0	1
Observation				
Seed was seen stored in open bags/ containers	0.155	0.363	0	1

Material on which stored seed is placed

Additionally, we see that over 80 percent of the farmers do not place the seed on the (Fig. 24).

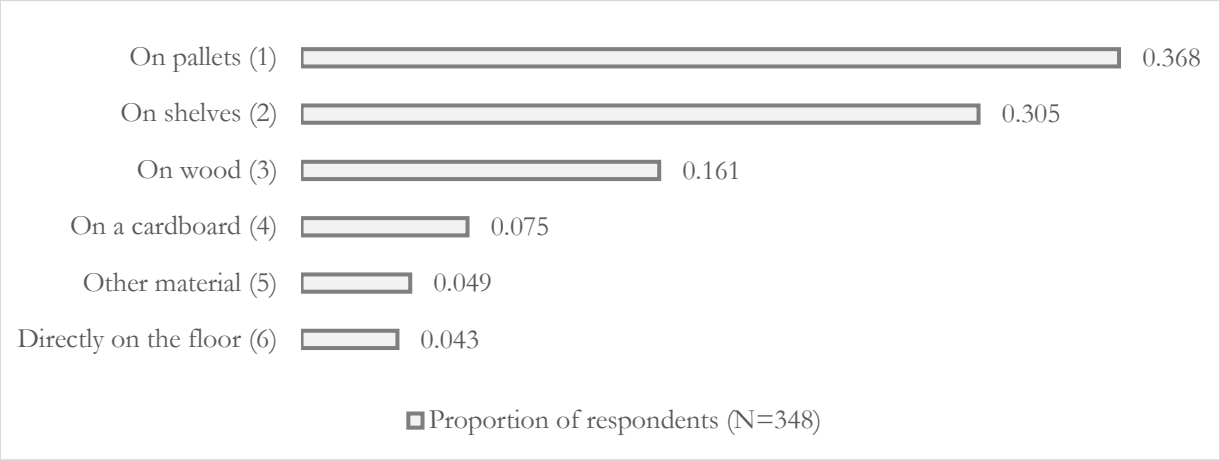

Figure 23: Materials for floor of seed store

3.7.4 Rating of shop on cleanliness and professionalism

Rating of agro-input shops was done by the trained research assistants and based on observation, the average rating for the agro-input shops was 3.45 and in Fig. 25 we see that 52 percent got a rating above average (4 and 5) implying that many exercise cleanliness and professionalism.

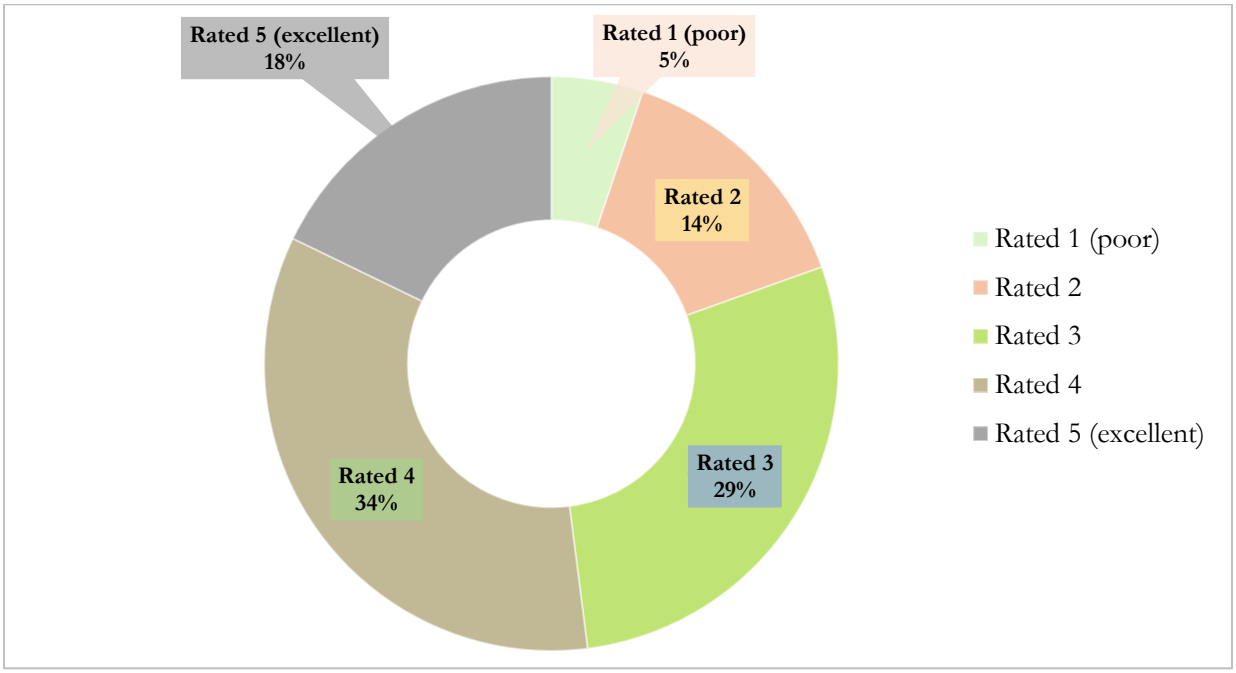

Figure 24: Rating of input dealers on professionalism and cleanliness

3.7.5 Practice with expired seed

As demonstrated (Table 21/22), not all seed bought in a season is sold off by all agro-input dealers and thus, a case of carryovers may present an issue of expired seed. In Table 26, it is implied that 41 percent of the agro-input dealers had had a case of expired seed and as a demonstration of good practice, 20 percent returned the seed to the supplier while 17 percent reported that they discard it. However, with the limits of this inquiry, we cannot conclusively take it that expired seed is discarded.

Table 26: Practice with expired seed

Variable	Obs.	Mean	Std. Dev.	Min	Max
Did not have experience of expired seed	348	0.589	0.493	0	1
Return to supplier	348	0.195	0.397	0	1
Discard the seed	348	0.172	0.378	0	1
Sell at a discounted price	348	0.006	0.076	0	1
Give away the seed	348	0.037	0.190	0	1
Sell at normal price	348	0.017	0.130	0	1
Mix with other seed	348	0.000	0.000	0	0
Other practice	348	0.046	0.210	0	1

3.7.6 Agro-input dealer provision of seed extension service to farmers

Advise on use of improved seed

For good yield, improved seed requires some complementary practice and thus, it is good practice for the providers of seed to the last mile client to offer some tips on how best to use the seed including use of complementary inputs such as timely fertilizer application. In this case, we find that only about 46 percent of agro-input dealers said they always give advice to farmers while another 46 percent do offer advise only when a farmer asks (Fig. 26). Additionally, 53 percent of input dealers said that they always do recommend to farmers use of complementary inputs.

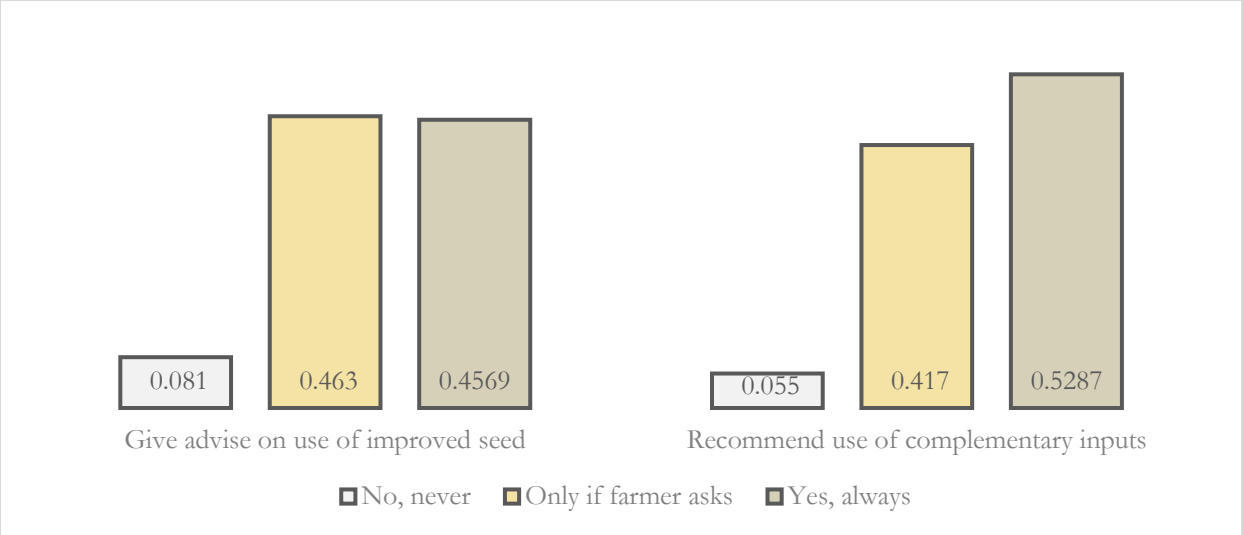

Figure 25: Provision of advice to farmers on use of improved seed

Training of farmers on use of improved seed

Fig. 27 shows that 52 percent of agro-input dealers do not offer any kind of training to farmers on use of improved maize seed.

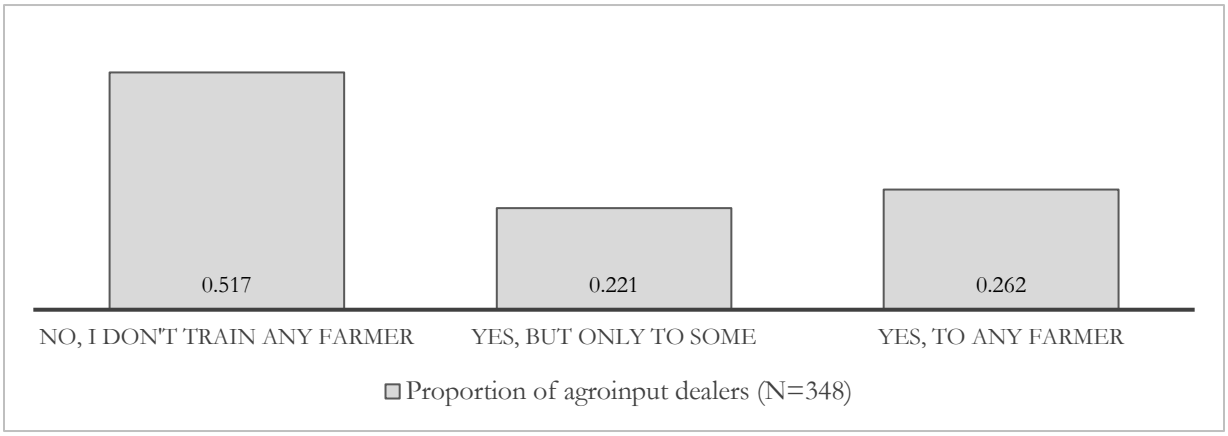

Figure 26: Agro-input dealer training farmers on use of improved seed

3.7.7 Agro-input dealer promotional practices

Attempts to scale up maize seed sales and adoption of improved seed require a multipronged approach among which include agro-input dealers engaging in sales promotions strategies such as discount sales, seed credit, seed delivery and convenient packaging. In this study, 75 percent of the agro-input dealers reported that they offer discounts on seed while only 9 percent sold seed on credit to clients always and 41 percent selectively sell on credit. Additionally, many (60%) do not deliver (Table 27). Only 31 percent of the agro-input dealers reported that they make deliveries but only for clients who buy large quantities.

Also, 52 percent of the dealers reported that they do repackaging of seed (26% for any seed and 26% for selected seed). For those who repackage (generally to smaller packs), 59 percent keep track of the date of expiry and 15 percent said they charge more for smaller packs. Seed is generally packed in 1-10 kg packages and the most popular is the 1kg package.

Table 27: Seed promotional practices

Variable	Obs.	Mean	Std. Dev.	Min	Max
Offer discount sales	348	0.750	0.434	0	1
Offer seed on credit					
Don't offer seed on credit	348	0.405	0.492	0	1
Offer seed on credit to only a few	348	0.569	0.496	0	1
Offer seed on credit to any farmer	348	0.026	0.159	0	1
Deliver seed to clients					
Never deliver	348	0.601	0.490	0	1
Deliver but only for large quantities	348	0.313	0.464	0	1
Deliver always	348	0.086	0.281	0	1
Do repackaging					
Yes, for any seed	348	0.261	0.440	0	1
Yes, but only for selected seed	348	0.261	0.440	0	1
No, I don't repackage	348	0.477	0.500	0	1
Charge more for small packs	182	0.154	0.362	0	1
Track date of expiry upon repacking	182	0.588	0.494	0	1
Commonly sold seed packs					
01 kg	348	0.701	0.458	0	1
02 kgs	348	0.247	0.432	0	1
05 kgs	348	0.009	0.093	0	1
10 kgs	348	0.006	0.076	0	1
Other	348	0.037	0.190	0	1

Furthermore, much as about 60 percent of the agro-input dealers are shown to offer seed on credit, the number of clients who took seed on credit for season 2020B is small, just about 11 clients and only 3 were women (Table 28).

Table 28: Number clients sold to seed on credit

Variable	**Obs.**	**Mean**	**Std. Dev.**	**Min**	**Max**
Est. of clients sold to seed on credit	199	10.683	13.716	0	120
Est. of women who took seed on credit	200	3.43	4.692	0	35
In season 2020B, got a complain on seed quality	348	0.644	0.48	0	1

3.7.8 Response to farmer complain on seed

Much as many agro-input dealers (64%) agreed that they received a complaint in relation to the quality of seed, Figure 28 reveals that many dealers do nothing about the farmer complains and about 42 percent of the dealers forward the complaint to the seed supplier. Only 18 percent gave new seed to the complaining farmer.

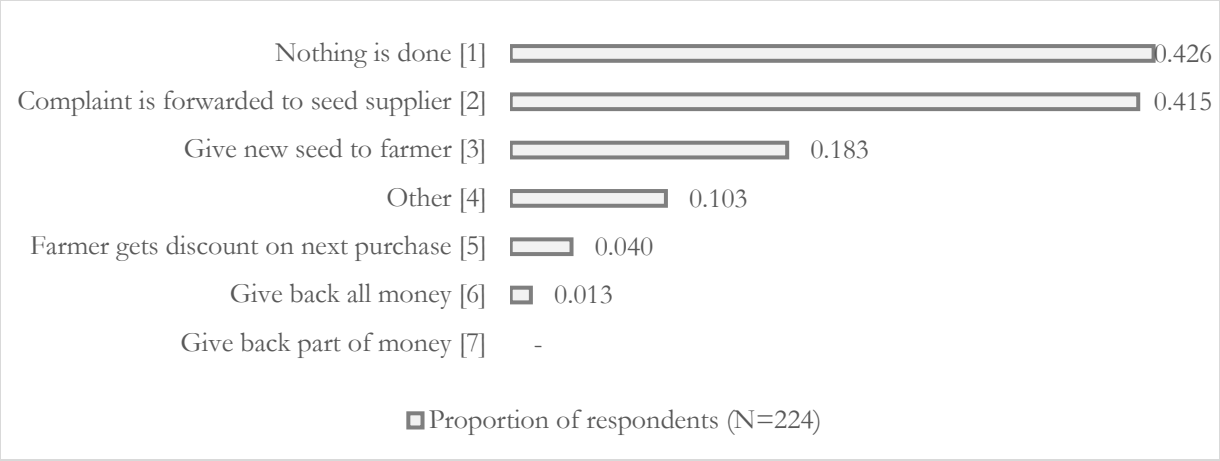

Figure 27: Redress to farmers with complain on seed quality

3.7.9 Payment methods

Figure 29 shows that cash payment is the most accepted mode of payment for seed bought by the clients. The recent phenomenon of digital based payment using a phone based mobile money system is gaining traction and we see that about 35 percent of the agro-input dealers acknowledge receipts in mobile money form as acceptable.

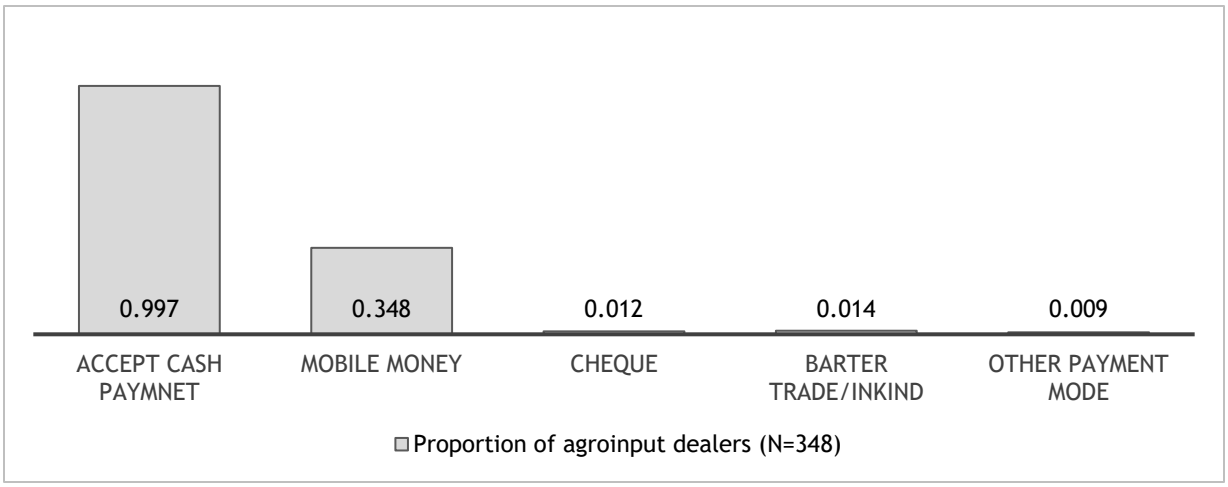

Figure 28: Accepted mode of payment for seed

Self-rating of agro-input shop

Using agro-input self-ratings, the general average score on all the parameters (location, price, product quality, and dealer reputation) is 4 which is synonymous with one less to be considered as excellent in every aspect (Table 29).

Table 29: Agro-input dealer self-rating

Variable	Obs.	Mean	Std. Dev.	Min	Max
LOCATION convenience to the customers	348	3.876	0.878	1	5
PRICE competitiveness	348	3.922	0.867	1	5
QUALITY products, especially seed	348	4.046	0.844	1	5
STOCK availability & convenient quantities	348	3.583	1.002	1	5
REPUTATION among clients	348	4.319	0.735	2	5

Note: The scales were as follows; Location: 1 extremely inaccessible – 5 very good location/access; Price: 1 for very expensive - 5 very competitively priced; Quality: 1 for very poor quality/often fake - 5 excellent quality; Seed stock: 1 for always out of stock and sells in only large quantities, 5 always has stock and accepts to sell in smaller quantities; Reputation: 1 for others think dealer is a lousy kind, 5 where some people think the dealer is an excellent one.

3.7.10 Agro-input dealer knowledge on seed and storage practices

Seed life span, seed storage, and varietal information

Improved seed has a limited life span after which its viability drops. For instance, OPVs can be carried over but only to a limit of six-month shelf life after which seed quality may degenerate losing desirable viability. In the case that the dealer is unaware of the seed characteristics, the farmers may suffer from poor yields, which in turn may undermined long term adoption. Several parameters were examined to tease out the knowledge gaps including seed storage, repackaging, and variety information. For most of the parameters that were examined, data shows that generally, many agro-input dealers are deficient in terms of knowledge on seed handling and appropriate seed advice to farmers (Annex 3).

The evidence shows that with respect to seed storage and carryover to next season, 46% of the dealers agreed it was not good practice to carry seed over to the next season while other concur it could be carried over to next season save for the 13 percent who knew neither. Additionally, about 50% agreed that seed should be stored in an airtight package yet technically, it is recommended to pack seed in a material that allows proper ventilation. Only 27 percent knew that it is best stored in a perforated package. Also, 64% did not concur that seed should be repackaged. On the clearance between the floor surface and the stored seed packs, we find that at least 53 percent agreed with the correct response (of 6 inches of the floor) while the rest either did not know (15%) or got it otherwise (25%). In the same vein, 55% agreed that seed should be placed on pallets while 32% said it should be on the shop display shelves with sufficient spacing between packs.

Regarding dealer information on maize varieties, the evidence reveals that few dealers are aware of the appropriate recommendations in the case of poor soils, recycling frequency, drought tolerance, and maturity. The results show that only 19 percent of the agro-input dealers knew LONGE5 as the variety of choice for poor soils and a dismal 5% were aware that among the available, WEMA was the variety with better drought tolerance. We also find that only 22 percent of the dealers had it right on MM3 being the variety that is the earliest maturing compared to other varieties while 31 percent were ignorant of such knowledge.

3.7.11 Compliance to good practice

To operate an agro-input shop in Uganda, one requires some local approvals and minimum standards namely operating license which must be displayed for the public to see. The results show that 75

percent and 46 percent were seen to have the local trading and seed operation license respectively on display (Table 30). The dealers also had been inspected by an average of 2 times in 2020 and 32 percent of the dealers have ever gotten a warning after inspection. On seed monitoring, only about 3 percent of the dealers said they had a tool to monitor seed moisture content and temperature of the storage facility.

A spot check by the research assistants revealed that the average room temperature to the storage facility was 25.3^{0}C and for the temperature check on a random pack also showed that the average moisture content was 13.6 percent. However, just 5 percent had seed which had expired and only 4 percent had seed packaging with visible date of packaging with seed of less than six months. Additionally, only 8 percent had a certification sticker on the bags and just 3 percent had e-verification mark.

Table 30: Agro-input dealer compliance to regulation and good practices

Variable	Obs.	Mean	Std. Dev.	Min	Max
Business is registered as seed dealer	319	0.442	0.497	0	1
Business has a trading license from LG	338	0.749	0.435	0	1
Business is a member of other professional body	325	0.345	0.476	0	1
Official operation certificate was seen on display	348	0.460	0.499	0	1
Number of inspections in 2020	335	1.866	3.843	0	43
Ever gotten a warning after inspection	334	0.317	0.466	0	1
Products confiscated after inspection	337	0.145	0.353	0	1
Business has ever been closed after inspection	342	0.009	0.093	0	1
Have equipment to monitor seed moisture content	348	0.026	0.159	0	1
Do monitor temperature of seed in store	348	0.026	0.159	0	1
Temperature of seed storage section (^{0}C)	345	25.311	2.996	19.50	52.00
Moisture content of random seed pack (%)	232	13.576	1.522	10.30	17.40
Random seed bag has DoE and seed is expired	041	0.049	0.218	0	1
Random seed bag has date of packaging	232	0.667	0.469	0	1
Packaging date is visible, and seed is of > 6 months	154	0.039	0.191	0	1
Random bag of seed is original & not damaged	232	0.935	0.246	0	1
Random bag of seed has a certification sticker	232	0.082	0.275	0	1
Random bag of seed has a lot number	232	0.501	0.501	0	1
Random bag of seed has a e-verification mark	232	0.026	0.159	0	1

Figure X shows that there is a positive relationship between age of the package and moisture content. Seed packages that have been on the shelf for about 80 days have moisture content that is more around 16 percent. For seed that has been produced only 30 days ago, seed content is generally 12-13 percent.

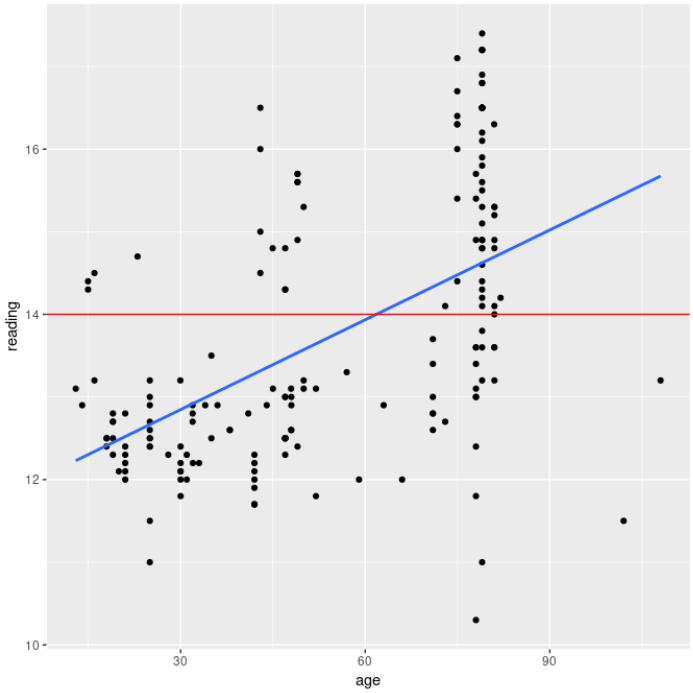

Figure x: relationship between shelf life (age in days) and moisture content (reading as percentage)

4.0 CONCLUSION

Technology adoption for output and productivity enhancement in sub–Saharan Africa is still a challenge and more needs to be done by government to realize meaningful agricultural transformation over the life of the global SDG initiative and the AU Agenda 2063. A vibrant commercial agro-input sector is needed to kickstart a green revolution in Africa as well.

Seed systems in particular are an important catalyst to increase yields. Without proper seed, other investments like fertilizer or pesticides will never reach full potential.

This baseline study set out to describe the present situation. For a field experiment, we collected detailed survey data from about 3500 farmers. We focus particularly on the use of maize seed, and where they obtained this seed. We also surveyed 350 agro input dealers, focusing on seed storage and handling practices.

We find that farmers still rely a lot on home saved local seed that has been recycled several times. An emerging network of agro-input dealers seems lacking in both knowledge and infrastructure, which results in low quality of seed. This in turn leads to reluctance among farmers to adopt in the longer run.

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ANNEXES

Annex 1: Perceptions on field performance traits of planted seed

Variable	Proportion of respondents		
	Pooled sample	Non-user of quality seed	Used quality seed
Rating on yield of seed planted			
Very low yield	0.060	0.071	0.050
Low yield	0.306	0.353	0.256
Yield is just Ok	0.242	0.245	0.240
High yield	0.312	0.276	0.350
Very high yield	0.077	0.053	0.101
Don't know	0.002	0.002	0.003
Tolerance to drought			
Very low	0.088	0.089	0.086
Low drought tolerance	0.296	0.304	0.287
Just Ok	0.352	0.340	0.366
High drought tolerance	0.193	0.193	0.193
Very high tolerance	0.045	0.050	0.039
Don't know	0.026	0.024	0.029
Tolerance to pests & disease			
Very low tolerance	0.261	0.244	0.277
Low tolerance	0.432	0.443	0.421
Ok pest/disease tolerance	0.181	0.172	0.190
High pest/disease tolerance	0.099	0.108	0.089
Very high tolerance	0.024	0.028	0.019
Don't know	0.004	0.004	0.004
Early maturity			
Very late maturing	0.032	0.051	0.012
Late maturing	0.196	0.318	0.070
Normal maturing	0.204	0.284	0.122
Early maturing	0.453	0.301	0.610
Very early maturing	0.111	0.043	0.181
DNK	0.004	0.002	0.005
Germination rate			
Very low germination rate	0.012	0.010	0.013
Low germination rate	0.123	0.128	0.117
OK germination rate	0.307	0.339	0.275
High germination rate	0.399	0.367	0.433
Very high germination rate	0.158	0.154	0.162
Don't know	0.001	0.001	0.000

Annex 2: Perceptions on market performance traits for planted seed

Generally, 3 out five parameters got farmer ratings that were more to the left of the scale indicating that save for the taste attribute, the farmers were not satisfied with the performance of the maize variety planted (in the second season of 2020) namely in terms of market demand, seed price, and seed availability.

Variable	**Proportion of respondents**		
	Pooled sample (N=3470)	Non-user of quality seed (N=1760)	User of quality seed (N=1706)
Market/ demand/market price			
Very low-price mkt/ demand	0.305	0.308	0.302
Low market price/low demand	0.302	0.307	0.298
OK price/ demand	0.208	0.217	0.199
High market price/ demand	0.109	0.098	0.120
Very high mkt price/ demand	0.026	0.016	0.036
Don't know	0.049	0.053	0.045
Price of seed			
Very low price	0.085	0.126	0.042
Low price	0.213	0.298	0.125
OK price	0.207	0.211	0.202
High price	0.262	0.176	0.352
Very high price	0.145	0.069	0.223
Don't know	0.088	0.120	0.056
Seed variety availability			
Very scarce	0.032	0.034	0.030
Scarce	0.150	0.162	0.139
OK availability	0.380	0.353	0.407
Highly available	0.260	0.234	0.287
Very highly available	0.154	0.196	0.110
Don't know	0.024	0.021	0.027
Rating on taste			
Very poor taste of variety	0.011	0.006	0.015
Poor taste of variety	0.062	0.036	0.089
Ok taste of variety	0.164	0.113	0.216
Good taste of variety	0.407	0.360	0.455
Very good taste of variety	0.350	0.480	0.217
Don't know	0.006	0.005	0.008

Annex 3: Agro-input knowledge of good storage seed practices and variety characteristics

Variable	Proportion of AIDs (N=348)
Knowledge on seed storage duration	
Seed is not carried over into next season (store <6 months)	0.457
Seed can be carried over into next season	0.336
Depending on seed kind (Hybrid/OPV), seed may/may not be carried over	0.075
Don't know	0.132
Storage of repackaged seed	
Airtight in polyethylene bags	0.486
In paper bags or perforated polyethylene bags,	0.270
In a sealed tin/plastic container	0.095
Don't know	0.149
Distance between floor and stored seed	
0 inches (seed is placed directly on the floor for maximum stability)	0.014
Minimum 2 inches from the floor	0.239
Minimum 6 inches from the floor	0.526
Don't know	0.221
Storage practice for seed in the room	
In sealed cardboard boxes	0.086
Stacked on pallets	0.552
Arranged on shelves with sufficient space between packets	0.322
Don't Know	0.040
Agree with Practice of seed repackaging	
Seed should be repackaged to visually verify that it is of good quality	0.069
Seed should be repackaged so you can sell more to small farmers	0.270
One should avoid repackaging seed as much as possible.	0.638
Don't know	0.023
Variety recommended for poor soils	
LONGE5	0.192
BAZOOKA	0.227
LONGE 10H	0.437
DON'T KNOW	0.144
Frequency of recycling of OPV seed variety	
Never, you must buy new seed every season	0.345
4-5 times	0.549
10-12 times	0.011
Don't know	0.095
Knowledge on hybrid yield	
Hybrid seed can double maize yield (say from about 4 to 8 bags per acre)	0.445
Hybrid seed can triple maize yield (say from about 4 to 12 bags per acre)	0.328
Hybrid seed can increase yield tenfold (say from about 4 to 40 bags)	0.124
Don't know	0.103
Variety for droughty conditions	
LONGE10H	0.511
LONGE7H	0.086
WEMA	0.052
Don't know	0.351
Early maturing maize variety	
BAZOOKA	0.172
LONGE10H	0.302
MM3 (MYEZI MITATU)	0.218
DON'T KNOW	0.308