EAST AFRICA SYNTHESIS REPORT
(KENYA, TANZANIA, UGANDA)

COUNTRY CASE STUDIES ON THE PASS VALUE CHAIN STRATEGY/ APPROACH AND ITS IMPACT/ EFFECT ON SMALLHOLDER FARMER YIELDS IN AFRICA

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ACRONYMS AND ABBREVIATIONS

ADP	Agro-Dealer Development Programme, PASS
AGRA	Alliance for a Green Revolution in Africa
CBOs	Community Based Organizations
EACI	Education for African Crop Improvement, PASS
FBOs	Faith Based Organizations
FGDs	Focus Group Discussions
FIAAC	Fund for the Improvement of and Adoption of African Crops, PASS
IcFEM	International Fellowships Evangelical Mission
KII	Key Informant Interviews
MFI	Micro Finance Institutions
MoA	Ministry of Agriculture
NGO	Non Governmental Organizations
PASS	Program for Africa's Seed Systems
SACCO	Savings and Credit Cooperative
SEPA	Seed Production for Africa Initiative, PASS

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1. BACKGROUND TO THE STUDY

1.1 The Program for Africa's Seed Systems

The Program for Africa's Seed Systems (PASS) is one of the four programs[1] of the Alliance for a Green Revolution in Africa (AGRA). AGRA is a partnership of the Rockefeller Foundation, the Bill and Melinda Gates Foundation and the UK Department for International Development (DFID), working with African governments, other donors, NGOs, the private sector and African farmers to significantly and sustainably improve the productivity and incomes of resource poor farmers. AGRA is contributing to the vision of a food secure and prosperous Africa by accelerating agricultural growth through a number of initiatives targeting smallholder farmers who are the primary producers of staple food in Africa. AGRA has three main goals to be achieved by 2020, namely to:

- Reduce food insecurity by 50% in at least 20 countries;
- Double the incomes of 20 million smallholder families; and
- Put at least 30 countries on track for attaining and sustaining a uniquely African Green Revolution.

PASS was launched in 2007. The purpose of PASS is to increase income, improve food security and reduce poverty by promoting the development of seed systems that deliver improved, locally adapted crop varieties to small-scale farmers in an efficient, equitable and sustainable manner. PASS consists of four sub-programmes that are working to strengthen the seed supply value chain in Africa.[2]

Seed is a major investment by smallholder farmers but across Africa there are multiple supply chain pathways, within which it is important to understand the different actors (breeders, seed companies, agro-input traders, etc) and the behaviour of farmers that underpin more sustainable models of seed production, distribution and related impacts in farmers' fields. There are also some challenging questions around the fact that farmers sometimes adopt varieties and capture the benefits in terms of livelihoods gains, but in other instances they may not sustain their adoption of new and improved varieties. It is important to understand why this is so.

1.2 Objectives of the Study

The Terms of Reference (TOR) articulates that the overall objective of the case studies is to, "*assess the impact, sustainability and efficiency of the PASS seed supply chain in helping farmers increase farm yields through the delivery of improved seeds*" (page 2). This will consider the **role of PASS in the seed supply chain** (in relation to other factors, constraints and opportunities), and the **uptake and use of the released varieties by smallholder farmers** (including the linkages to fertiliser application, the accessibility to women, farmer perceptions about utility, and the contribution made to increased yields). It is also important to test some of the assumptions around the adoption and sustainability – as both lead to a means to improve the performance of PASS.

The purpose of the case studies is to critically assess the role played by PASS in the diffusion of improved seeds to smallholder farmers in six selected countries of Ghana, Burkina Faso, Mali (West Africa) and Kenya, Tanzania and Uganda (East Africa) that will critically assess the impact, sustainability and efficiency of the PASS seed supply chain in helping farmers increase farm yields through the delivery of improved

[1] In addition to PASS, the other three major programmes of AGRA are Soil Health, Market Access and Policy and Partnerships. In addition, cross-cutting issues such as water management, extension, gender and youth are incorporated into the four programmes.

[2] These are: (i) Education for African Crop Improvement (EACI); (ii) The Fund for the Improvement of and Adoption of African Crops (FIAAC); (iii) The Seed Production for Africa Initiative (SEPA); and (iv) The Agro-Dealer Development Programme (ADP).

seeds. This synthesis report considers only the three East African countries of Kenya, Tanzania and Uganda.[3]

The main questions to be addressed by the study are (TORS) and the sampling framework identifies how these will be addressed followed by the limitations in the approach:

A. Uptake pathways:

- What is the uptake of improved seed varieties released with the support of PASS (at each stage of the supply chain)?
- What are the constraints to uptake?
- What are the opportunities for increased uptake?

B. Equitable access:

- To what extent do women get access to improved seeds?

C. Quality and utility:

- How do farmers perceive the utility of small seed packs supplied by PASS-supported seed companies, cooperatives and farmer groups?
- How do farmers perceive the quality of the improved varieties supplied by PASS-supported seed companies, cooperatives and farmer groups?

D. Yields:

- What is the level of farmer fertilizer use and its relationship to improved seed application?
- What yields have been achieved from PASS-improved seed varieties?
- How does this compare with yields of other improved varieties being applied by farmers?

1.3 Methodology

The Country Case Studies were preceded by an Inception Phase, during which both teams of consultants (East Africa Team and West Africa Team) were invited to AGRA headquarters in Nairobi for a briefing by the client. Terms of Reference for the study as well as the conceptual approach and methodology were discussed and harmonised during the meeting held with AGRA on Thursday 4th November 2010. The Team for East Africa also had the opportunity to participate in a field trip to Embu District, where they interviewed beneficiaries of AGRA-PASS activities seeking to strengthen the agro-dealer network of Kenya. Reconnaissance visits (interviews of breeders and seed companies) were conducted by the Regional Consultant in the second and third week of December 2010 whilst fieldwork was carried out by the national teams in the third and fourth weeks of March and the first week of April. Data capture and cleaning was completed by first week of May.

The following section outlines the sampling frame, the data collection tools, as well as the challenges and limitations of the study.

1.3.1 Sampling framework

The sampling framework had to address a number of issues in this study. Firstly, there is little accurate data by which to stratify the sample at the outset (particularly as one goes further down the supply chain; from breeders to seed companies, to agro-dealers/farmer associations, and to farmers themselves). And yet, a purely random sample of farmers would be unlikely to capture sufficient data on PASS-supported (improved) varieties. To overcome this, it has been necessary to incorporate an element of snowball sampling, whereby information from breeders is used to sample the seed companies, and information from seed companies is used to sample the agro-dealers/ farmer associations, and so on. Secondly, there is the challenge of obtaining a sufficiently representative view of the PASS-supported crop varieties

[3] The three West Africa case studies were undertaken by a separately contracted team, and areported elsewhere.

(especially for yield data), while also ensuring that the particularities of each level of the supply chain is captured. This is an important consideration, as seed supply chains tend to be more context specific – involving individual organisations (such as particular farmer associations), each of which may have different bulking, distribution and marketing/ packaging strategies.

After considering three possible sampling options, ALINe settled on a sampling approach that best permitted an analysis at many levels, and fulfils the requirements of the TOR. This option (analysis by variety) enables:

- An analysis of the adoption patterns;
- A minimum sample size of 30 farmers per variety - sufficient observations to permit statistically valid conclusions;
- A sufficient sample size to explore yield variations under several scenarios; and,
- Provides for a random sample to adequately represent male and female farmers (with issues of access further explored through FGDs).

The process for undertaking the sampling is set out as follows:

1. For each crop, breeders' information was obtained on seed companies involved in multiplying and commercialising the seed varieties.
2. For each crop, varieties were stratified according to number of seasons they have been on the market, then by total tonnage sold by seed companies to agro-dealers/ farmers to-date.
3. From this, two varieties were systematically sampled for detailed household-level interviews.
4. Information was obtained from seed companies on where each of the sampled seed varieties was sold (districts/ sub-district).
5. A district/ sub-district where the variety has been sold was then selected (while also ensuring that the names matched the ones provided by AGRA).
6. In each sampled area, 3 agro-dealers were randomly selected on the basis of those who are actively involved in distributing the PASS-improved variety.
7. From each agro-dealer information was obtained on villages where farmers that have been buying the improved seed variety reside.
8. The villages were stratified according to proximity to the agro-dealer.
9. One village was then randomly selected from the stratified sampling frame of villages.
10. For each village (i.e. for each agro-dealer), 10-15 farmers were randomly selected from the stratified sample for quantitative interviews.
11. In each household, interviews were conducted with either a male or female respondent (i.e., the one who makes the final decision on which seed variety to purchase for each targeted crop).
12. Two groups of 10 farmers each (one comprising males only and another females only) were then selected for the FGDs.

The key advantage of this approach is that the random sample of farmers enables analysis of adoption patterns in areas where the seeds have been distributed. For each variety there will be a minimum sample size of 30 farmers per variety, which gives rise to a sufficient number of observations to permit statistically valid conclusions. The number of farmers in the control group is determined on the basis of the actual proportion of farmers that have not adopted (in PASS intervention areas). It is likely to be more than 2 farmers per variety. This provides a larger sample size to explore yield variations under several scenarios: (i) farmers exclusively growing PASS-improved varieties; (ii) those growing PASS-improved varieties and other improved varieties; (iii) those growing PASS-improved varieties and local non-improved varieties); (iv) those growing other improved varieties only; and (v) those growing local non-improved varieties only. Focus Group Discussions (FDGs) have then been used to supplement the analysis of constraints affecting women's access to improved varieties and other associated inputs.

A total of 839 households were sampled across the three countries. The data was collected in three districts in Kenya (Bungoma, Malindi, and Nyeri), two in Tanzania (Mbeya and South Unguja-Zanzibar) and Uganda (Iganga, Kamwenge and Mubende). See Table 1, below.

Table 1: Sample Sizes by Country and District, Kenya, Tanzania and Uganda

	District	Region	Crop assessed	Sample size, Households	Crop Breeders	Seed Companies	Agro-dealers	FGDs
Kenya country study	Malindi	Coastal	Cassava	102	1	0	3	3
	Nyeri	Central	Maize, Beans	102	2	2	3	3
	Bungoma	Western	Maize, Beans	102	2	2	3	3
			Sub-total:					
Tanzania country study	Mbeya	Southern	Maize	74	1	1	3	3
	South Unguja	Central District Zanzibar	Cassava	54	1	0	3	3
			Sub-total:					
Uganda country study	Iganga	Eastern	Rice	135	1	2	3	3
	Kamwenge	Central	Beans	135	2	1	3	2
	Mubende	Western	Maize, Rice, Beans	135	1	1	3	3
			Sub-total:					
Totals				**839**	**11**	**9**	**24**	**23**

1.3.2 Data collection tools

Five main data collection instruments were used – based on those prepared by the West Africa Team. These include:

- Interview Guide for Breeders;
- Interview Guide for Seed Multipliers;
- Interview Guide for Agro-dealers;
- Household survey questionnaire for Farmers; and,
- FGD Guide for Farmers.

The final data collection tools are annexed to the Inception Report. These instruments were used to consider the following issues:

1.3.3 Key informant interviews with breeders

The focus here is to look at the improved varieties produced by breeds and how they have been passed on to the seed companies/ farmer associations involved in seed multiplication and commercialisation. The relationship between breeders and seed companies is an important part of the supply chain, and the data collection instruments have been used to understand the challenges and opportunities confronting breeders (i.e. when producing new varieties; getting authorisation for variety release; and in production of sufficient foundation seed to pass on to seed companies).
The study gathers information on the tonnage of breeders' seed and foundation seed produced over the last five years, how much was sold to seed companies/ farmer associations for seed multiplication, and planned future production. The study also solicits information on the breeders' own evaluation of potential yield impact of the new varieties, especially from on-farm trials that they may have conducted prior to release of the varieties. These interviews also look at the challenges faced by breeders in passing on foundation seed to seed companies.

1.3.4 Key informant interviews with seed companies

The purpose of these interviews is to confirm the sources of foundation seed for varieties commercialised by seed companies and farmer associations. The aim is to understand the whole range of varieties multiplied, and reasons why seed companies chose to multiply PASS varieties ahead of, at par with, or behind others on the market. Also considered are the level of satisfaction of companies (such as with the quality of varieties) and whether and how seed companies provide feedback to breeders on this important issue.

The study also establishes volumes of seed sold to agro-dealers, which agro-dealers they supply with which seeds, and what has been sold directly to farmers over the past five years. Challenges and constraints in dealing with breeders are investigated together with the nature and adequacy of support they receive from breeders – plus how companies get their seed certified, and any bottlenecks in the process.

The relationship between seed companies and their customers (agro-dealers and farmers) is also important for the study. It is important to better understand the support (services) seed companies provide to their distribution chain, and the mechanisms to provide feedback to seed companies (i.e. that are available to agro-dealers and farmers), and the nature of feedback provided to date. This also covers the support seed companies have received from AGRA-PASS, such as in terms of relevance, adequacy and effectiveness.

1.3.5 Key informant interviews with agro-dealers

This element of the study looks at the PASS and non-PASS-supported varieties that are being stocked by agro-dealers (including the official names, local names and other identifiers). Furthermore, the study looks at where the agro-dealers source their seed and fertilizer supplies, how reliable these sources are, the prices they are purchasing the seeds for and how much they are selling to farmers or other retailers in the outlying areas. The study considers whether agro-dealers that are selling PASS-supported varieties are participating in, or affected by, any government or NGO input subsidy programmes. Questions also consider the characteristics of farmers and farmer groups that are buying PASS or other competing varieties, their tastes and preferences, and their perceptions concerning the positive and negative attributes of the PASS-supported varieties. Where possible, quantities of seed bought and used by farmers are confirmed, together with the factors that determine how much of the improved seed they purchase and use. Also, information on farmer preferences in relation to optimal sizes of seed packs (and fertilizer packs) – and the willingness and capacity of seed suppliers to supply smaller seed packs.

AGRA supplied the consultants with a list of names of breeders and seed companies to interview in each country, and these were interviewed in the initial phase of data collection at the country level. These KIIs were conducted by the regional consultant, using checklists jointly developed by the two teams contracted by AGRA to carry out the study (one team was responsible for East Africa and another for West Africa).

1.3.6 Focus group discussions with farmers (male, female)

At farm level, there is interest in knowing whether or not male and female farmers are adopting the improved PASS-supported varieties, the pattern of adoption and the type/ variety of PASS seed varieties that are being planted by farmers. Factors that influence farmers choice of varieties such as yield advantage, early maturity, other aspects of agro climatic suitability, awareness campaigns by seed suppliers, complementary extension support provided by agro-dealers/seed companies, affordability (retail price and credit support), consumer tastes/preferences, labour requirements and cooking attributes, constitute some major areas of focus of the analysis at farm level.

In particular, the study is interested to know the level of priority given to PASS varieties in relation to land allocation compared to local varieties (land-races) of the same crops, other competing improved varieties, or other competing crops. Decisions farmers make in relation to how much land to allocate to the PASS varieties relative to non-PASS varieties need to be investigated as well. For farmers who are aware of the existence of the PASS varieties but have decided not to plant them, the study considers the reasons why farmers have opted not to adopt PASS varieties, or for some reason, have decided to discontinue planting these varieties.

1.3.7 Household surveys of farmers

The household survey is the main instrument for data collection. It captures information on the household characteristics (age, gender, education, occupation, assets, etc) and farming practices and patterns (crops, area, etc). The main focus however is on the adoption of different varieties, including improved and PASS-supported varieties, the channels by which farmers obtain information (demonstration plots, informal, etc), farmer preferences (packaging, varieties), fertilizer use, and yields.

1.4 Limitations of the Study

As with all methodologies, there are limitations. In the process of developing the harmonised approaches and methodologies, the final approach entailed a revision of the East Africa Team's Technical Proposal to include household surveys while reducing the use of participatory tools, which were the original main tools proposed by the East Africa Team. Household surveys were carried out at a much higher cost than budgeted and the process of mobilising these additional resources, recruiting national teams for the quantitative household surveys, and the holding of national elections delayed commencement of the farm level data collection phase by two-and-half months in Uganda. The timing of the survey around Christmas time made it difficult for some of the intended interviewees were either on holiday or on annual leave, and therefore not available to meet the study team.

Furthermore, by focusing more on household data and reducing other elements of the original proposal (including less use of participatory tools), it reduced the depth of analysis of explanatory variables around farmers priorities and perspectives – such as their decisions around adopting, and continuing to adopt, particular varieties (e.g., taste, cooking time, amount of labour input required, etc). Requirements by AGRA for full harmonisation of the approaches for the East and West Africa Teams without the teams sharing full details of their sampling approaches made it difficult to reach agreement on the most suitable approach and methodology and further delayed the implementation of field work. Most importantly, the prescription by AGRA of a minimum sample size of '10 farmers per variety' without clarity on the rationale, complicated the East Africa Team's decisions on sampling, resulting in the team proposing three sampling options and a protracted negotiation with AGRA.

The sampling framework selected provided a sound basis to capture different requirements of the study – particularly to cover all crop types (maize, beans, cassava) in each country (Kenya, Tanzania and Uganda). However, the sample size is not sufficient to generalise at the village level – with larger villages (with more than 150 farmers each) potentially requiring even larger sample sizes. This is not a major concern, as the ability to compare village data is seen as a secondary concern – less important than say the comparison between crops and different supply chains. Also, the absence of baseline information means that the household survey has had to rely on recall information. This inevitably introduces the possibility that the recall period for area planted, fertilizer application, quantity of seed used, harvests, etc might be too long for some farmers. In many cases, it may not even be possible to verify the farmer's information, particularly where evidence of harvest may not be available (i.e. just prior to the next harvest).

Lastly, time pressures meant that the study was conducted in one stage – missing the opportunity to stagger the survey and qualitative data collection which would have enabled a more in-depth investigation of some of the preliminary findings from the household study (especially those that are particularly interesting or insightful). Instead the findings from the key informant interviews and focus group discussions were conducted alongside the household survey data collection.

2. FARMING SYSTEMS

The context of each district and region is an important consideration in the uptake and use of improved seed varieties.

Malindi, Kenya: Land in the study area is used for small scale crop farming and livestock production. There are issues of land ownership in some of the villages (e.g. In Malanga land is owned by farmers although no freehold title deed has been issued). The average crop area is 2 acres, and rain dependent agriculture is practiced. Cassava (92.2%) is the most common cultivated crop grown by small scale farmers followed by maize (78.4%), and beans (37.3%). Cashew nut and mango tree crops were planted by virtually all the households in Milimani and Karia Papo villages which are relatively moist compared to Malanga. The vast majority of households own livestock (78.4%) from chicken/ local type (78.4%), goats (50%), cattle (47.1%), sheep (8.8%), pigs (1%) and improved breeds of chicken (1%).

Nyeri, Kenya: Small scale mixed agriculture is practiced in Nyeri. Land sizes are very small, ranging from a quarter of an acre to 4 acres. On average, households in the study area own 1 acre of land generally on freehold titles. Despite the small sizes of the land owned, intensification of crop production was observed with highly elaborative farming systems. Farming is primarily rain-fed with about 1% of the households running irrigated agriculture. The most common crop grown was maize with 95.1% of the households cultivating, mainly for local consumption. Other common crops included beans (57.8%), potatoes (43.1%), onions (18.6%) and vegetables (10.6%). Eighty seven percent of the sample farmers owned some livestock and of those, 82.3% reared cattle, primarily for milk production. The other common livestock were goats kept by 84.3% and sheep by 69.6%. Chicken, both local and improved variety were reared by 54.9% of the farmers.

Bungoma, Kenya: In Bungoma, small-scale mixed agriculture is practiced and household land ownership was, on average, 1.5 acres, which is apparently inadequate to support a fairly large family of 5.7 persons. Mixed cropping of mainly maize and beans was practiced by 63.7% of the farmers. Some farmers carried out a mono cropping farming method for beans (12.7%) and groundnuts (14.7%) while others intercropped. Other crops cultivated include soya beans, sorghum, pigeon peas, cassava, sweet potatoes and early millet, amongst others. Farming is basically rain dependent. Of the total sample households, 9.8% had no livestock at all (large stock, shoats or chicken). Of those who owned livestock, poultry and cattle keeping were the most common. Those owning cattle and shoats represented 76.5%, meaning 13.7% of the population owned poultry alone. On average, more chicken were reared. The study found that households owned more livestock in 2009 compared to 2010.

Mbeya Urban and Mbeya Rural, Tanzania mainland: In Mbeya Urban agriculture was the main economic activity. The dominant livestock kept were cattle, pig, hen, ducks, and dogs. In Mbeya Rural, agriculture and small shops were the main economic activities. Major cropping systems include the maize-based system, the rice-based system and the coffee/banana-based system. Beans, sunflower and potatoes were also included in some maize-based systems. Maize is commonly rain-fed as mono-crops or intercropped in mixed crops and grown in small fields 0.5-1.5 ha per household. A limited amount of maize is grown under irrigation.

South Ungunja, Central District in Zanzibar Island: The central district in Zanzibar was selected for the cassava varieties supported by AGRA. Land is in extreme short supply in the Zanzibar islands, with some estimates of 60% landlessness.

Uganda: The Uganda study was carried out in the Iganga, Kamwenge and Mubende districts. The main crops planted were maize, beans (cowpea) and rice. The study found that most farmers (89.1%) kept livestock.

Iganga: The average plot sizes among the farmers in the Iganga district is 1.55 acres. The majority of plots are rain-fed: 222 out of 225 are rain fed and only 3 are irrigated. The most common livestock were cow, goats, chicken local, calves and bull.

Kamwenge: The average plot sizes among the farmers in Kamwenge is 2.07 acres. The majority of plots are rain-fed: 265 out of 266 plots are rain fed while only 1 is irrigated. The most common livestock were chicken local, goats, cow, pigs, calves, bull and sheep.

Mubende: The average plot sizes among the farmers in Mubende is 1.58 acres. The majority of plots are rain-fed: all 390 plots are rain fed. The most common livestock were chicken local, goats, pigs, cow, bull and calves.

3. COUNTRY CONTEXT AND AGRA-PASS SUPPORT

This section summarises key findings in relation to the country context of seed systems. The first part provides a summary of the seed policy and legislative environment for improved seed varieties by smallholder farmers in East Africa. It also highlights the institutional responsibilities, capacity and functionality as well as the market shares and sources of improved seed in each of the countries in which the study was undertaken. This is coupled to the AGRA-PASS support to the country seed systems which provides a link with the areas in which sampling occurred as a result of the AGRA support. Finally, the sections look at the seed production and supply chain related to breeder seed, foundation and certified seed production and marketing and distribution of certified and quality declared seed, and farmers preferences.

3.1 The country seed systems

This section summarises the situational context of the seed systems in Kenya, Tanzania and Uganda and the regulation and institutions governing the production of breeder seed, production of foundation and certified seed and the marketing of seed.

Kenya

In Kenya, seed production and marketing were liberalized through the Ministry of Agriculture's Seed and Plant Varieties Act Cap 326, allowing private seed companies to cover all stages of the seed value chain. The Act regulates testing and certification, and procedures relating to the introduction of improved and new varieties bred locally and imported. All crop varieties fall under Schedule II of the Act requiring mandatory inspection before official registration and varietal release. Seed laws are harmonized with international conventions. Imported seed requires phyto-sanitary certificates and International Seed Testing Association (ISTA) certificates. Local seed is considered to be over-regulated as production and distribution is subject to stringent regulations. This is coupled with long varietal release processes which make the seed expensive and contributes to seed shortages.

The Kenya Agricultural Research Institute (KARI) employs 61% of trained crop breeders followed by national universities (23%), private companies (9.6%) and international organizations (6%). The majority (90%) are trained in conventional breeding methods in conventional breeding programmes. KARI, the International Agricultural Research Institutes (IARCs), the Coffee and Tea Research Foundations are most active organizations producing improved varieties. KARI's practice of non-exclusive rights over the distribution of certain varieties has created some conflicts and led to a shortage of breeder seed for varieties of orphan crops and legumes which are pivotal food security crops.

By 2009, there were 62 companies in Kenya. Five are public, including the KARI seed units and have supported a strong public research capacity with competing private sector entities for the genetic material. The Kenya Seed Company controls 75% of market share of maize seed. Foundation seed bulking and commercial seed multiplication are constrained by limited stocks of basic seed. The procurement of seed produced by the public seed system involves lengthy processes that delay the availability of seed to farmers at the appropriate planting times.

The Kenya Health Inspectorate Services (KEPHIS) established by the 1966 State Corporate Act (Cap 446) is the National Regulatory Authority for the seed industry responsible for variety evaluation, release, registration, plant protection and the implementation and development of seed standards. KEPHIS conducts seed certification services but is overwhelmed by the demand for seed inspection and certification services and sometimes leads to rejection of crop under trials. The fees charged are considered high and contribute to high costs of seed.

Donors, NGOs and CBOs play a crucial role in filling the unmet demand for seed. These organisations promote the collection, multiplication and distribution of seed using various strategies, including working

with farmer groups that they train and provide with seed capital to boost their seed business. They also import seed and disseminate it to farmers using direct distribution of relief seed, the voucher system and seed fairs.

All seed agents and stockists are expected to be registered by KEPHIS to promote traceability of seed movement and enforce quality standards (inspections etc). KEPHIS registers them as outlets and distributors of seed at a charge of US$1,600 per agent and US$600 per stockist. This is factored into the wholesale and retail price of seed and tends to increase the cost of seeds. Most of the stockists/agents benefit from training on product knowledge, technical aspects of agronomic practice, financial literacy and business skills. KEPHIS also trains some to serve as effective disseminators of information on seed. They have limited access to micro-finance due to limited availability and high cost of capital.

Farmers form a significant, if not the most significant player in the seed industry. They obtain seed through both formal and informal channels; with the latter source constituting the largest source for smallholder farmers (see section on market shares below). The weak research-extension-farmer linkages are a major limitation to adoption of improved varieties.

The demand for maize seed in Kenya was estimated at 44,015MT in 2005, with that for beans standing at 62,069MT. Sixty-two percent of the seed maize demand was met by the formal seed market whilst the remainder (38%) was met from informal channels. For beans the proportions were 2% and 98%, respectively. For cassava, the national demand for cassava is not well known. The KARI seed units are breeding, multiplying and distributing disease resistant cassava varieties to farmers through the Ministry of Agriculture, the ALRMP, NGOs, farmer groups, and entrepreneurs. Current annual supply of cassava planting materials through these formal channels is estimated at 500,000 cuttings through Ministry of Agriculture, 100,000 cuttings through ALRMP, 300,000 cuttings for NGOs, 510,000 cuttings through entrepreneurs and farmer groups (combined)[4].

The low market share of the formal channel for the open pollinated beans shows the low investment by the seed industry into formal commercial seed production for beans. Inadequate formal seed supply systems dampen or limit diffusion of new bean crop varieties.

The significant role played by the informal market for seed stems from the high distances to market travelled by farmers. On average smallholder farmers in Kenya travel 7km to the nearest source of fertilizer and hybrid maize, with the distances increasing up to 25.5 km and 1.7km respectively along the coastal lands and lowest in the Western Highlands (3.2 km for fertilizer and 1.5 km for maize).

The utilization of improved hybrid seed increases by farm size, with farm sizes less than 2 acres using less (85% of farmers used hybrid seed in 2004). About 93% of farmers owning 2-5 acres used hybrid maize, and 90% of those with more than 5 acres used hybrid maize. Ownership of assets was also found to be positively correlated with the use of improved seed in general. Regional differences were also observed with farmers in the Eastern Lowlands least likely to use the improved seed varieties.

Tanzania

Estimates are that Tanzania requires 100 000 tons of seed annually, but due to inefficiencies in the seed sector, only 13 000 tons of improved seed are marketed annually, including 5 000 tons of maize. Due to inefficiencies, the country at times imports emergency seed in times of drought and other climatic disasters.

Tanzania's seed sector was liberalized since the early 1990's; hence the sector has a mix of public and private players who are active in crop improvement, production and distribution of seed pertaining to various agricultural crops.

[4] These statistics were provided to the consultant by Dr Benjamin Muli, Agronomist, KARI Mtwapa, January 2011.

Main policies include the Seed Act, 2003, which established TOSCI (Tanzania Official Seed Certification Institute, the sole seed certification agency enforcing regulations on importation, exportation, production, processing, distribution and sale of seed. Other important legislation included The Protection of New Plant Varieties (Plant Breeders Rights) Act, 2002; The Seed Act No. (1) 18 of 2003; which repealed The Seed (Regulation of Standards) Act of 1973 and The Plant Protection Act, 1997. The Seed Act 2003 recognizes QDS (Quality Declared Seed).

Seed traders (seed companies), agro-dealers and farmers are under-represented in the National Seeds Committee, an advisory body to the MAFC, with negative implications for lobbying of favourable policies at this level.

Formal seed systems characteristically operate at low production and have a low market share estimated at 10%, with 90% seed usage being of farmer saved seed. Agricultural Seed Agency (ASA), a government agency mandated to produce, process and market agricultural seed also has the sole mandate to provide all foundation seed for varieties bred from public institutions; hence it faces a conflict of interest.

In Zanzibar, the apex body for agriculture is the Ministry of Agriculture, Livestock and Environment and it enforces the Plant Protection Act, 1997, which regulates the control of seed imports into the islands, quarantine and subsequent destruction of pest infested seed or plant material. This potentially provides some protection for vegetative crops such as cassava against viral and other diseases.

Zanzibar has also recently granted the establishment of a Variety Release Committee with representation under MALE.

Uganda

The Seeds and Plant Act of 2006 regulates the promotion, regulation and control of plant breeding and variety release, multiplication, conditioning, marketing, importing and quality assurance of seeds and other planting materials, and for other related matters. Uganda is a member of the Organization for Economic Co-operation and Development (OECD) Seed Schemes.

Only seed which meets the standards established by the National Seed Certification Scheme (NSCS) for domestic seed trade and ISTA certificate or domestic certificates and a phyto-sanitary certificate can be imported. Imported seeds have to be inspected by an authorized Inspector of the Department of Crop Protection in the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF), for compliance. All seed intended for export must comply with the requirement of the importing country, as well as meet the minimum standards of Uganda certified seed.

In addition, there are a number of laws, regulations, administrative and technical procedures that govern seed production and distribution in Uganda. These include, Agricultural Chemicals (control) Act of 2006, The Adulteration of Produce Act, Cap.27; The Cotton Development Act, Cap 30; the Uganda Coffee Development Authority Act, Cap 325; the Uganda National Bureau of Standards Act, 1983; the Export Promotions Board Statute, 1996; the National Environment Act, CAP 153 and the National Agricultural Research Act, 2005.

MAAIF, through the National Seed Board (NSB) formulates seed policies and implements them. The NSCS in the Department of Crop Protection is responsible for implementing the Seeds and Plant Act 2006 and handling all matters relating to seeds. The National Agricultural Research Organization (NARO) is the apex body for guidance and coordination of all agricultural research activities in the national agricultural research system in Uganda. NARO is the only source of seed research for new variety development and releases the variety. The private seed companies are totally dependent on NARO and are subject to problems NARO may have, such as inadequate government funding or loss of key research personnel.

Private seed companies want to invest in seed research and production, but lack the incentives and financial and technical resources. A 'plant variety protection law' would create an incentive for firms to invest in new variety development to enable earnings from royalties on seed sales.

NARO produces new varieties through plant breeding, production and maintenance of breeder seed and germplasm conservation. Makerere University's Department of Crop Science is also involved in breeding soya beans and cowpeas, and some seed companies are currently initiating variety production. NSCS tests all varieties (for VCU and DUS) intended for release. NSCS is supposed to conduct the NPTs and DUS. But some NPTs are still being conducted by NARO breeders. The VRC/Technical Committee conducts the release varieties and the NSCS registers all those varieties released and are legible for multiplication and processing by the private seed companies.

The Seed Policy, 2006 (draft) recognizes the existing 'inadequate capacity for effective seed certification and inspection services' as a challenge. It is noted that 'there is inadequate capacity in terms of manpower and infrastructure to cope with the various activities and to carry out surveillance and quality control'. The Department of Crop Protection and NSCS lack capacity and finance to handle functions listed under the Seeds and Plant Act, 2006. Staff members often do not carry out inspections because of lack of funds and some merchants have taken advantage of this situation to sell substandard seeds. There are only 9 PhDs and 10 MSc staff are active plant breeders - each crop usually has only one breeder. Despite this, new varieties continue to be developed and released on an annual basis and breeders are able to supply seed companies with the seed type and quantities required.

The seed system in Uganda is composed of the formal and the informal seed supply systems. The formal seed system is responsible for the production of improved and certified seeds. Seed production is characterized by a structured system of multiplication, distribution, marketing and quality control. The formal seed system provides about 5-10% of the improved and certified seed used in the country. The informal seed system provides 90-95% of the seeds to the farming community with seed that is not certified and of unknown quality.

The formal seed system is comprised of many players both public and private. These include MAAIF and its constitutents, namely, NARO, the National Seed Board (NSB), VRC/Technical Committee and NSCS, private seed companies (23 companies), seed distributors and stockists, government and donor projects, NGOs and Relief Agents, and farmers. All are linked together through MAAIF and NARO.

The Uganda Seed Trade Association (USTA) has a membership of 13 seed companies and six 'associate' members (mainly agro-input organizations).

3.2 AGRA-PASS Support

See Appendix for a list of PASS grants to Kenya, Tanzania and Uganda covering the areas of pertinence in this study.

4. Findings on Seed Production and the Supply Chain

This section summarizes the main findings on Seed Production and its supply chain in Kenya, Tanzania and Uganda.

4.1 Analysis of Breeding and Sustained Seed Production

Kenya

The analysis on Maize focuses on the KH500 series. From 1997, the breeding programme has focused on mid-altitude varieties with hard grain, resistant to pest attack. The main challenge faced by breeders continues to be the length of time it takes to release a variety. **Breeders estimate that it takes close to 6 years with lower levels of vigour reducing the final quantity of basic seed that can be sold to seed companies for bulking and multiplying. In addition, the KH500 series comprises variety cross hybrids which breeders have to maintain at the level of single pure lines and the single lines are ordinarily not sold to the seed companies.**

Costs for varietal testing and release are high with KEPHIS charging USD600 per entry for National Performance Trials, a similar amount for DUS tests, and then Kenya Shillings 20,000 for each inspection visit. These charges were considered to be too high and, to some extent, a deterrent to investment in breeding programmes by small local seed companies. The process by which KARI makes a determination on whether a variety should be given exclusive or non-exclusive distributorship licence was reported to be unclear to some of the seed companies.

The potential for impact of the KH500 series is significant (See Table 2) however many varieties are arriving on the market faster and it is important that new varieties released must hit the market in large quantities before they are quickly superseded.

Table 2: Distributorship licensing, varietal characteristics and potential impact on yields of Maize in Kenya

Variety	Year of Release	Licence Type	Seed Company Licensed to distribute	Characteristics	Impact on Yields[1]
KH500-21A	2002	Non-exclusive	Freshco, Dryland	Matures in 120 days, large cobs, good grain, white, sweet, easy to pound/mill, streak resistant	3
KH500-31A	2005	Non-Exclusive	Leldet, Faida, Freshco	4th Generation inbred lines (80% purity), semi-dent, not very resistant to maize streak virus	1
KH500-32A	2005	Exclusive	Freshco		2
KH500-33A	2005	Exclusive	Freshco		2
KH500-34A	2005	Exclusive	Leldet		2
KH500-43A	2007	Exclusive	East Africa Seed	Top performer, high yielding, disease resistant	1
KH500-46A	2007	Exclusive	OLERAI	Suitable for low rainfall, mid-altitude areas	N/A
KH500-44A	2007	Exclusive	Victoria		1
KH500-47A	2007	Exclusive	Victoria		No data
KH500-22A	2007	Exclusive	Olerai	Suitable for high rainfall, mid-altitude areas, sweet grain, flint, one of top performers for KEPHIS	1
KH500-49A	2007	Exclusive	Leldet		N/A

Source: (Own Source) Interview with Dr Jane Ininda. *Notes*: ratings for expected impact: 1=very high, 2=good, 3= some problems, 4=serious problems

The **Cassava** breeding programme at KARI Mtwapa, dates back to the pre-2000 and the funding for this ended when trials were at farm-trials stage but not yet released. **The AGRA-PASS support enabled the programme to continue and approve, release and distribute six varieties to farmers.** However, six other varieties remain to be further developed and released. **The remaining six (not yet released) include some that have a yield potential of up to 100 MT per ha,** and potential to outstrip the performance of the first six already released (See Table 3).

Table 3: Varietal Characteristics of PASS Improved Cassava Varieties in Kenya

Variety	Descriptive characteristics	Breeder's rating of impact on cassava yields
Shibe	Highest yielder, 70.1MT/ha, 8-12 months to maturity	3
Tajirika	63.3 MT/ha, 8-12 months to maturity, marketable	1
Nzalauka	52.9 MT/ha, early maturing (6-12 months to maturity)	4
Karibuni	52.7MT/ha, suitable for intercropping, 8-12 months	4
Karembo	68.2 MT/ha, beautiful crop appearance,	2

Notes: (1) ratings for expected impact: 1=very high, 2=good, 3= some problems, 4=serious problems; **(2) yields can be contrasted against the average of 28MT/ha achieved from old improved varieties and 10MT/ha for farmers' own local varieties.**

Cassava was previously not one of the scheduled crops in the Seed Act and not subject to mandatory inspection by KEPHIS. Therefore, KEPHIS has empowered KARI Mtwapa to supervise on-farm production due to yields that can be realised from the new cassava varieties. KEPHIS is in the process of widening the band of crops covered under Schedule II to include cassava (and cashew).

Sustainability of cassava breeding programmes depends on continued funding and investment in cassava processing technologies to expand marketing opportunities for the crop. The new cassava varieties produce mixed results at farm level – initially promoting adoption of improved varieties and production of surplus cassava, but eventually leading to a reduction in acreage planted to cassava since the crop has limited marketing potential, in its unprocessed form. **Farmers are hesitant to expand acreage unless they are guaranteed a buyer/processor.** The private sector is interested in investing in cassava processing, but only if guaranteed that there will be an adequate supply of cassava to support processing operations. **A lack of irrigation facilities and cold storage for germplasm also constrain sustainable cassava breeding**.

Objectives of the **Bean** breeding programme over the past 20 years have been to breed improved varieties resistant to bean root rot and bean mosaic diseases. Over the years, some improved bean seed varieties have been released which are doing well in the immediate environs of the research station in terms of their ability to resist common diseases and they are high yielding seeds. KK8 and KK15 seed varieties released in 2008 are very popular with farmers. Breeding of three other varieties namely (i) KK071, (ii) KK072, and (iii) KK020 has been made possible by AGRA-PASS. KK071, KK072 and KK020 are at NPT stage. They are likely to be released within the year.

The main challenges that affect sustainability of bean breeding and production activities include: inadequate funding, lengthy process of registration of new entrants and high susceptibility to diseases constraining community based production systems. Continuous monitoring to ensure the bean seed is recycled makes it an expensive process. There is a likelihood of over production by farmer group members that could easily lead to a glut in supply of bean seed on the local market and reduction of incomes from community based been seed production systems.

Tanzania

Maize

The AGRA-PASS supported program in the Southern Highlands of Tanzania involved the hybridization of a total of 23 inbreds developed over time extending from the mid 1980s for maize populations 62 and 84

with origins from East African germplasm and introgression of traits from North and Central American germplasm. **Focus of this AGRA PASS- supported program was selection of hybrids with tolerance to maize streak virus (MSV), turcicum leaf blight (*Exserohilum turcicum*), rust and Grey Leaf Spot (GLS)**. An intensive set of activities running on a tight schedule from making crosses to advancing the single crosses to 3-way hybrids adapted to high altitudes of the Southern Highlands. In the second year the activities centered on evaluation of both single crosses and 3-way crosses and the production of breeder seed of 10 maize (See Table: 4) variety trials across several sites and on-farm evaluations. **The potential yields are in the region of 8-10t/ha.**

Table 4: Traits of maize varieties supported under PASS, released by ARI-Uyole and distributed by Highland Seed Growers Ltd, Mbeya Tanzania

Maize Variety	UH 6303	UH 615	UHS 5210	UH S5350
Year of Release	2004	2001	2009	2009
Cultivar pedigree	3-way hybrid	Top cross	Modified single cross	3-way hybrid
Grain colour	White semi-dent texture			
Grain Texture	Semi-flint	Semi-flint	Flint	Semi-flint
Disease tolerance	High tolerance to Grey leaf spot, Good tolerance to Turcicum leaf blight	High tolerance to Grey leaf spot, Good tolerance to Turcicum leaf blight	Very high tolerance to Maize streak virus, good tolerance to Grey leaf spot and Turcicum	High tolerance to Grey leaf spot, Good tolerance to Turcicum leaf blight
Yield potential	9-10 t/ha	8-9 t/ha	9-10t/ha	8-9t/ha
Days to maturity	160-165	170 days	140 days	150 days

The production of foundation seed through the ASA and Foundation Seed Farms is unlikely to meet the demand of public varieties some of which have been lost due to lack of maintenance under Foundation Seed Farms. It is likely that UH615, UH 6303, UHS 5210 and UHS5350 will also be replaced with varieties produced by local private companies or imported by international companies as their restricted availability threatens profitability. Financially, production of hybrid seed is exorbitant, costing up to US$850 per hectare, which restricts caliber of farms contracted as seed growers and size seed houses that may engage in certifies seed production without external financial assistance. **Hence it is critical that the Government of Tanzania changes the ASA policy to allow foundation seed production by interested private companies licensed to produce and distribute each released variety. To ensure that varieties are not lost either when private companies deliberately shelve varieties, breeders seed should remain under the protection of crop improvement programs as rightful owners. Government could also insist on mandatory reserves for public bred varietiess licensed to private companies. Critical skills capablility of out-growers needs to be built more comprehensively to enable seed companies to bulk seed.**

The **Cassava** varieties Kizimbani, Mahonda, Kama, Machui varieties were officially released in December, 2006, and these have varying levels of resistance to diseases. Most tolerant to the two viral diseases, Kizimbani is early maturing, taking 8 months (12 months for most varieties). **Kizimbani also has a preferred leaf vegetable test, making it dual purpose. Mahonda, the second highest yielding variety, potentially produces 25 tha^{-1}** See Table 5.

Table 5: Characteristics of PASS-supported cassava varieties on current distribution by Kizimbani Research Station, Zanzibar

	Variety			
Parameter	**Kizimbani**	**Mahonda**	**Machui**	**Kama**
Production of	Kizimbani Research	Kizimbani Research	Kizimbani Research	Kizimbani Research

Foundation Seed	Station, Zanzibar	Station, Zanzibar	Station, Zanzibar	Station, Zanzibar
Multiplication of Seed	Pilot Farmers	Pilot Farmers	Pilot Farmers	Pilot Farmers
Distribution of varieties	Local Sale by pilot farmers	Local Sale by pilot farmers	Local Sale by pilot farmers	Local Sale by pilot farmers
Potential yield	>30t/ha (highest yielder among the four)	>25t/ha (second highest yielding)	<25 t/ha (third highest yielder)	<25t/h (least yielding)
Tolerance to Drought	Tolerant	Tolerant	Tolerant	Tolerant
Market preference and use	Dual purpose (tuber and leaf vegetable), retains leaf area even in drought, though tubers bitter if harvested early	Sweet hence preferred for fresh cooking	High dry matter, preferred trait for processing	Has some bitterness (higher cyanide content)
CMD[1], CBSD[2]	Tolerant	Tolerant	Tolerant	Tolerant

[1] cassava mosaic disease, [2]Cassava brown streak disease

Zanzibar, with a crop improvement program at Kizimbani Research Station under the Root and Tuber program (KRTP), has had no recent history of variety release associated with the station. Unless cassava crop improvement activities targeted at retaining tolerance to viral diseases (see table above) are sustained to introduce new varieties periodically, tolerance of old varieties breaks down eventually, within 5-10 years at the most, leaving farmers exposed once more.

Part of the popularity of these varieties hence the high demand is due to the unusual adaptability of these specific varieties to high altitude above 1,500-1,800m unlike most of the imported varieties pitted against them on the market.

Limitation in quantities of foundation seed presents major hurdles for certified seed multiplication, and partly explains the inability to meet the high certified seed demand.

Uganda

NARO's Cereals Research Programme has focused on maize and rice varieties that address critical agronomic constraints faced by farmers and their taste preferences. Priorities are defined through participatory research and the involvement of other industry players.

Maize breeding efforts have included addressing declining yields as a result of low soil fertility, low fertilizer use and poor agronomic practices, high disease susceptibility and major diseases such as (1) maize streak virus; (2) *tuscicum* leaf blight; and (3) grey leaf spot. **Three maize varieties were released in 2002, Longe 6H, 7H and 8H by the cereals research programme including multiplication, marketing and distribution. In 2009, Yara 41, Yara 42 and Longe 9H, 10H and 11H were also released** (See Table 6). **Future efforts will include disease and pest resistance, drought tolerance and striga including shorter season varieties suited to Uganda.** Hybrid production is inherently long and requires investment which government cannot meet. **More than 20 companies would like access to the varieties but the slow pace and exclusive licensing arrangements make it difficult for breeders to satisfy company needs. Breeding is also heavily reliant on rain-fed agriculture and breeder seed very inadequate to meet the demand by companies.** NARO's recent charge of USD300 per kilogram of breeder's seed, whilst positive is not likely to generate significant revenue. NARO is in the process of drafting a new agreement with seed companies to introduce the payment of royalties equivalent to 3% of turnover. However, how these royalties will benefit breeders is unclear.

Table 6: Varietal characteristics of AGRA PASS supported Maize Varieties in Uganda

Variety	Year of Release	Characteristics	Licensed Seed Company	Type of License	Rating of Impact on Farmers Fields to date
Longe 6H	2002	Disease resistance, high yield, good grain	FICA	Exclusive	Introduced 2004.

		characteristics			Impact rating "2"
Longe 7H	2002	Disease resistance, high yield, good grain characteristics	Harvest Farm	Exclusive	NASECO made it available in 2009 Seasons A and B. Impact rating "3".
Longe 8H	2002	Disease resistance, high yield, good grain characteristics	East African Seed	Exclusive	Breeder seed contaminated. Impact rating "4".
Yara 41	2008	N/A	Victoria	Exclusive	N/A
Yara 42	2008	N/A	Victoria	Exclusive	N/A
Longe 9H	2009	Disease resistance, good grain characteristics, lean plant architecture, drought resistance	FICA	Exclusive	Available 2010 Season B in Mukono.
Longe 10H	2009	Disease resistance, good grain characteristics, lean plant architecture, drought resistance	NASECO	Exclusive	Available 2010 Season B.
Longe 11H	2009	Disease resistance, good grain characteristics, lean plant architecture, drought resistance	CAII	Exclusive	Seed bulking in progress, not yet available.

Notes: (1) Originally exclusive to Harvest Farm, but later opened up to 2 other companies who are selling the variety using two different names to enable traceability. (2) Impact rating scores 1=very good, 2=good, 3=some problems, 4=serious problems. (3) Yara 41 and 42 are varieties that were developed by KARI-Muguga Research Station and evaluated and Released in Uganda by Victoria Seeds.
Source: (Own Source). Interviews with: (1) Godfrey Asea, Plant Breeder, Cereals Research Programme, NARO Namulonge; (2) CAII; and (3) FICA.

Rice breeding in Uganda has focused predominantly on selection of suitable NERICA varieties rather than breeding per se. In 2002, WARDA in collaboration with IITA released ITA 257 and ITA 325 rice varieties (familiarly named NARIC 1 and NARIC 2, respectively). NARIC 3 (popularly known as NERICA 4) was also released in 2002. However, due to resource constraints, two other varieties, NERICA 1 and NERICA 10 were only released in 2007 (See table 7). Future work on rice research in Uganda will require training breeders at PhD level focusing on improving current varieties with new traits, for example, improving NERICA 4 with aroma whilst preserving attributes of this variety. Some of the new rice materials developed by the breeders are now at F5 generation stage and ready for testing and selection together with farmers. The funding of rice breeding is dependent on donors such as the Japanese government. Weak institutional capacity of the National Seed Certification Scheme (NSCS) is hindering the pace at which new varieties are being produced. The NSCS has an acute shortage of seed inspectors with only 3 inspectors to support a network of about 23 registered seed companies. Farmers are planting retained seed rather than certified seed purchased from seed companies. Once a new variety is released and introduced on the market, active participation of farmers in the market to buy new seed is confined to a period of the first two seasons, allowing subsequent purchase from neighbours. This pattern for rice is a major disincentive to the private sector in terms of investing in seed multiplication, certification, promotion and distribution.

Table 7: Varietal Characteristics of AGRA PASS Supported Rice Varieties in Uganda

Variety	Year of Release	Characteristics	Licensed Seed Company	Type of License	Rating of Impact on Farmer Yields To-date
NARIC 1	2002	Highly susceptible to rice blast, late maturing (150 days), no data on yields, high tillering/branching ability	Open	Non-exclusive	4 (Being phased out)
NARIC 2	2002	Variety Release	Open	Non-exclusive	3 (Low adoption rate of 6%)
NARIC 3/NERICA 4	2002	1.2MT/acre, early maturity (120days), many tillers /branches, highly tolerant to rice blast disease, open distributorship, 70-80% of market share	Open	Non-exclusive	1 (70% adoption rate in upland and lowlands)
NERICA 1	2007	Variety Release	FICA	Exclusive	2 -(Availed in 2010, prioritised in Govt tender)
NERICA 10	2007	1.2MT/acre, early maturing, susceptible to rat attack, exclusive rights to supply	NASECO	Exclusive	2 -(Availed in 2010, prioritised in Govt

					tender)

Notes: (1) Impact rating scores 1=very good, 2=good, 3=some problems, 4=serious problems.
Source: (Own Source). Interviews with: (1) Jimmy Lamo, NARO-Namulonge; (2) CAII; and (3) FICA.

NGOs and UN agencies have purchased fresh stocks of certified seed for distribution to farmers at little or no cost suppressing local markets. The number of new seed varieties released by NARO per year has also been declining historically until the AGRA-PASS intervention, but remains low when compared to the demand for new varieties coming from over 20 seed companies currently operating in Uganda. Furthermore NARO has been producing and selling very little quantities of breeder's seed (1 kg or less) for new maize varieties to seed companies who are granted the licenses to multiply and distribute the varieties.

The **Bean** breeding programme in Uganda is focused on producing varieties that are disease resistant (especially root rot and anthracnose which can cause complete yield loss), yield, colour, bean shape and size, taste, and the period to maturity (growing season). AGRA-PASS has continued supporting breeders to acquire further education (PhD training) and at the same time continue with the bean breeding activities and accelerate the rate at which new varieties are introduced, which had declined from 12 new varieties released between 1994 and 1999 to only 6 new varieties released between 2000 and 2010.

AGRA-PASS-supported the release of NABE 12C, 13, 14, 15 and 16. NABE 15 and 16 were bred from the local landrace Kanyewa crossed with lines from CIAT (G233 and PI702) which are resistant to athracnose fungal disease (See Table 8). NABE 14 is being bred to make it more tolerant to low soil fertility environments. In addition, further support is enabling bean breeders to work on moisture tolerance so that the bean varieties can be grown in the rainy season. NARO-Namulonge is working on releasing five new varieties that are in their current breeding programme. These are NARBL220, NARBL60, NARBL252, NARBL110 and NARBL 122 -2. These are all resistant to athracnose and have various other attributes. Participation by farmers at an early stage in bean breeding, helps tailor varieties to local preferences.

Table 8: Major characteristics of selected AGRA-PASS supported Bean varieties in Uganda

Variety	Year of Release	Characteristics	Rating of Impact on Farmer Yields To-date
NABE 12C	2006	Climber, high yielding	3 (Stacking problem reported in Kamwenge district)
NABE 13	2006	Large seeded, red, tolerant to root rot disease and low soil fertility, not resistant to anthracnose, suitable for highlands maintains colour at altitude >1,500m	4 (Being phased out due to susceptibility to anthracnose, small quantities, 2 districts)
NABE 14	2006	Large seeded, red, tolerant to root rot disease, tolerant to anthracnose fungal disease (seed borne), more work being done to make it tolerant to low soil fertility environment, suitable for highlands, maintains colour at altitude >1,500m	3 (Limited adoption, small quantities, 4 districts, but has potential to achieve a rating of "2")
NABE 15	2010	Very early maturing (60 days), more resistant to anthracnose, has market class (sweet), bush type, 1800kg – 2000 kg/ha, edible when green	New. Not yet available to farmers – bulking in progress (Potential impact rating of "2" due to high yield)
NABE 16	2010	Very early maturing (65 days), red, more resistant to anthracnose, has market class (sweet), semi-climber growth type II, 2000 – 2500 kg/ha	New. Not yet available to farmers-bulking in progress (Potential impact rating of "1" due to high yield)

Notes: The most widely grown bean varieties are K132/NABE 4 released in 1994 and 1999, respectively. These have an impact rating of "1" very good. *Source*: (Own Source). Interview with Michael Ugen, NARO-Namulonge.

In recent years the process of releasing varieties has also been simplified, with two variety release meetings now being held every year. Breeders have to present 2 year on-farm data, on-station data, results of stability tests done, and DUS tests done for at least two seasons. Whilst the above analysis shows many opportunities that exist in bean breeding, the challenges facing these programmes are

many. Yet, in order to effectively address all/most concerns of farmers, breeders need to incorporate many improved genes to one background gene. Hence the usual mismatch between the duration of funding and that of the breeding programme. Breeders are in need of cold room facilities to safely store and maintain the germplasm which they collect locally and internationally and which once in a while they have to regenerate in field.

4.2 Production of Foundation Seed and Certified Seed by Seed Companies and NARIs

Kenya

Maize

Through a combination of exclusive and non-exclusive distributorship rights, KARI commercialises varieties through small and medium seed companies. The criteria used to classify the varieties and licensing however are not clear to seed companies with reports of a lack of transparency. The system of allocating varieties to seed companies has been changed to a tender system, but the seed companies complain that the bidding process and criteria for selection of companies who deserve to get exclusive distributorship rights for a specific variety are subjective. Seed companies believe that exclusive distributorship rights should be given to companies that have developed their own varieties, but those released by KARI should be subject to non-exclusive distributorship rights. Exclusivity tends to give the Kenya Seed Company a favoured position relative to other purely private sector entities, not only due to its close link with KARI and KEPHIS but also its larger capacity to compete for new varieties released by KARI. Without clear criteria and transparency, it was feared that opportunities for rent seeking behaviour would be widespread.

Seed companies that are bulking and distributing the KH500 series of maize varieties are employing four main methods to secure production of pre-basic and certified seeds. These are: (1) growing the crop on their own plots, (2) growing the crop on leased land, (3) contracting large scale out-growers, and (4) contracting small scale growers (mostly individuals who are organised into farmer groups). All the seed production activities are carried out under strict supervision of the breeder and agronomists appointed by the seed companies.

Varieties that are not under exclusive distributorship were accessed by seed companies through the breeder or through purchases from the companies that were first to receive the varieties. For example, FAIDA bought its initial stock of KH500-31A from Freshco. Producing an economic quantity of foundation seed took 2-3 seasons for most companies, after which they then looked for larger plots for production of certified seed irrigation and/or rain-fed conditions. An example of the growing success of the varieties is with Freshco, which has expanded acreage under certified seed production activities to 280-300 acres per year by 2011. Freshco allocates 2 acres to bulking of breeder's seed, 10 acres to production of foundation seed, and the remainder to production of certified seed.

Seed companies said the support from the maize breeder during the bulking of breeder's seed and production of foundation seed is very good. They attributed this to the keenness of the breeder to see new entrants into the seed industry and personally facilitate their entry. The main challenges reported to be encountered by seed companies in Kenya during the process of converting breeder's seed into certified seed included the following: (1) getting reputable farmers; (2) the high cost of establishing irrigation facilities; (3) high cost of capital; (4) inadequate supply of qualified and experienced seed production officers; and (5) the long queue on KEPHIS seed germination tests (due to the high number of seed companies and inadequate capacity within KEPHIS).

In 2009, out of the 8,311 hectares of maize seed inspected by KEPHIS, 185 hectares were rejected. For beans the corresponding areas were 583 hectares and 53 hectares, respectively. Supervision of out-growers has to be conducted by qualified agronomists, but is in short supply in Kenya. Seed companies are resorting to hiring agronomists from within KARI. This is draining the public system of experienced staff but the expertise is being retained in the wider seed industry.

The cost of establishing irrigation facilities is high in Kenya. This, coupled with high interest rates (18-20% per annum) for agricultural loans, slowed down the pace at which companies are investing in irrigation facilities. The advent of the ASIF is a welcome development as loan interest rates are much lower at 8%, but the time to get approval of the loan application is a constraint.

Cassava

KARI Mtwapa promotes the dissemination of varieties by identifying farmers in each of six target districts and training them in clean planting material production, value addition to the harvested cassava (e.g., preparation of cassava chips, flour, juice, etc) and entrepreneurship skills. KARI then selected individual entrepreneurs and farmer groups from these and provided initial stock of material for one acre in April 2009. A year later the first crop of planting materials produced by the entrepreneurs and farmer groups was sold to farmers. Yields were 50-70 MT per variety against the average of 28MT/ha achieved from old improved varieties and 10MT/ha for farmers' own local varieties.

Whilst other farmers are eager to adopt the new cassava varieties, the absence of a vibrant cassava market in the coastal areas is a setback to farmers that needs to be urgently addressed, especially in the wake of the important role maize could play in bio-fuel production and the importance of cassava as a substitute crop for maize in people's diets. Another challenge encountered is the disintegration of the groups, suggesting perhaps the need for more appropriate institutional arrangements for cassava clean material production.

Beans

Once bean varieties have been released KARI increase production to allow farmers to buy the seed from them (KARI) through the farmer groups or by direct transactions with KARI. For KK8 and KK15, KARI has worked with 200 farmer groups to produce and market certified bean seed. These are spread within Kisii, Kitale and Kakamega. All the districts within these counties are widely planting the two bean seed varieties, essentially accessing the seeds through the farmer groups. These farmer groups are informal because they are not registered with KEPHIS. They are otherwise strictly by law not allowed to produce improved seeds varieties since they are not registered with KEPHIS and the Seeds Traders Association of Kenya.

KARI issues the 200 farmer groups and, to some extent, CBOs, NGOs and church groups, certain quantities of improved seed in order for them to produce clean seed varieties through a closely monitored process. The approach was found not to be working well with large groups but smaller groups of about 50 members each made management and monitoring logistics more efficient and effective. The arrangement is that each member would receive 15kg of the improved seeds out of which KARI will recover 40kg on harvesting. The farmer could sell the rest of the harvested bean seeds to local farmers and recover her/his costs as well as a profit. The sale price at KARI is at 80/= per kg while farmers sell at 100/=.

Before farmers' groups could receive the improved seed varieties, they all have to undergo training on how to undertake on-farm production of clean bean seed. Therefore, the 200 farmers groups, consisting of about 50 members, are so well trained that they could even be sub-contracted by seed companies to produce even larger quantities of bean seed.

Tanzania

Cassava

Kizimbani Research Station has retained the responsibility to maintain foundation seed for PASS-supported cassava varieties such as Kizimbani, Mahonda, Kama and Machui. However, costs associated with this role appear not to be sustainable under the Research Station as land is restricted. Currently, the station has 7 hectares under the foundation seed which is very expensive to maintain

From these foundation seed plots, the Kizimbani Root and Tuber Program (KRTP) with support from AGRA-PASS have phased in 80 selected pilot farmers from target districts as trained multipliers who sell outputs directly to neighbouring farmers. The KRTP distributed cassava planting material to 7 400 farmers in Unguja, and 3 000 farmers in Pemba, a total of 10 400 farmers, significantly higher than the 6 000 farmers originally targeted.

Maize

Production of certified seed of UH615 and UH6303 was through an out-grower scheme. Highland Seed Growers Ltd has 15 out-growers, and the largest of these have 600 acres of land and the smallest 20 acres. The company has however suffered as a result of lack of experienced seed growers. Currently, Highland Seed Growers Ltd contract growers have limited capacity, achieving only 1-1.5 t/ha yields, which limits production levels. This situation appears to be a country-wide phenomenon. Potential contract seed growers for certified seed need high level crop production skills and a basic knowledge of certified seed, usage and management of inbred lines

Though certified seed production is lucrative for seed out-growers at TZS850/kg as opposed to TZS 300 for grain maize, several challenges were identified by out-growers that affect seed yields and profitability:

- Very high cost of agricultural inputs including fertilizers and pesticides, and out-growers and seed multipliers currently do not have access to subsidies nor loans, this limits production capacity and yield levels
- Additionally, besides availability of agrochemicals being erratic, efficacy of available generic pesticides on the market is low, as a result of inadequate quality control and monitoring by the Tropical Pesticide Research Institute (TPRI)
- Seed out-growers also complain of late inspections of seed crops by TOSCI officials, most likely due to financial limitations faced by the organization, which increases the risk of rejections.
- Out-growers have also experienced challenges with germination efficiency resulting in low stand densities, especially inherent in most hybrid male seed, and requires high levels of moisture and weed management to overcome the challenge. Training of out-growers is needed in agronomic techniques focusing on moisture, nutrient and weed management, as well as principles of seed production

The Tropical Pesticide Research Institute (TPRI) administers the Tropical Pesticide Research Institute Act of 1979 and its role is to regulate the production, importation, distribution, sale and use of pesticides in Tanzania. Accusations by both out-growers and agro-dealers is that TPRI is bureaucratic; it focuses on revenue flows from its high registration costs hence registers many applications including undeserving ones, and lacks vigilance on importation of efficacious agrochemicals.

Uganda

Maize

NARO has used exclusive distributorship licensing arrangements to ensure that the seed is traceable on the market. Breeders at NARO claimed that an open bid system is used for maize hybrids to transparently choose seed companies that were best suited to distribute the varieties in question. Exclusivity was meant to give the licensed company the incentive to invest in bulking and multiplication of the seed, as well as aggressively promoting the variety among farmers in a commercially viable manner. NARO tries to

avoid the free rider problem, whereby one company significantly invests in promoting one hybrid variety and another rides on the popularity of the variety, does not invest in promotion and is able to sell at lower costs than the company which promoted the variety. This decision was in recognition of the significant investment required in introducing demonstrations, running field days, and disseminating information about the new variety to farmers. If there is also a problem with the seed, this can easily be traced to the seed company that produced and distributed the seed.

While the benefits are clearly articulated, the disadvantages of exclusive licensing are also obvious. Exclusive licensing did not work very well for Longe 7H and 8H hybrid varieties. Harvest Farm stopped operating while having been given the exclusive license to bulk and multiply Longe 7H, and the passing on of the breeder who was helping the East African Seed Company to bulk breeder seed for Longe 8H negatively affected the bulking and distribution of these two maize varieties in Uganda. Given these developments, there is a strong view in the maize industry that non-exclusive may be more favourable for all AGRA-supported varieties. Companies should have been allowed to purchase breeder seed from NARO and then allowed to compete on the quality of certified seed made available onto the market. NARO is considering for the future to issue distributorship licenses to two companies per variety as opposed to one company. AGRA-PASS could contribute intellectual input into this policy discourse in Uganda to ensure new varieties are produced in sufficient quantities so as to achieve significant impact at the farm level.

Some of the new maize and rice varieties are still being bulked or have only recently reached farmers and supply bottlenecks are significant, and these range from the limited quantities of breeder's seed made available by NARO to farm level production constraints being faced by seed companies which include reliance on rain-fed farming, inadequate working capital, inadequate access to processing facilities and the limited capacity of the seed inspectorate services of government to provide seed inspection services in a timely manner. CAII with the license for Longe 11H is still bulking breeder's seed on its farms. Longe 11H has not yet been marketed as multiplication is still in progress.

FICA used its experience as an out-grower for Monsanto to bulk and produce certified seed. In addition to supplying the domestic market, FICA also successfully introduced Longe 6H, 2H and 4H in Malawi where the company competes favourably with other varieties. The Centre for Agricultural Inputs International (CAII) with the license for Longe 11H is still bulking breeder seed on its farms. CAII has access to a total of 600 acres, 230 of which are owned by its directors and the balance outsourced from other farmers through out-grower contracts. About 130 acres that it owns are in the Central Region while 100 acres are in the Eastern Region. All the production of foundation seed for Longe 11H which was carried out by CAII in 2010 was exclusively on their own farms. Longe 11H has not yet been marketed as multiplication is still in progress. For CAII the financial support from AGRA has contributed to the improvement in its viability from a break even position in 2009 to 50 million UGX in 2010. The company projects doubling its profit figure in 2011 without additional funds from AGRA.

The support from PASS has been instrumental in enabling seed companies to secure more land, train management, train out-growers in seed production and recruit technical staff capable of supervising seed production activities both on their own farms and on the plots of out-growers, and secure services of a qualified bookkeeper for management of the company finances. Key challenges encountered in bulking breeder seed and the production of certified seed include: (1) inadequate financing to purchase inputs, lease additional land, establish irrigation facilities and purchase produce from out-growers on time; (2) poor services from the seed regulatory authority; (3) unreliable quality of rainfall; and (4) the weak capacity of out-growers. Seed companies also reported challenges with getting sufficient breeder seed, especially for maize hybrids. Companies have invested in multiplying breeder seed which may not be their core business.

Companies awarded licenses to multiply and market maize and rice seed varieties supported by AGRA PASS bulked foundation seed on both their farms and through outgrowers, with the latter in general accounting for more than 50% of the area planted. FICA, for example, used its experience as an

outgrower for Monsanto to bulk and produce certified seed. In addition to supplying the domestic market, FICA also successfully introduced Longe 6H, 2H and 4H in Malawi where the company competes favourably with other varieties.

Rice

Multiplication and distribution of rice varieties are through two main channels: (1) through registered seed companies; and (2) through the NARO outstations. Like maize, the bulking of rice to produce foundation seed and multiplication to produce certified seed has been driven largely by demand which has been strengthened by government, FAO and NGO tenders.

AGRA supported NARO-ZARDI in the marginalised Western Nile region5 to support the adaptation, multiplication and distribution of open pollinated seed varieties of rice and beans. NARO-ZARDI also produces planting materials for cassava and groundnut seed. ZARDI conducts adaptation trials, production of foundation seed, then raising awareness among farmers, transferring the technology, supporting the farmers to produce Quality Declared Seed, and then linking the farmers to markets. With breeder seed of Nerica 1 and 4 and NABE 4 and K132 bean seed, groundnuts (Serenut 3 and 4) and new varieties of cassava (TME 14 and 2004, and 00067), ZARDI worked 43 covering 3 districts of Adjumani, Nebbi and Yumbe. These districts are remote and not served by seed companies. However, the Uganda Seed Traders Association is penalising them for the production of quality declared seed without a license. Another challenge encountered by this model is the poor crop husbandry practices of farmers. Farmers view these methods as introducing additional costs which make seed production less profitable. In addition, farmers also find it difficult to sell their produce through agro-dealers who prefer to sell products duly certified and have a seal from the seed regulatory authority. NARO-ZARDI is also linking farmer groups producing quality declared seed to the CAII, a farmer-owned seed company that is producing certified seed for both the local and international (mainly South Sudan) markets.

Grow More Seeds (GMS) received 20 kg of NERICA 4 breeder seed, half of which the company retained whilst the other half was planted under an out-grower contract arrangement to produce 400 kg of foundation seed in 2009. GMS also purchased foundation seed from the Uganda Seed Traders Association and this seed was planted using an out-grower contract arrangement. From this foundation seed, GMS produced 8 tonnes of certified seed which was sold to the National Agricultural Advisory Service (NAADS). GMS had won a contract to supply 10,000 MT of seed rice to two sub-counties in Hoima district in August 2009.

Beans

Commercial bean seed production is an unattractive area of investment by many seed companies because farmers rely on the informal market. According to breeders interviewed, the private companies are only guaranteed getting viable turnover in the first season of introducing the improved bean variety, or when NGOs and UN agencies float tenders for the purchase of certified seed for humanitarian interventions. As a result, breeders promote bean seed production mostly through farmer groups. The channels for dissemination of improved varieties of beans are therefore limited in this regard.

Few companies that approach NARO for breeder seed for beans, often do so only once, yet NARO encourages them to come every year to get fresh supplies of breeder seed to maintain varietal purity. While breeders ideally would like to raise the price at which they sell breeder seed to twice the price for commercial seed, the lack of interest by the private sector suggests very poor cost recovery. Effective demand for improved bean seed is also limited by low income levels of farmers; hence NARO has a policy to hand out foundation seed for beans free to farmer groups who produce Quality Declared Seed. CAII started as a farmer group in 2007 with 15 members, and was registered in 2008 as a seed company.

Most of the seed multiplication is being done by NARO by out-growers. Multiplication of bean seed is a very labour intensive exercise, spacing is also much larger and this reduces yields. When promoting multiplication through farmer groups, the main challenge is with the establishment of well functioning groups and the cost of following up the groups to ensure that they are doing the right things at every

stage of commercial seed production. Farmers are often reluctant to remove off-types for fear of compromising their yields. Extension services are weak, often demand-driven and enterprise based. Breeders have to work with farmers for a long time to change their mindsets, beliefs, attitudes, and behaviour/practices. They need constant awareness promotion, for example, on the difference between producing for seed and for grain, as they often get tempted to use produce meant for commercial seed as food. Only after many years of strong engagement do breeders achieve positive results.

4.3 Marketing and Distribution of Certified/ Quality-declared Seed

Kenya

The maize seed industry of Kenya is dominated by the Kenya Seed Company, a public company, which has enjoyed this pole position since the pre-1996 era of heavy state monopoly and control over the industry. Though facing growing competition, the Kenya Seed Company still enjoys more than 75% of the market share for seed maize. The met demand for maize seed in Kenya was estimated at 44,015MT in 2005 with that for beans standing at 62,069MT. Sixty-two percent of the seed maize demand was met by the formal seed market whilst the remainder (38%) was met from informal channels. For beans the proportions were 2% and 98%, respectively. For cassava, the national demand for cassava is not well known, but until recently when the KARI seed units started implementing a national cassava production promotion programme that is funded through the Arid Lands Resource Management Programme (ALRMP), almost all of the demand for cassava planting materials was met through informal channels (farmer to farmer purchases or sharing). The KARI seed units are breeding, multiplying and distributing disease resistant cassava varieties to farmers through the Ministry of Agriculture, the ALRMP, NGOs, farmer groups, and entrepreneurs. Current annual supply of cassava planting materials through these formal channels is estimated at 500,000 cuttings through Ministry of Agriculture, 100,000 cuttings through ALRMP, 300,000 cuttings for NGOs, 510,000 cuttings through entrepreneurs and farmer groups (combined)[5].

The low market share of the formal channel for the open pollinated beans shows the low investment by the seed industry into formal commercial seed production for beans. Inadequate formal seed supply systems dampen or limit diffusion of new bean crop varieties.

The significant role played by the informal market for seed stems from the high distances to market travelled by farmers. On average smallholder farmers in Kenya travel 7km to the nearest source of fertilizer and hybrid maize, with the distances increasing up to 25.5 km and 1.7km respectively along the coastal lands and lowest in the Western Highlands (3.2 km for fertilizer and 1.5 km for maize).

Tanzania

The demand for maize grain exists both in the Southern Highlands, and in the neighbouring countries of Malawi and Zambia. Access to loans also affects seed sales. Farmers within the Southern Highlands access group loans through the District Agricultural Development Fund. Observations are that the Warehouse System is still in its nascent stages, and is well established for coffee growers.

Agro-dealers also currently process seed vouchers from Government subsidies, realizing higher profits with vouchers as a result of increased customer purchases. However agro-dealers experience delays in voucher redemptions, which negatively affect restocking of inputs in agro-dealer shops. The views of extension personnel were that the seed voucher system operated by Government was riddled with corruption at all levels (including secretariat, agro-dealer levels) making seed accessible to smallholder farmers, particularly the poor ones. Most poor farmers fail to raise the 50% contribution.

Problems cited at agro-dealer level include:

[5] These statistics were provided to the consultant by Dr Benjamin Muli, Agronomist, KARI Mtwapa, January 2011.

- inadequate supplies across all product
- data to inform stocking levels was often inadequate, which often led to overstocking in some lines and low stock levels in items desired by farmers
- agro-dealers were often capital-bound, which equally affected stocking levels
- lack of credit, and excessively high interest rates. Supply of seed by some seed companies, where payments to suppliers are only made after sales are concluded, partially counters problems of credit
- agro-dealers were also faced with an extensive array of trade names for products with the same active ingredient, which often confused farmers. TPRI was being requested to restrict the range of products with the same active ingredients but bearing different trade.
- labels on some products were often misleading and sometimes had wrong instructions
- seed adulteration with grain by some agro-dealers was also identified as a serious problem, and the regulatory system had completely failed to address the issue. In some instances original packaging was photocopied and packed with fake seed.

Promotional efforts for seed have taken various forms including demonstration plots and the farmer field school approach in target areas around the Southern Highlands

Agro-dealers mentioned that large packs often overstay on the shelves, which to them may explain problems of poor germination experienced by some farmers.

Evidence provided indicates that some agro-dealers bulk break, not just seed but also agrochemicals including fertilizers, exposing these products to adulteration. Some of the requirements for small seed purchases are for gap filling stands.

Uganda

Maize

Hybrids Longe 6H, 7H, 8H, 9H, 10H and 11H were mainly distributed to farmers through exclusive licensing of seed companies. These companies have been disseminating the varieties to farmers using a combination of strategies, the main ones being: (1) responding to Government, UN and NGO tenders for seed procurement and distribution; (2) direct sales to farmers; and (3) selling seed through agro-input dealers (wholesalers and retailers). All seed companies advertise their products using demonstration plots, unique packaging, and direct extension service provision through their agronomists.

The experience of seed companies in Uganda in relation to bulking and distributing AGRA-PASS-supported varieties, shows that the capacity of the seed company chosen to distribute a particular variety and the demand for the variety through input subsidy programmes had a significant bearing on whether the variety was bulked quickly and reached the market sooner or later, and whether it did so in small or large quantities. Longe 4 and 5 were reported to have been very popular since they are open pollinated varieties and had a ready market through NGO, UN and government input subsidy programmes, further promoting the multiplication and distribution of these varieties. AGRA supported varieties need this type of support to expand distribution and their adoption at farm level. In 2010, NERICA 1 and NERICA 10 and NERICA 4 were the preferred varieties under the World Bank funded agricultural input procurement and distribution programme through the National Agricultural Advisory Services which tendered for 850 MT of rice for the second season. FAO's rice promotion programme has also been a significant vehicle by which new varieties have been reaching farmers. NGOs have been active in Uganda distributing rice seed in areas affected by natural disasters.

AGRA-supported rice and bean varieties clearly need these types of complementary support to expand distribution and adoption of new technologies at farm level. Hence the growing significance of social protection and agricultural development programmes presents an opportunity that AGRA-PASS should increasingly take advantage of in promoting rapid adoption of new improved varieties. In each targeted country, it is imperative that AGRA-PASS keeps track of policy discussions on social protection, especially,

those related to agricultural recovery and input subsidies to ensure that programme design is adequately informed by new technologies that are being released from research activities.

All seed companies are investing substantial resources in advertising their products using a combination of strategies (demonstration plots, unique packaging, and direct extension service provision through their agronomists). Most smallholder farmers prefer to purchase seed in small seed packs (1 kg or less) since they have less that 1 acre plots and the use of small seed packs is now common among seed companies. FICA, however, will only start selling seed in 1kg packs in 2011. Its smallest pack size is 2 kg. CAII sells most of its seed in small packs (1kg -5kg). Most seed companies also find selling seed in small packs expensive and adding to the cost of seed. However, farmers see smaller seed packs more convenient and also reducing losses as they only purchase what they need and avoid possible loss that could arise from inter-seasonal storage of unused seed.

Rice

AGRA-PASS supported varieties reached farmers through (1) licensed seed companies; (2) farmer-to-farmer sales; (3) government handouts; and (4) NGO handouts. The Government seed distribution programme, implemented through NAADS, has been issuing large donor funded tenders (up to 850MT of rice seed per year). FAO's rice promotion programme has also been a significant vehicle by which new varieties have been reaching farmers. NGOs have been active in Uganda distributing seed rice in areas affected by natural disasters.

Beans

Distribution of improved bean varieties is mainly done through farmer groups who are given free foundation seed by NARO to produce and market Quality Declared Seed. Plans are under way to link these farmer groups to CAII, a registered company also owned by a group of farmers to facilitate sales through the established network of agro-input dealers.

4.4 Traceability and quality assurance of seed

Kenya

Seed maize is most stringently controlled by KEPHIS and it is estimated that only 1% of seed sold in Kenya as certified seed is fake seed. KEPHIS has vigilant systems to detect and bring to book the perpetrators.

- Labels used on packaging materials are distinct (distinctive bar codes), of good quality, not easy to forge and issued by KEPHIS.
- Each registered retailer has an ID assigned to them by KEPHIS.
- KEPHIS runs an SMS based customer protection programme (Zain and Safaricom) whereby they encourage the farmers to ask the seed seller for their KEPHIS ID No., Verify the seller by SMS and receive confirmation that they have a license.
- KEPHIS visits stockists regularly.

Supporting this SMS programme is a ***Buying TIPs* facility** provided to the farmers**.** This is a seed tracking farmer awareness programme **to enhance seed buying skills of farmers and their ability to take recourse in the event of dissatisfaction with the seed products.**

The trading of fake seed maize is, however, believed to be most rampant at the agro-vet/retailer level but, overall, the magnitude of contaminated seed or ordinary grain falsely labelled "certified seed" is minimal, especially when compared to the experience in other countries (e.g. Uganda and Tanzania where the practice is rampant and continues unabated due to the extremely weak capacity for enforcement of seed laws). In Kenya, it is expected that the new Seed Act which was being developed at the time of the survey, will be more stringent and will enforce a Kenyan Shilling 2 million fine to discourage the trading of bogus seed on the Kenyan market.

The system for enforcing traceability of **bean seed** is the same as for maize but less strictly enforced for beans given the use of unregistered farmer groups to multiply and distribute the bean varieties.

Cassava is not included under Schedule II crops and therefore remains not subject to stringent traceability conditions. Clean planting material production is being promoted through farmer groups and individual entrepreneurs who do not have to be registered as yet. However, KARI seed units supervise production on-farm, train farmers and sensitise them on the best agronomic practices for production of clean cassava planting material.

Tanzania

Certified seed grade **maize** is marked, packed and labelled in accordance with the existing seed laws. Classes of seed exempted are Quality Declared Seed (QDS), which the Tanzanian Seed System recognizes. **The major challenge identified and discussed earlier in the report is the irregular and late field inspections by TOSCI for certified seed, sometimes leading to seed rejections. Farmers indicated that when problems such as poor germination occur, redress does not occur and agro-dealers refuse to refund.**

The **cassava** project under Kizimbani Research Station Root and Tuber Program has maintained monitoring and supervision of the process of multiplication at all levels. However, sustainability beyond project life is not guaranteed, as agents such as extension personnel, are not involved in this process.

Uganda

On paper Uganda has a seed regulatory framework (the Seeds and Plant Act of 2005) which is aligned to international best practice, but its implementation is severely hampered by shortage of seed inspectors within the government system. The situation weakens supervision of seed production and enforcement of regulations on trading of fake seed. For this reason, the sale of fake seed on the Ugandan market is reported to be very high at around 40%. The presence of fake seed on the market is reducing farmers' confidence in the seed supply chain and negatively affecting adoption of improved varieties of seed. The Government and the World Bank are working on resolving this issue by making a provision within a WB funded agricultural development programme to hire qualified seed inspectors on contract. It is critical that AGRA-PASS keeps track of these developments and where possible, complements on-going government efforts to strengthen the seed regulatory framework for Uganda.

The yield advantage of most AGRA-PASS varieties compared to local varieties is visible, but when compared to other improved varieties on the market, the picture is mixed, again emphasising the point that AGRA-PASS supported varieties should "hit the market" quickly, in sufficient quantities and with a reliable supply system so that the varieties fully exploit the rather "short window period" when no other comparable improved varieties outcompete them.

Among AGRA-PASS supported varieties, one of the top performers irrespective of the competing varieties is NERICA 4 for rice. This was promoted as upland rice but later adopted in the lowlands as well. The new varieties (NERICA 1 and NERICA 10), which have built on the strengths of NERICA 4, will be expected to now replace NERICA 4 until it is regenerated and comes back with additional advantages such as even higher yield, aroma and disease and drought tolerance. However, landraces for rice appear to continue to control the largest market share maybe reflecting the impact of cost of seed on adoption

In the case of maize, the most promising to-date has been Longe 6H (although farmers surveyed districts still preferred Longe 5 and Longe 4 which have been around for longer time and may have better supply), while the most recently released varieties (Longe 9H, 10H and 11H) are still new and not widely adopted by farmers as some (Longe 11H) are in fact still being bulked.

In the case of beans, NABE 14 is most widely grown among the AGRA PASS varieties but lags behind K132.

5. Findings on Smallholder Adoption and Impact on Farmer Yields

This section summarises key findings in relation to the adoption of improved seed varieties by smallholder farmers, and the subsequent impact on yields. The first part of this section summarises the extent of uptake, looking at where farmers source their seeds, how they receive information about different varieties and the choices they make – including preferences for different types of seed packaging, and the accessibility for women farmers. The section then goes on to consider other inputs used when growing improved varieties, particularly artificial fertilisers, as well as access to rural credit. The section ends with the performance of improved seed varieties, both in terms of farmer perceptions and yields.

5.1 Adoption of improved seed varieties

This section summarises the adoption of improved seed varieties, with a particular focus on those produced with PASS support. See Table 9 below.

Table 9: PASS-supported Improved Varieties for Maize, Beans and Cassava in Kenya, Tanzania and Uganda.

Locations in Kenya	Crop	Variety
Kiambu, Githunguri, Ol-Rongai, Subukia, Mangu, Marigat, Sotik-Bomet, Mulot, Nyamira, Nakuru, Kirinyaga, Kimilili, **Nyeri**, Mukurweni, Karatina, Nyandarua, **Bungoma**, Mulot, Bomet, Chebunyu, Kangundo, Machakos, TransMara, Makueni	Maize	KH500 Series KH500-21A, KH500-22A, KH500-31A, KH500-34A, KH500-33A, KH500-34A, KH500-22A KH500-43A KH500-46A KH500-44A
Bungoma, Mumias, Vihiga	Beans	KK8, KK071, KK072, KK015
Coastal Kenya - Msambweni district, Kwale, Kaloleni, Kilifi, **Malindi** and Lamu	Cassava	Shibe, Tanjirika, Karembo, Nzalauka
Locations in Tanzania	**Crop**	**Variety**
Njombe**, Mbeya,** Iringa	Maize	uh615, uh5350, uh6303, uh5210
locations in Uganda	**crop**	**variety**
Masaka, Sironko, Kapchorwa, **Mubende**, Kabale, Kisoro, Mbarara, **Kamwenge,** Wakiso, Gombe, Jinja, Kamuli	Beans	nabe12c, nabe13, nabe14, nabe15, nabe16
Masindi, Masaka, **Mubende**, Igembe, Mbale, Mukono, Lira, Gulu, Amuru	Maize	longe 6h, 7h, 8h, 9h, 10h, 11h, yara 42, yara 41
Kasese, Hoima, Masindi, Luwero, **Mubende,** Mukono**, Iganga** and Bugiri, Kamuli, Arua Nebbi, Adjumani	Rice	nerica 4, nerica 1, nerica 10 naric 1 and naric 2

Note: The highlighted location was sampled in the household survey.

In Kenya, a high proportion of farmers use improved varieties of maize and bean seeds. In Nyeri, up to 78.4% of the farmers interviewed reported to have planted improved variety of maize seed. The other

farmers planted local maize seeds (6.9%), recycled but from improved seed (2.9%), purchased a mixture of local/ improved (2%), and 9.8% of the farmers did not indicate the type of maize seed they used. For the other common crops, potatoes and beans seeds were essentially of local varieties while vegetable farming, which was run mainly on a commercial basis, was with seeds of improved varieties. In Bungoma, The proportion of maize farmers using improved maize seed varieties accounted for 72.5% while those using improved bean varieties was 52.9%.

In Nyeri most farmers used PASS-supported maize varieties of KH500-31A (59.2%) of Frescho, and KH500-22A of Olerai Farm (32.4%). To a lesser extent other improved varieties were used, including KH513 (2.8%), KH614 (1.4%) and KA6213 (4.2%). Since 2008, the use of improved maize seed has been fluctuating to some extent within the season, with just above half of the farmers reporting to plant the seeds. By 2010, the number of farmers using improved maize seed increased, coinciding with the introduction of PASS seeds (KH500-21A and 31A). One of the reasons for this was the intervention by Government in 2010 through seed relief, following a drought spell in 2009 that prevailed in the area. The seed relief package included KH500-31A, as well as PH4, DK8031 and KH500-513. In Bungoma, the PASS-supported KK8 and KK015 bean varieties were released by KARI in 2008 through Rockefeller Foundation support. These are the most commonly used seeds by farmers. One of the contributory factors to uptake in Bungoma is that the utilization of the improved seed varieties and in particular of beans and maize is not new to the region – particularly with the close proximity of Kakamega KARI. This history of innovative practice provides a prerequisite upon which adoptability of improved varieties (including PASS-supported ones) stand a good chance of adoption. This was demonstrated by the apparent immediate uptake of the KK071 PASS-improved variety even before its official registration early in 2010. In addition, the presence of community / faith based organizations has played a key role in terms of access of information and of the inputs (seeds and fertilizer) – particularly IcFEM in the Bungoma area.

In contrast, cassava cuttings in Malindi were mainly locally sourced and only 10.9% of the farmers bought improved *Karembo* variety cuttings. The low adoption of the PASS-supported varieties of this crop is attributable mainly to the approach taken by KARI for bulking and distribution. The evidence gathered by this survey on the introduction of the new cassava variety is that the cuttings delivered from the KARI Mtwapa Sub-Station started sometime in 2009/ 2010 when the research institution gave a Kakuyuni village farmers group some *Karembo* cuttings for bulking purposes. The group was provided with enough cuttings to plant one acre of land in March 2009. Consequently, the 14 individual members of the group received cuttings in 2010 sufficient to plant ¼ acre each on their individual plots. In 2010, KARI identified two focal farmers of whom each was given the *Tajirika* variety and the other *Shibe* cuttings, enough to plant an acre. The bulking for the two varieties was ongoing by the time of this survey, thus actual distribution has yet to commence. Apparently, the *Karembo* variety has been given prominence and is fairly well known to the farmers as compared to the *Tajirika* and *Shibe* varieties, which were less intensively introduced (by KARI) to the farmers.

In Tanzania, key benefits are associated with PASS-supported varieties, both cassava and maize. The maize varieties UH615 and UH6303 being distributed among farmers, are semi-flint. From the focus group discussions held with farmers, besides the varieties being tolerant to drought and giving high yields, being semi flint they: (i) have lower husk levels which means they provide higher flour levels using local processing techniques; and, (ii) the prepared taste levels are much higher than that of comparable dent varieties, and compares well with local recycled varieties, but with the added advantage of higher yields.

In general, the value addition of cassava in Zanzibar is very limited and currently 95% of production is consumed in fresh form – lasting three days in optimum conditions, with tubers stored underground only for a maximum 2 months after maturity. Among the four varieties released, Machui is sweet, easier to peel, hence more desirable in the fresh market. Conversely, Kizimbani the highest yielder has acceptable taste, unless harvested early, when it tends to be bitter to the taste; also Kama is generally bitter. The introduction of improved cassava varieties has also ushered in commercialization of livestock, cow and chicken manure used in fertilizing cassava.

Across the three districts surveyed in Uganda, Longe 5 enjoyed the largest market share of maize seeds (at 20%). Of the PASS-supported varieties, Longe 6H had the largest market share, being planted 6% of farmers. The other varieties had lower market shares. Longe 7H for instance had been planted by 3% of the sampled farmers whilst Longe 10H was reported by less than 0.5% of the farmers. Farmers' preferences were driven by yield advantage, sweetness of taste (for marketing as green maize), density of endosperm to improve viability, whiteness of the grain to improve personal appeal, and resistance to diseases and pests. Longe 5 for example, an open pollinated variety that has a very sweet taste was found to be the most widely adopted in the three districts surveyed. Farmers also considered availability of the seed, the days to maturity and suitability of the variety to their agro-ecological region. Other factors determining adoption rates for maize appeared to be the length of time the variety has been on the market, as older varieties had benefitted from greater investment in product promotional activities.

In the three surveyed districts in Uganda, Iganga emerged as the major rice growing district with 17% of sampled farmers having cultivate rice in the previous season, while in Kamwenge and Mubende only 6% and 3% of farmers had planted rice. **Local aromatic varieties had been most widely adopted (commanded 34% of market share), emphasizing the importance of the landraces in rice production.** NERICA 3 came second together with Superica 1, and NERICA 1 third. The market shares for the NERICA series were less than expected, but the trend was being addressed through deliberate efforts by the government and humanitarian organisations to promote the adoption of these superior varieties through input distribution programmes.

In terms of beans, Mubende came out as the main bean growing district with 84% of the farmers reporting to have grown beans in the previous season. In the other two districts, Iganga and Kamwenge, the proportions of bean cultivators were 34% and 30%, respectively. The household data also shows that **K132, a variety that has been on the market for the longest period, still enjoyed the largest market share as it was grown by 72% of bean cultivators in the three districts.** NABE 14 came second at 17% and K131 third at 5%. KK8 and NABE 12C were at 1% each. For beans the main determinants of farmer preferences were found to be the colour and size of the bean in relation to local market preferences, overall yield potential, pest and disease resistance, the extent to which the variety maintains freshness after cooking, and the taste (sweetness). The days to maturity are also an important consideration, so is local market availability of the seed and cost.

For all crops (maize, bean and rice), the decision to grow or not was heavily influenced by not just the above variety specific factors but also the general overall cost of growing the varieties and the price they would receive on the markets were also equally important overarching factors.

5.2 Information sources and farmer choices

5.2.1 How farmers get information on improved varieties

In Kenya, farmers mostly obtain information about improved varieties from other farmers and through community meetings, as well as family and friends through their day-to-day interactions. In Malindi, 57.8% of the cassava and 31.4% of the maize farmers reported to have obtained information on improved varieties of the crop seeds from various sources, though mainly from amongst themselves and through their normal interactions (either with family/ friends or other farmers). This was similar in Nyeri, with 78.8% of the households interviewed confirming to have received the information from other farmers, family and neighbours or from community meetings. Other fairly important sources of information are extension workers, agriculture input dealers from whom they buy, and a wide array of other players.

Only in Bungoma is the situation different, where the IcFEM Faith Based Organisation (FBO) has been working with, and supporting, groups of farmers on improved beans varieties that have been raised by KARI. IcFEM conveyed the information about the bean seeds to slightly more than half of the total

farmers sampled. The second important source of information was KARI itself as it directly works with farmer groups for multiplication of seeds.

Table 10: Information sources by location and country (number of households)

	Kenya					Tanzania		Uganda		
	Malindi (cassava)	Malindi (maize)	Nyeri	Bungoma (beans)	Bungoma (maize)	Mbeya	Unguja	Iganga	Kamwenge	Mubende
Farmers	12	9	27	7	39	11	52	80	63	126
Friends or Family	12	4	11	2	3	15	15	8	9	33
Community meetings	13	3	41	1	1	5	12	-	-	-
Faith Based Organisation	-	-	3	46	2	-	-	-	-	-
Extension workers	12	9	8	5	5	29	5	63	11	33
Agricultural input dealer	-	5	5	1	4	10	10	24	6	13
Research institute/ University	4	1	-	19	1	2	9	-	-	-
Multiple sources*	-	-	-	-	-	36	36	-	-	-
Others	6	1	6	6	1	7	9	-	-	-
Total (households)	**59**	**32**	101	**89**	**56**	**115**	**148**	**175**	**89**	**205**

Sources: Kenya report (pages 34, 45 and 57); Tanzania report (page 23) and Uganda report (page 27).

In Tanzania (Mbeya Southern Highlands), the major source of information on availability of alternative improved crop varieties is the extension worker 25 percent of the time. Information from farmers, neighbours and family when combined are however of almost equal importance (24 percent). The agro-dealer is ranked third as an important source of information contributing close to 10 percent as an information source. **In Unguja, Zanzibar, where the focus is on cassava seed, the role of the extension worker is not as prominent. Rather, it is the smallholder farming community and family members who are the major source of information** (45 percent when combined) regarding availability of new varieties. It is notable however that research has a more visible role in Zanzibar (6 percent) than on mainland Tanzania, which may be explained by Zanzibar's smaller geographical area.

I**n Uganda, about 66 percent of the 405 farmers surveyed reported that farmer-to-farmer information dissemination was the most common source of information on improved varieties**, followed by extension worker (26 percent), family or friends (12 percent) and agro-dealers (11 percent).

In summary information about new varieties is mostly spread through farmer-to-farmer interactions (and through family, friends and community meetings), and where there has been more of an influence, this has been where FBOs or research institutes have worked *more directly* with farmer groups. The most notable example of this being IcFEM and KARI in Bungoma (Kenya). The role of extension workers in providing information on improved varieties is generally far less significant, though in some locations it is more important (such as Inganga, Uganda). And finally, this is an assessment of those that have received information about improved varieties. Indeed, a significant minority of households have not heard such information. So for example, in Kenya (Malindi), some 57.8 percent of households said that they had received information on improved varieties of cassava; leaving over forty percent of the population sample claiming not to have heard about these varieties.

5.2.2 The role of demonstration plots and trials

In Kenya, somewhere between 15 and 57 percent of farmers have witnessed demonstration plots. In Malindi, cassava demonstrations were witnessed by 46.9%, followed by maize at 40.6%. Others included beans, groundnuts, sorghum, and mangoes. The figures are slightly higher in Bungoma, with more than half (56.9%) of the farmers confirmed to have witnessed demonstration farms or farm trials conducted by KARI, MoA, The Good Wood Projects, Moi University, Wise Group, One Acre Fund and IcFEM. Whereas in contrast, farming demonstrations were not common in Nyeri, with only 15.7% of the farmers confirmed

to have witnessed one in the locality. The demonstrations mentioned were on maize, beans, potatoes and onion farming, and conducted by the Ministry of Agriculture (MoA) and KARI.

The witnessing of demonstrations increased the uptake of improved varieties considerably, from 25% to over 84%. In Malindi, 25.7% of cassava farmers who had witnessed the demonstration plots have already adopted the improved varieties, with a further 71.4% confirming their intent to do so in the near future. For maize, 57.6% of farmers who had witnessed the demonstrations testified to having adopted the varieties, while 30.3% reaffirmed their willingness to use them in the near future. The figures are however much higher in Bungoma, where 84.9% of farmers who had witnessed the maize demonstrations stated that they already procured the variety, while a further 13.2% said they would do so in the near future.

In Tanzania, farm demonstration plots were less instrumental in influencing farmers' decisions to adopt improved varieties of maize, sorghum, cassava, and cowpea in Mbeya, Southern Highlands and South Unguja, Zanzibar. About 46% of farmers who used improved varieties did not witness demonstration plots in Mbeya, while in South Unguja at least 84% had not witnessed demonstration plots.

In summary, up to around 4 or 5 farmers in 10 witnessed demonstration plots, though it varies a lot by location. Importantly though, even when farmers do witness demonstrations, the eventual uptake of improved varieties can vary greatly; from the high of 84.9% adoption rates for maize varieties in Bungoma to lows of 25.7% for cassava in Malindi, Kenya. The higher rates in Bungoma may again be attributable to the activities of IcFEM and KARI, who worked much more directly with farmer groups.

5.2.3 Farmer preferences for seed packs

Small seed packs are much preferred amongst some smallholder farmers, particularly those with less than 2 acres. Small packs deliver tangible benefits to farmers, including: flexibility to purchase the desired quantity, affordability, easier storage for the next season, reduction losses, and because they help minimize the packaging of fake seed. For instance in Nyeri, farmers unanimously preferred the 2 kg packaging format primarily due to its affordability (i.e. farmers can afford the 2kg pack more easily) and its convenience for a small-scale producer. This stand point was regardless of the variety of the maize seed. It is also important to bear in mind that, "It is not just the pack size but the type of packaging material is important to protect seed from direct sunlight" (FRESHCO).

Table 11: Percentage of certified seed sold in seed pack size

	Freshco	Dryland	Leldet	Faida	OLERAI	East Africa Seed
25g	0%	0%	20%	0%	100%	0%
100g	0%	0%		0%		0%
1 kg	0%	20%		0%		20%
2 kg	95%	80%	80%	60%		60%
5 kg	5%	0%	0%	30%	0%	0%
10 kg	0%	0%	0%	10%	0%	20%
>10 kg	0%	0%	0%	0%	0%	0%
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Source: Seed company records.

Although seed sales figures show a clear preference towards the 2kg packs, in other areas, farmers opt for buying seed loose using for example the 2kg measuring tin. This method allows the farmers to purchase as much as can be afforded. So for instance in Malindi (Kenya), most of the farmers were buying the improved maize seeds in measuring cans so as to buy as much as they could afford (80%), and because the packaging can easily get destroyed (6.7%). Only 13.3% of the farmers preferred the 2kg packaging highlighting its advantages in terms of any remaining seeds being easily preserved. In

Bungoma, 70.9% opted for kg as the measuring unit while the rest preferred the use of a measuring tin of 2kg. The main reasons cited included: (i) farmer can buy the amount of seeds he or she can afford; and, (ii) the paper packet is easily damaged. Again, amongst those who preferred 2 kg packet this was because the remaining seeds could be easily preserved after use. For beans, 84.1% preferred kg as the unit of measurement, the main reason being affordability. A measuring tin was also opted for again for affordability, while those who preferred bigger units, like 10kg and 25kg bags, was because it was the amount they required for planting on their plot of land. For instance, 25kg will be sufficient to plant on an acre plot. Similarly, in Tanzania, about 26% of farmers preferred improved seed to be weighed and presented in kilograms. On the other hand the majority of cassava farmers (13%) preferred improved seeds (cuttings) to be packed in 50kg bags followed by 25kg weight packages.

5.2.4 Access by women farmers to improved seeds

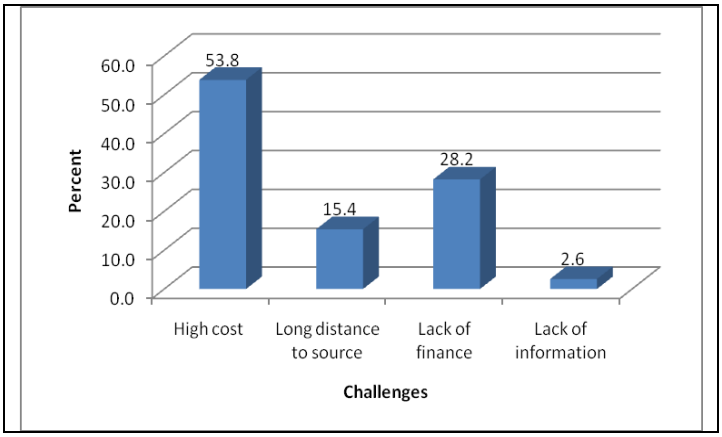
In Kenya, no specific gender disparities were observed, and indeed there were some good instances of activities to improve access by women. In Malindi, the adoption of improved varieties by *both* men and women in the area was generally low, hence few observable gender disparities. In the Bungoma area, the situation was different with KARI and IcFEM providing direct access to improved seed varieties and, in particular, the bean seeds. Both agencies used a group approach as the entry point and the majority of members in these farmers' groups were women – with improved varieties of maize and bean seeds and fertilizers being given on credit, thus helping to benefit more people. Similarly in Nyeri, Freshco introduced KH500-22A directly to farmer groups using two women village leaders as the entry point. Consequently, more women bought the seeds than men, although sustainability was not ensured as access to the seed variety ended once the stock brought by the bulking company finished.

In Tanzania, women's access to improved seeds was markedly lower than that for men (with 20 percent of women using improved varieties as opposed to 80 percent of men). This situation is said to be influenced by the position of females within the household, with the male household head typically responsible for farming decisions. **Similarly in Uganda, access by women to improved varieties (as supplied through the commercial market) was found to be generally less favourable than that for men**. Increasingly, this disparity was being addressed through humanitarian assistance (FAO and NGOs) and government social protection programmes. These programmes distributed subsidized inputs to farmers, with the poor and marginalized women farmers being reported as the primary target group. These programmes however tended to distribute small quantities of "starter packs" hardly intended for the women producers to graduate into net surplus producers.

5.3 Associated farming inputs

5.3.1 Fertiliser application for improved varieties

Figure 1:. The challenges of fertilizer use in Kenya



In Kenya, there are considerable differences in the application of fertiliser between the locations sampled, but no associated increase with the adoption of new improved varieties. In Malindi, the application of fertilizer in the sample area was virtually non-existent, with only five households reported to have been applying it over the past year (DAP and CAN 26:0:0 applied by 2 households on cassava and 3 households on maize). This was primarily due to high cost and poor accessibility – with farmers' rating of the cost of fertilizer ranging between "expensive" to "very expensive". While the ability of the local dealer to meet farmers' needs for fertilizer was rated as high (at 72%), the distance was seen as prohibitive. The average distance from dealer store ranges from 19 to 24 km which exacerbates the purchase cost as transport was inevitably required.

In Nyeri, slightly less than a quarter (24.5%) of the farmers sampled applied fertilizer on maize, and these farmers mainly applied DAP. The utilization of fertilizer on other crops was found to be low. Within the sample, 52% of the farmers had no problem with accessing the fertilizer while those who were constrained point out cost and a lack of finance as the main limitations. Farmers rated the cost of fertilizer as "expensive" (54.1%) to "very expensive" (44.6%), and only 1.4% of farmers viewed the cost as being "fair". At 4.2 km away on average, the distance to the closest agriculture input dealer was also a factor.

In Bungoma, fertilizer utilization in the 2010 season was found to be very high as the data showed that 98 farmers (representing 96.1% of the sample) applied it. Most of these farmers confirmed to have applied DAP which was essentially purchased (90%), while for others the fertilizer was either donated or loaned. The main source of fertilizer is from the agro-dealers, with the average distance to the nearest agro-dealer estimated at 6.1 km. On the application of fertilizer on the maize crop, farmers reported that the level of use has remained the same for the new varieties as compared to the local (89.2%), with only a few saying that it had reduced (9.2%) or increased (1.5%). For beans, the amount of fertilizer being used on the improved varieties that has remained the same (79.2%), has increased (6.3%) or has reduced (14.6%).

In Tanzania, the use of PASS-supported hybrid maize was accompanied with significant increases in fertilizer usage in Mbeya district, with corresponding yield increases. Farmers observed that the higher yields from improved varieties have come with increasing costs of fertilizer use; a high proportion of farmers (26%) reported an increase of 50% in fertilizer quantities, and an even bigger proportion (43%) reported that usage had increased by more than 50%. The main challenge encountered by farmers is high costs of the fertilizers (64%), though some farmers encountered no challenges in accessing fertilizer (19%), and others the long distance to the sources (9%) and low quality of the fertilizers (8%).

In Uganda, only about a third (35%) of the sampled farmers surveyed confirmed to have used fertilizers in crop production; saying that it is not viable on maize due to low producer prices. Of those who had ever used fertilizers, DAP topped the list with 46.7% of users reporting having applied it in their fields, while 38.3% used UREA (46:0:0); 9.0% used other forms of fertiliser and 3.6% had applied manure. Many factors were raised as influencing fertilizer use in Uganda, including: (i) the cost of fertilizer vis-à-vis the market value of the crop commodities that the fertilizer will produce; (ii) the reliability of fertilizer supply on local market; (iii) the distance the farmer had to travel to the nearest source of fertilizer (especially given old age of farmers and lack of transport to ferry large quantities). While most (69.5%) of the surveyed farmers who accessed fertilizer obtained it from a point within 5 km from their farms, 18% were 6-10 km from source while about 12.5% were more than 10 km from their source of fertilizer. The large

fluctuations in producer prices, especially for maize was a significant factor discouraging the use of fertiliser in maize in Uganda. The yield benefits of new varieties and of fertiliser use were being heavily eroded away by the corresponding reduction in market prices following a bumper crop. Hence perhaps the lesson from this recent experience in Uganda shows that efforts to promote technology adoption especially for maize should be accompanied by concerted efforts to promote the processing, storage, marketing and export of the surplus produce to better connect the local market to the international market where prices are more stable and in fact firming due to the general rise in prices for bio-fuel products.

5.3.2 Access to rural credit

In Kenya, access and participation in rural financial markets is very limited. In Malindi, none of the sampled household members applied for credit. According to the FGDs, there were a whole host of limiting factors. Firstly, the preconditions of the financial institutions meant that farmers had to form farmers groups in order to apply – and farmers feared members defaulting and/ or their own inability to repay the loan which would result in losing an asset. Secondly, credit (from Kilimo Plus Loans, as offered by Equity Bank in conjunction with the Ministry of Agriculture) was primarily for the provision of seeds and did not cater for other farming expenses (such as transport and additional inputs). Also, the loan application processes were seen as tedious, and the risks involved in rain-fed agriculture in the area (categorised as drylands) were seen as high.

In Nyeri, agricultural credit was requested by 23.5% of the farmers, however, only 6 (or 24%) of the loan applications were approved. Of those whose loans were approved, 4 were women. Reasons for loan denial were cited as lack of collateral, having had an outstanding loan, tough loaning repayment conditions and not having sufficient information. Information deriving from the FGDs showed that farmers were fairly aware of the credit services offered locally (such as Equity bank and Taifa SACCO). Access to such services was however limited to those who could support their repayment through regular income such as milk processing or having a salary from an employed member of the household. In Bungoma, 30% of the farmers have applied for agricultural credit in the year 2010. The FGDs similarly showed that farmers were knowledgeable about the presence of institutions giving out loans (mainly Equity Bank and One Acre Fund), but that crop failure in 2009 led to some farmers defaulting and being less inclined to take out loans in 2010.

In Tanzania, access to credit is very limited amongst smallholder farmers, with less than 17% in Mbeya, and barely above 8% for South Unguja. In Mbeya, the main source of credit is from NGO programmes whereas in Zanzibar, farmer groups are a common source of credit. Whilst it is acknowledged that several players have attempted to provide credit, and back it up with credit guarantees as in the case of AGRA, the magnitude of the problem of limited credit sources remains significant. In Zanzibar, the role of the neighbouring farmer is invaluable as a source of agricultural information and extension messages, as well as a source of credit within the farmer group ambit. Whereas in Mbeya, NGOs and the village banks are major sources of credit. Once credit has been secured, it is not all exclusively used for seed and other inputs. In fact, the activity that receives disproportionate support from credit resources is land preparation. This also suggests that if credit is provided, it may not necessarily support increased production inputs such as seed as it would support initial land preparation. Hence, it is critical that support has to be directed to address constraints on land preparation in tandem with support for increased purchases of improved seed.

In Uganda, about one fifth (20.2%) of the farmers attempted to obtain credit, with the vast majority of those that applied receiving credit. The highest proportion that received credit obtained it from farmer groups (25.6%), followed by those who secured it from commercial banks (19.5%) and those who secured the credit from NGOs/MFI (19.5%). These results indicate the importance of informal finance as a channel that appears to be the most accessible. The agricultural cash credit was mainly used for land preparation (56.1% of those who borrowed, followed by the purchase of inputs and for other agricultural purposes

(23.2% of borrowers). A win-win strategy for AGRA-PASS in this case would appear to come from the pursuit of strategies that place smallholder farmer groups at the centre of information dissemination, capacity building, and financing production and marketing of certified seed. This would take the form of programmes that seek to strengthen local seed production and distribution systems and strengthening informal finance systems through farmer group development, developing village savings and loans schemes, and other related agricultural micro-credit schemes.

5.4 Performance of improved seed varieties

In Kenya, Nyeri district, 57 % of maize farmers confirmed higher yields, better adaptability and sweeter taste when toasted. But, the yield data for KH 500-22A and 32A are not as encouraging as hoped. Indeed while the data illustrates the higher adoption of improved varieties, yields are not as encouraging as expected possibly due to the lack of fertilizer application. Perceptions by farmers however show that for the maize seed varieties donated mainly by the government (which was dominated by the PASS varieties, KH500-31A and KH500-22A), 56.5% of the 80.4% of the farmers who received the seed donations reported the yield to be higher than the local variety and it was impressively adaptable (15.2%). Adoption of the improved seed varieties, especially of maize crops, has been maintained by 64.7% for the crop currently on the farm and of the farmers who are willing to use the seeds in the coming season. It is expected that it will soon stabilize and non-adopters will be encouraged to take up the practice as farmers continue to receive higher yields as they have reported.

In Kenya, Bungoma district, 74% of farmers have switched to PASS-supported maize varieties. The same number of farmers had also planted the same varieties during the prevailing season and would repeat the same come the next season. In terms of yield, 93.9% lauded the improved varieties of maize as higher yielding than the local ones and were adaptive to the local conditions (4.1%). For bean varieties, farmer assessments of the improved bean seed varieties were that the crop was high yielding than the local varieties (87.1%). Others were of the opinion that the improved varieties were no different in yield with the local varieties (3.2%) and were adaptively poor to the local environment (8.1%). Farmers who reported to have planted improved breeds of beans during the past season were 51.9%. A slight drop (51%) was observed during the prevailing season but this peaked to 56.9% for those farmers who were positive about planting the improved varieties in the coming season. The drop was mainly blamed on unavailability of the seeds, scarcity of finance for buying inputs and susceptibility of the seeds to diseases.

For cassava (Malindi), nine farmers reported average yields of 1.5 bags of 90 kg each (across all varieties). Indeed, 27.9% of the farmers could not estimate the yield harvested mainly because harvesting was done on “needs basis”. The other farmers were yet to harvest their cassava crop by the time of this study. Since no tangible outcomes have been realized hitherto, it was not possible to collect generalisable data to assess the impact of improved varieties. Based on the Mtwapa sub-station data, an average 2 acres of land cultivated by households in the sample area will yield a seven times increase once the new cassava varieties are fully adopted. It is thought that increased yields from the newly introduced cassava varieties will help enhance a household’s food security and income from the sale of any surplus – although these figures need to be viewed with caution, as sub-station yields may be the result of effective land preparation, inputs, etc (rather than the realities of a farmer’s experience in less suitable land, different practices, alongside other crops, trees, etc). Furthermore, the uses made of cassava is currently limited to powder and the consumption of the tuber. There is a need to improve utilization (and value added of the cassava crop) and also the linkages between farmers, breeders (KARI) and extension workers to support improved agronomic practices.

In the Southern Highlands of Tanzania, 46% of farmers claimed that the improved varieties of maize in the Southern Highlands give higher yields compared to local varieties - a very significant figure considering the relatively low level input-based agriculture practiced in the region. In further comparison, only 4% observed higher yields for improved bean varieties. However, whilst research results give yields

of 6-9 t/ha for the Southern Highlands Region, average maize yields for the majority of farmers in the region is regarded as 1 800-2 000 kg/ha, with the 2010 yield average being placed at 2 800 t/ha by key informants. **These yields are significantly below the yield potential for the varieties being produced from the PASS-supported crop improvement program, and reflect the wide chasm between what farmers ought to do in terms of agronomic practice, and what they currently practice**. It is therefore critical that farmers are also subjected to extensive training on agronomic practices so that yields cease to be limited by fertilizer amounts available necessarily, but that as long as farmers have some access to fertilizers, these should be used efficiently on smaller areas commensurate with available fertilizer amounts to achieve yields closer to genetic potential inherent in released varieties.

In Unguja, Zanzibar, the situation for improved varieties of cassava is even more impressive where 98% of farmers assessed improved variety yields compared to the case of using local varieties. Yield estimates from key informant interviews indicated that farmers using new varieties achieve 40 bags of cassava (a bag full of tubers approximately weighs 60kg) per acre, implying farmers achieve 5 000 kg per hectare tubers. The introduction of new varieties has also had major effects on cultivation of coral soils in the Northern and Southern provinces, Zanzibar. These soils present a number of challenges, including physical limitations of hardness, stoniness and shallowness, which make crops grown in such soils more susceptible to drought. For some reasons, most probably medium sized and superficially growing tubers, the varieties released tend to do well in these coral zones, compared to other varieties, which has opened up new opportunities for use of land in an island that faces acute shortages of land for cultivation. *Kizimbani* especially has shown high adaptability, giving tuber yields in areas otherwise impossible to grow cassava.

In Uganda, the PASS-supported NERICA 4 is widely adopted both in uplands and lowlands, and NERICA 1 and 10 are now being aggressively promoted as a matter of Government policy in recognition of the potential impact. The yield advantage of most varieties compared to local varieties is quite visible, but when compared to other improved varieties on the market, the picture is mixed, again emphasizing the point that once released AGRA-PASS supported varieties should be distributed onto the market quickly, in sufficient quantities and with a reliable supply system so that the varieties fully exploit the rather "short window period" when no other comparable improved varieties outcompete them.

Among AGRA-PASS supported varieties, one of the top performers irrespective of the competing varieties is NERICA 4 for rice. This was promoted as upland rice but later adopted in the lowlands as well. The new varieties (NERICA 1 and NERICA 10), which have built on the strengths of NERICA 4, will be expected to now replace NERICA 4 until it is regenerated and comes back with additional advantages such as even higher yield, aroma and disease and drought tolerance. However, NERICA 4 continues to achieve the highest yield of 1,574 kg/acre much higher than the average for all rice varieties of 933 kg/acre. Despite lower yield, landraces for rice appear to continue to control the largest market share maybe reflecting the impact of cost and availability of seed as well as aromatic taste on adoption of improved rice varieties. NERICA 10 appears to be performing lower due to susceptibility to rat attack.

In the case of maize, the most promising to-date has been Longe 6H (although farmers in the three surveyed districts still preferred Longe 5 and Longe 4 which have been on the market for longer time and probably enjoy better supply), while the three most recently released varieties (Longe 9H, 10H and 11H) are still relatively new and not widely adopted by farmers as some (longe 11H) are in fact still being bulked. Longe 4 and 5 recorded the highest yields at 2,623 and 2,306 kg/acre respectively against an all maize average of 1,617 kg/acre and that for Longe 6H of 1,239 kg/acre. The limited use of fertilizer on maize may explain the under-performance of Longe 6H.

In the case of beans, NABE 14 is most widely grown among the AGRA PASS varieties but lags behind K132 in terms of adoption. At 1,766 kg/acre, NABE 14 however, has the highest yield among the bean varieties grown in the 3 surveyed districts. Its yield potential exceeds the average for all types of beans by about 15%.

6. CONCLUSIONS AND RECOMMENDATIONS

In this section we bring together the main conclusions from the studies. The study aims to both gain a representative estimation of adoption rates while also capturing sufficient concentrations of yield data for particular varieties. Furthermore it aims to better understand the challenges around the seed system from breeding, the production of foundation and certified seed, through marketing, distribution and uptake by farmers. The study design required a trade-off between these different objectives. Firstly, seed supply chains are context specific (involving relatively few organisations, as supported by PASS), and this necessitated a more focused analysis around relatively a few supply chains using in-depth interviews and focus group discussions. Secondly, there was a trade-off between linking the more context-specific nature of the supply chain with obtaining a representative picture of adoption by farmers – hence random sampling is used to select households for interview at the farmer-level (but focused around areas where PASS-supported varieties have been distributed). And thirdly, the stratification was designed to capture relative concentrations of PASS-supported varieties to be able to obtain yield data (see chapter 1 for details). In the absence of pre-existing data on sales and distribution at the lowest levels of the supply chain (agro-dealer, farmer groups, etc), this last part of the stratification was based on the premise that PASS-supported seeds had been widely adopted in the areas concerned, and that this would lead to sufficient concentrations of data around PASS-supported improved seed.

This proved to be true in some cases, but low adoption rates in other areas highlight that the initial focus on breeding and seed sales may not yet have resulted in a sufficiently high concentration of uptake by smallholders in any one area – and that this has yet to have a widespread impact on yields, food security and incomes. The findings in Malindi are an archetypal example of this, where only 10.9% of the farmers sampled bought the improved (and PASS-supported) *Karembo* variety of cassava cuttings. This was partly a consequence of the process and time required to obtain sufficient bulking of the variety.

In other areas, especially Uganda, improved varieties are being adopted but PASS-supported varieties have yet to capture a sizeable market share. So for example the maize variety *Longe 5* has a 20% share, whereas the PASS-supported varieties of *Longe 6H, Longe 7H* and *Longe 10H* are planted by less than 6%, 3% and 0.5% respectively. Similarly for rice, local varieties are most widely grown, and while the improved varieties of *NERICA 3* and *Superica 1* come second, the PASS-supported NERICA 1 comes third. Likewise for beans, *K132* was the most widely adopted variety, being one that has been on the market for the longest period, and still enjoys a larger market share as it was grown by 72% of bean cultivators. PASS-supported varieties of *NABE 14* and *NABE 12C* were grown by 17% and 1% of farmers respectively.

Only in Kenya, is there both a high proportion of farmers using improved varieties (of maize and bean seeds), and high adoption rates of PASS-supported seeds. In Nyeri, most farmers used PASS-supported maize varieties of KH500-31A (59.2%) of Frescho, and KH500-22A of Olerai Farm (32.4%). To a lesser extent other improved varieties were used, including KH513 (2.8%), KH614 (1.4%) and KA6213 (4.2%). In Bungoma, the PASS-supported KK8 and KK015 bean varieties were released by KARI in 2008 through Rockefeller Foundation support, and these are the most commonly used seeds by farmers.

In Nyeri, Kenya, 57% of maize farmers confirmed higher yields, better adaptability and sweeter taste when toasted. But, the yield data for KH 500-22A and 32A are not as encouraging as hoped, and this may be due to a lack of fertilizer application.[6] Perceptions by framers however show that for the maize seed varieties donated mainly by the government (which was dominated by the PASS varieties, KH500-31A and KH500-22A), 56.5% of the 80.4% of the farmers who received the seed donations reported the yield to be higher than the local variety and it was impressively adaptable (15.2%). Similarly in Bungoma, 93.9%

[6] There may also be other factors, such as farmer practices (planting times, variable rainfall patterns, pests, etc) and the use of less than optimal land (marginal areas, soil erosion, intercropping, etc).

lauded the improved varieties of maize as higher yielding than the local ones and were adaptive to the local conditions (4.1%). And, for bean varieties, farmer assessments of the improved bean seed varieties were that the crop was high yielding than the local varieties (87.1%).

Country seed system examination illustrates that AGRA-PASS has helped to revitalize the breeding of improved varieties and supported constructively the production of foundation and certified seed in all three of the East African countries. NARIs are stronger as a result of support and remain a good source of publically bred improved varieties, with breeders relatively well trained especially in Kenya, despite them being pursued by the private sector to maintain lines that have been commercialised. There are a growing number of local seed companies although the varietal licensing process appears to require more transparency and there is competition from state run seed companies and facilities. The long timeframe between varietal testing and release and in some cases the high costs or the lack of capacity to inspect provides good (as in Kenya) or limited traceability (as in Uganda and in some cases in Tanzania) across the region. In Kenya 62% of the seed maize demand is met through the formal system, the rest being supplied by the informal. In the case of Beans it is 2% supplied through the formal system and 98% met through the informal system. Cassava varietal adoption in the longer term will require rejuvenated markets for Cassava to sustain the adoption of new varieties. Estimates for seed in Tanzania are 100,000 tonnes annually. However, due to inefficiencies in the seed sector only 13,000 tonnes of improved seed are marketed annually, including 5,000 tonnes of Maize. Formal seed systems characteristically operate at low production and have a low market share estimated at 10% with 90% seed usage being of farmer saved seed. In Uganda, NARO is the only source of seed research for new varietal development, despite seed companies wanting to invest in seed research and production but find they lack the incentives. NARO also produces and maintains breeder seed and germplasm alluding to a lack of capacity of trained breeders in the private sector. The country's Seed Policy 2006 (draft) recognizes the '*existing inadequate capacity for effective seed certification and inspection services'* as a challenge. The seed market in Uganda is potentially large because of the acreage and diversity of crops grown, and its strategic placement to supply Tanzania, Southern Sudan and Rwanda.

In relation to supply chain issues further downstream, limited adoption levels observed – even in areas closely supported by AGRA-PASS- reveal a lack of data on farmer adoption levels and data of yields in farmers' fields. Although it may be a little early to see this, the yields on station and in trials are very encouraging especially in Kenya for Maize and Cassava, in Tanzania for Maize, Cassava and Beans and in Uganda in Rice and Beans. Some concerted attention to releasing new improved varieties in sufficient quantity to provide market penetration is of prime importance (particularly as these varieties are being superseded by newer introductions) and a closer focus on tracking the uptake and performance of improved varieties is important. More concerted efforts to support breeder and foundation seed production and a more direct involvement with farmers is likely to consolidate the upstream strength in the supply chain to meet the vast demand downstream.

Clearly there are some supply chain issues around bulking and distribution (as per cassava in Malindi), but there are also a number of important lessons about the way in which farmers behave. Firstly, information about new varieties is mostly spread through farmer-to-farmer interactions (and through family, friends and community meetings). The situations where higher adoption have occurred (e.g. Bungoma), have been where FBOs or research institutes have worked *more directly* with farmer groups. The most notable example of this being IcFEM and KARI. Also, in areas such as Nyeri, Government seed relief in 2010 following a drought spell in 2009, helped increase the availability of improved varieties (the seed relief package included KH500-31A, as well as PH4, DK8031 and KH500-513). Demonstration plots have a role to play, though a significant proportion of farmers have not witnessed such demonstrations (such as 46% of farmers in Mbeya, Tanzania; and up to 84.3% in Nyeri, Kenya).

6.1 Recommendations

There are a series of recommendations for PASS. These are grouped around the areas of improving the policy and regulatory environment, sustaining the breeding programme, increasing the efficiency and capacity of multiplication and distribution, and strengthening the contribution of out-growers, agro-dealer networks and input distribution programmes.

Recommendation 1: Improving the Policy and Regulatory Environment.

- There is a need to participate and contribute to processes that strengthen the seed regulatory framework for Tanzania and Uganda to bring it to a level comparable to the high standards of Kenya, South Africa, etc.

- Greater use could be made of AGRA-PASS experience to contribute to the policy discourse on whether maize hybrid varieties should be on exclusive or non-exclusive basis. As a general rule AGRA should encourage seed regulatory authorities to grant non-exclusive distributorship licences to facilitate rapid diffusion of the technology.

- There is a need to continue participating in, and influencing policy dialogue on, royalties, to secure breeders' rights.

- In addition to focusing on seed, AGRA should address policies that hinder the private sector from increasing its investment into value addition, and those that hinder free trade of surplus seed and grain of staple crops in the region and beyond.

- AGRA should help influence changes in national policy towards creating a more favourable environment for establishment of more sustainable financing mechanisms for technology generation activities. This should build on gains made so far by the enactment of new seed laws in the region, and the growth of the private sector owned seed business

Recommendation 2: Sustaining and improving breeding programmes

- AGRA should continue to support training of breeders and providing financial and other needed resources (infrastructure) to improve the quality of breeding and the pace at which varieties are released. This is also important to keep breeders motivated and to stay in the system so as to maintain the varieties.

- Further attention to non-exclusive licensing and breeder and foundation seed production is also necessary.

Recommendation 3: Increasing efficiency and capacity of players involved in seed multiplication and distribution

- There is a need to leverage or facilitate access by small and medium sized local seed companies to more appropriate business finance products (in terms of amount, duration, cost and structure).

- Irrigation development efforts of seed companies and NARIs require more support, especially as most smallholders operate rain-fed systems of agriculture.

- There is also a need to support the strengthening of national seed regulatory authorities to ensure efficient service delivery and quick scale up of output for new seed varieties in sufficient quantity.

Recommendation 4: Strengthening Out-growers

- AGRA should continue to support the transformation of promising farmer groups to become large scale out-growers for established companies, or to become stand alone private entities licensed to produce certified seed (such as the example of CAII). These efforts should build on current efforts by NARIs to build strong linkages with farmer groups to promote the multiplication and diffusion of improved varieties of crops otherwise shunned by the private sector (beans, rice, cassava, orphan crops).

- AGRA should intensify efforts to diffuse new technologies through farmer groups as farmer-to-farmer extension appears to be one of the most effective ways to do so.

Recommendation 5: Strengthening Agro-dealer Network

- Continue with agro-dealer strengthening programme with an emphasis on produce marketing, value addition and export aligning these initiatives to the crops that are being promoted. Inevitably, this will require leveraging financial resources appropriately structured for this level.

- Working to strengthen sustainable capacity building approaches (KEPHIS, STA).

- There is also a need to strengthen input distribution programmes that target poor farmers, such as through government and NGO support.

Recommendation 6: Improve the monitoring and learning functions of PASS

- Improve the timely collection of data along the supply chain (e.g. sales and distribution figures at all levels, adoption rates, and farmer perceptions). Such regular monitoring data can be used to understand what is working or not as the programme is rolled out – and provide an early warning to managers about performance. This data can also be used to provide the framework for more targeted studies and evaluations that aim to understand specific challenges and lessons.

- Undertake 'spot checks' of yields for specific varieties in situ, and track this from season to season. This can be used to provide more reliable data of yields based on actual farming practices, rather than trial plots – and helps minimise an overreliance on recall data across more than one season. This will also permit the capture of data for PASS-supported varieties which may have lower adoption rates.

6.2 Appendices

6.2.1 PASS sub programs

Kenya

Sub-program	**Target Beneficiary**	**Project Title(s)**	Funds allocated
ADP[1]	• Equity Bank Limited	Kilimo Project	US$2,500,000
EACI[2]	• Moi University	• Training of postgraduate plant breeders at MSc level • Post-graduate programmes in plant improvement and seed systems	US$468,460
FIAAC[3]	• Farm Input Promotions Africa Limited • Forum for Organic Resources Management and Agricultural Technologies	• Rapid dissemination of post-millenium improved varieties of maize, beans, cassava, and sweet potato developed by KARI to increase the productivity of small farmers' food crops in Kenya • Mobilizing new crops, seed systems and scientific networks for a green revolution in Africa	US$318,266
SEPA[4]	• Kenya Agricultural Research Institute • Integral Advisory Limited • University of Nairobi • Duncan Kirubi • Christian Agricultural and Related Professionals Association • Drylands Seeds Limited • Leldet Limited • Kenya Agricultural Research Institute	• Multiplication of high yielding and disease tolerant cassava clones and creation of distribution channels for planting material • Business Management support to AGRA-funded seed companies in Africa • Establishment of Seed Management Institute (SEMIs • Further strengthen the capacities of Tanseed International Ltd, particularly on seed production and processing, over a period of six months. • Increasing Cassava Production through Multiplication and Distribution of Improved Planting Materials for Food Security Enhancement in the Semi-Arid Areas of Kenya • Production and Delivery of Improved Crop Varieties to Poor Small Scale Farmers in the Arid and Semi Arid Areas of Kenya • Certified orphan seeds for Kenyan arid and semi-arid zones • Seed production and dissemination of improved, high-yielding and disease resistant bean varieties	US$5,432,008
Grand Total			US$8,718,734

[1] Agro-dealer Development Program; [2]Education for African Crop Improvement; [3]Fund for the Improvement and Adoption of African Crops; [4]Seed Production in Africa

Tanzania

Sub-program	**Target Beneficiary**	**Project Title(s)**	Funds allocated
ADP[1]	• National Microfinance Bank Limited • Ministry of Agriculture, Food Security and Cooperatives	• Guarantee fund to facilitate access to credit facilities by agro-dealers serving poor farmers in Tanzania • Preparation of the Tanzania agricultural inputs access framework	US$1,246,046
EACI[2]	• Sokoine University of Agriculture	• Support of M.Sc. training in plant breeding, plant pathology, entomology and horticulture	US$401,945
FIAAC[3]	• Division of Research and Training, Ministry of Agriculture, Food Security and Cooperatives	• Addressing Rural Poverty in the Southern HIghlands of Tanzania through Improvement of Angular Leaf Spot and Anthracnose Disease Resistance in Common Bean (Phaseolus vulgaris) • Participatory Sweetpotato Improvement in Tanzania • Farmer Participatory Improvement of Cassava Germplasm for Farmer/Market Preferred Traits in Tanzania • Soybean variety development, adoption and utilization • Towards Improvement and Adoption of African Crops: Development, Production, Testing, Distribution and Promotion of Tanzanian Experimental Hybrid Maize Cultivars • Developing and Disseminating Improved Maize Varieties in Tanzania for Food Security and Improved Household Income	US$1,117,305
SEPA[4]	• Division of Research and Training, Ministry of Agriculture, Food Security and Cooperatives • Itente Company Limited • Tanseed International Ltd • Meru Agro-Tours and Consultants Co. Ltd. • Agriseed Technologies Ltd • Aminata Quality Seeds and Consultancy Limited • IFFA Seed Company • Zanobia Seeds Limited • Krishna Seed Company	• Enhancing farmers' initiatives for multiplication and dissemination of cassava virus tolerant planting materials in Zanzibar • Seed Production and Dissemination by Itente Company in the value chain approach and options for upscaling crop productivity in Kagera region of Tanzania • Production and dissemination of improved seed of maize, pigeon pea and sesame in Tanzania • Production, promotion and distribution of selected improved seed varieties at affordable price to small-scale farmers in Northern Tanzania • Delivering Improved Seed to Smallholder Farmers of Singida, Tabora and Dodoma Districts in Central Region of Tanzania • Production And Dissemination Of Quality	US$1,622,777

	Limited	Seeds Of Improved Varieties Of Maize, Paddy, Sunflower And Sesame In Tanzania • Addressing Seed Needs of Farmers in Northern Region of Tanzania to Improve Food Security and Incomes • Production and delivery of improved seed to poor small-scale farmers in Tanzania • Reducing hunger and poverty among Tanzanian small-scale farmers through use of improved seed	
Grand Total			US$4,388,073

[1] Agro-dealer Development Program; [2]Education for African Crop Improvement; [3]Fund for the Improvement and Adoption of African Crops; [4]Seed Production in Africa

Uganda

Sub-program	**Target Beneficiary**	**Project Title(s)**	Funds allocated
ADP[1]	• AT Uganda Ltd. • Uganda National Agro-input Dealers Association (UNADA)	• Agro dealer network strengthening for Uganda	US$2,592,123
EACI[2]	• Makerere University	• Master of Science in Plant Breeding and Seed System for Mozambican, Rwandan and Ugandan Nationals based at Makerere University • Masters in Crop Science, Plant Breeding Option, for Rwanda and Uganda Nationals at Makerere University	US$1,043,300
FIAAC[3]	• National Agricultural Research Organisation • Victoria Seeds Limited • Makerere University	• Breeding for Anthracnose (Colletotrichum Lindemuthianum) Disease Resistance in Uganda's Market Class Dry Beans: Advancement of Segregating Materials through Pedigree Selection • Strengthening of Resistance in Segregating Cowpea Materials to Cowpea Aphid Borne Mosaic Virus and Yield for sustainable Household Food Security and Incomes in northern and eastern Uganda • Breeding for improved aroma characteristic, tolerance to drought and assessment of technology uptake of released Rice varieties in Uganda • Breeding high yielding banana genotypes with multiple resistance to majors pests and diseases in Uganda • The Development, Promotion and Dissemination of Anthracnose (Colletotrichum lindemuthianum) Resistant Bean Varietiesin Uganda • Development and Dissemination of Stress	US$1,657,525

		Tolerant Maize Varieties for Improved Food Security in Uganda • Participatory development and selection of acceptable high yielding bean genotypes for consumption and the market requirements for the rural communities in Southwestern and Western Uganda • Participatory development of groundnut varieties with resistances to major diseases and pests with desirable market attributes • Maize Streak Virus resistant maize for mid and high altitude agro-ecologies of Uganda • Deployment of Maksoy 1N and Namsoy 4M soybean varieties and development of rust resistant soybean genotypes for improved household food security and income in Uganda	
SEPA[4]	• National Agricultural Research Organisation • African Agricultural Capital • Busia Women Producers Association • Uganda Seed Trade Association • Centre for Agricultural Inputs International (CAII)	• Sustainable community-based, farmer-led bean seed enterprises to reach communities not served by the formal seed sector for improved income and livelihoods • Establishment of a farmer-based seed multiplication and delivery system for improved varieties of cassava, beans, groundnuts and rice in West Nile zone, Uganda. • Multiplication and promotion of Black Sigatoka-Resistant Banana Genotypes in Uganda • Fund Management for African Seed Investment Fund • Establishment of an effective, efficient and sustainable seed delivery system to increase production and profitability of Groundnuts and Cassava in Busia district of Eastern Uganda • Quality Assurance to Promote Production and Use of Certified Seeds in Uganda • Improving the productivity and incomes of poor, small-scale farmers through access to high quality seed of improved food and cash crop varieties	US$13,107,146
Grand Total			US$18,400,094

[1] Agro-dealer Development Program; [2]Education for African Crop Improvement; [3]Fund for the Improvement and Adoption of African Crops; [4]Seed Production in Africa