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CGIAR RESEARCH PROGRAM ON Maize

Zambia Study Report

Seed Sector functioning and the adoption of improved maize varieties

Photo: KIT – Geneviève Audet-Bélanger © Agricultural Fair Eastern Province

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Acronyms

AGRA	Alliance for a Green Revolution in Africa
CGIAR	Consultative Group on International Agricultural Research
CIMMYT	International Maize and Wheat Improvement Center
CRP	CGIAR Research Program
DAP	Diammonium phosphate
DTMA	Drought Tolerant Maize for Africa
EGS	Early generation seed
FGD	Focus group discussion
FISP	Farm Input Subsidy Program
FRA	Food Reserve Agency
GRC	Genetic resources conservation
IOPV / OPV	(Improved) open pollinated variety
QDS	Quality declared seed
QPM	Quality Protein Maize
SADC	Southern African Development Community
SCCI	Seed Control and Certification Institute
SIMLEZA	Sustainable Intensification of Maize-Legume Systems for the Eastern Province of Zambia
SSA	Seed Sector Analysis
SVCA	Seed Value Chain Analysis
ZKW	Zambian kwacha

Exchange rate at the time of the study 1 ZKW = US$0.13 (June 2015)

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Executive Summary

This document describes the adoption of improved maize germplasm at small scale farmer level in Zambia. The objective is to understand whether smallholder farmers have access to affordable, quality maize seed, and if so, how the seed sector supports this. This study is part of a larger research project commissioned by MAIZE, with similar studies conducted in Malawi, Bihar in India, and Chiapas in Mexico.

A seed sector stakeholder workshop, key informant interviews, focus group discussions (FGDs) with farmers, and a household survey were conducted. The workshop provided information on general seed sector functioning, whilst key informant interviews provided insights into the sector's dynamics in and around Chipata, Eastern Province. Zambia has favorable policies and ecological conditions for private seed companies to thrive. Over the years a number of international and national companies have established themselves in the country, producing for both the national and regional African seed market. Hybrid maize varieties are widely available across the country and generally suit the agro-ecology, as well as farmers' requirements.

Over the years, the involvement of the public sector in the development and production of maize seed has diminished and the private sector now takes up most of this function. Improved open pollinated varieties (IOPVs) are available, developed by the public sector and made available by both the public and private sector. The public sector regulates and certifies seed across the country, as well as playing an important role within seed distribution because of the Farm and Input Subsidy Program (FISP). FISP makes hybrid maize varieties and fertilizer available to small scale producers at subsidized rates via farmer cooperatives. Stakeholders indicated that the current state of the formal maize seed system is better than 10 years ago, when FISP had only just been established. Nowadays, an increasing number of players and dynamism has resulted in a large number of varieties being available on the market. However, seed certification and quality control in sales remain weak links of the formal system due to limited resources. Also, extension and financial services, such as loan schemes, appear to not be responding effectively to farmers' needs.

A household survey, carried out around Chipata in the Eastern Province, provided valuable insights into the use of different variety types, appreciated varieties, agricultural practices, producers' preferences and productivity. Complemented by key informant interviews and FGDs, the survey provided information on both the informal and formal seed system functioning at farm level. Maize is primarily an important crop for food security, although farmers do sell their surplus, often to the Zambian Food Reserve Agency (FRA). Although companies have developed well adapted hybrid maize varieties (short maturity period and high yields), producers also look for food quality related traits (poundability, flint grains, dry matter and taste), which are still mainly found in local varieties.

It is not uncommon for farmers to grow hybrid maize on their main maize plot from seed acquired through the FISP subsidy scheme, and grow local maize varieties on other fields as a buffer or risk mitigation strategy. Farmers were found to have grown hybrids on 56% of main maize plots and local varieties on 30%. Among farmers surveyed, Pannar is a popular seed brand for hybrids, while Dekalb (Monsanto) and Pioneer (which now owns Pannar) varieties are also widely grown. Many farmers acquire their seed through official FISP farmer cooperatives as this is the distribution channel for subsidized inputs. Agro-dealers were not found to have a major role in seed distribution and marketing in Chipata. Although accessible in country, IOPVs were not found to be widely known or grown among the surveyed farmers and key informants in the Chipata region. Farmers were found to use recycled maize hybrids, even up to two generations. This practice is common when farmers can't access sufficient amounts of hybrid seed or do not receive subsidy to buy hybrid seed at the reduced rate.

Local varieties were reported to yield around 1.7 t/ha while hybrids reached 2.4 t/ha. Recycled hybrids provided variable, but on average, low yields at 1.6 t/ha. The difference in average yields was statistically significant between local and hybrid varieties. It was found that producers who

had received the seed and input subsidies were able to reach yields of 2.5 t/ha, while producers who had not only reached yields of 1.8 t/ha.

Due to the favorable environmental conditions in Zambia, the maize seed sector has flourished. The combination of FISP and FRA has significantly stimulated the use of improved maize varieties at farm level, because the harvest can easily be sold to FRA at prices higher than the regular market. Hybrids are perceived as prone to weevil infestations and unsuitable for storing, but with FRA's involvement, producers are relieved of storing grain. Hybrids are also produced for household consumption, although farmers expressed a preference for local varieties for food purpose.

Farmers are widely using hybrid varieties, but this may be due to the subsidy available for this type of seed. It is unclear whether farmers would continue to grow hybrid varieties at such high rates, in the absence of the incentive. Hybrid varieties are being recycled and this suggests that farmers do not automatically go to buy new hybrid seed, particularly when they don't receive a subsidy. The geographical proximity of the Eastern Province to Malawi, and the relatively porous border, may allow producers to access subsidized or cheaper seed from Malawi. Also, since fertilizers generally require an even larger financial investment than hybrid seed, it is doubtful that farmers would opt for hybrid varieties in combination with fertilizers in case of discontinuation of the subsidy.

In summary, it seems that presently, the Zambian maize seed sector is functioning reasonably well and is supporting the use of improved varieties and better quality seed. However, it remains to be seen whether the present organization of the seed value chain will lead to long-term adoption of such varieties, particularly if the subsidy schemes would be discontinued.

1 Introduction

For Africa, the last decade has seen a continuous high economic growth and quickly developing food and other agricultural markets. This translates into unprecedented opportunities for agriculture-based economic development. Intensification of agriculture is sought with the double objective of improving food and nutrition security of producers and fast growing urban populations, as well as rural economic development. A highly essential input for sustainable agricultural intensification is high quality seed with a high production potential, well-adapted to both the agro-ecology and to market demand. However, improved high quality seed is often not accessible and available, especially for the poorer households (Dalberg 2015).

Through breeding, improved varieties of crops can be developed. In addition to good crop management, the quality of seeds, both genetically and physiologically, determines to a large extent crop yield and produce quality, and hence its market value and/or its potential contribution to food security. Seed characteristics also determine how the crop will cope with adverse conditions and risks (Louwaars and de Boef, 2012). IFAD (2011a) shows that in the 1980s and 1990s, the use of seed of improved varieties of crops accounted for half of the yield growth in China for example. When comparing regions, sub-Saharan Africa has particularly fallen behind Asia in the use of improved varieties for cereals (IFAD, 2011b).

The CGIAR research program MAIZE takes a holistic approach to increasing the contribution of maize to food security and poverty reduction (http://maize.org/). The MAIZE flagship project 5, aims at reducing constraints to seed production and increasing the number of MAIZE derived varieties available to farmers. The project intends to do this by improving access to germplasm through working with the National Agricultural Research Systems and small-scale, as well as larger seed companies. It is expected that improved access to germplasm and the release of improved varieties should positively impact on productivity and food security, and reduce demands on land. For this, the maize seed sector needs to become more vibrant, plural, competitive and responsive to users' needs, in particular those of smallholder farmers.

The aim of this project is to document the adoption and impact of improved maize germplasm at small scale farmers' level. Furthermore, the study sought to understand how smallholder farmers' access to affordable quality maize seed can be achieved through seed sector development. The assumption is that understanding the challenges, opportunities and implications of change, will improve research results and support higher adoption and impact of research-derived maize germplasm. For this project four countries (Mexico/Chiapas, India/Bihar, Malawi and Zambia) were studied independently. Subsequently, an overarching analysis process will take place. This report focuses on the outcomes of the research undertaken in Zambia.

2 Methodology

The same methodology was applied for all four study sites of the project (Chiapas/Mexico, India/Bihar, Malawi and Zambia). Zambia was the second country in which the research was carried out.

A mixed-method approach to data collection on maize seed use by smallholder farmers was used. A quantitative survey was developed for collecting data from farmer households, taking into consideration important elements such as maize growth seasons, subsidy schemes, production and sales figures, variety type and variety used, input use and changes in practices over time. The survey provided quantitative information regarding farmers' practices and their access to, and use of, quality maize seed. A national level seed sector analysis workshop, key informant interviews, and focus group discussions (FGDs) with farmers form the qualitative part of the study.

These tools were designed to provide insight into relevant factors, enablers and constraints of the maize seed sector. Key interventions influencing the functioning of the seed value chain, perceived changes, and views of key actors on what will be needed to further optimize the seed value chain in the study areas, were also explored through these qualitative tools. By combining these different types of data, it is possible to obtain insights into seed sector functioning and the adoption of improved varieties of maize.

The national level seed sector analysis workshop took place in Lusaka, and farmer surveys took place in the eastern region of the country around Chipata. The workshop was held in Lusaka because a greater number of actors, including seed companies, are based in Lusaka as opposed to Chipata. Chipata was chosen because of the presence of the SIMLEZA[1] project implemented by the International Maize and Wheat Improvement Center (CIMMYT), which means that there is a good knowledge of the area, and a functioning network to facilitate the exchange of experience with maize sector stakeholders.

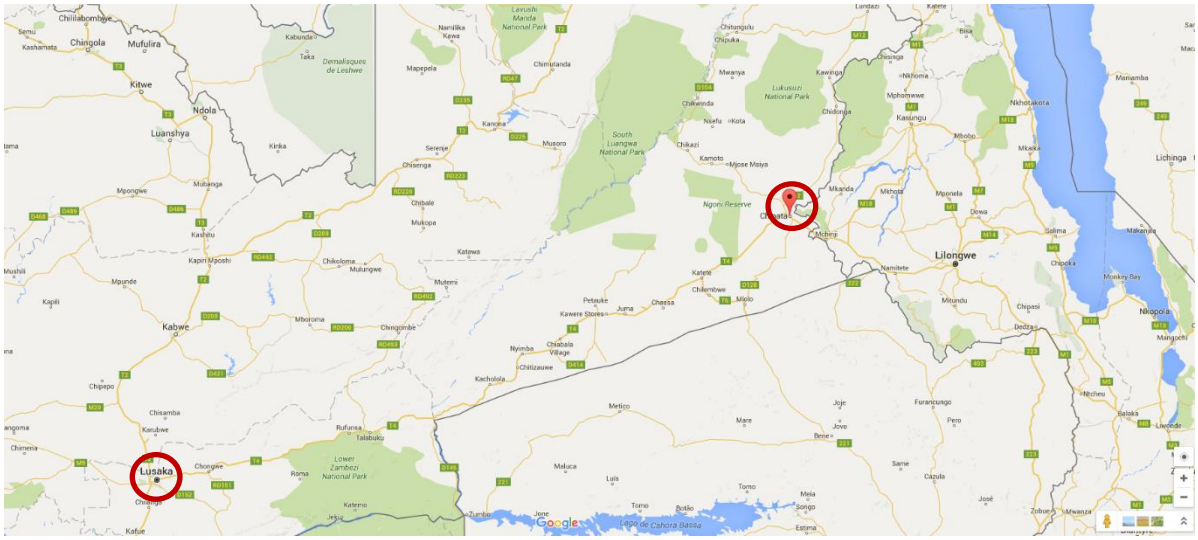

Figure 1 Location of workshop (Lusaka) and survey location Chipata (source: google maps 2016)

2.1 Data collection tools

The workshop and key informant interviews used two qualitative data collection tools:

1) Seed Sector Analysis (Subedi *et al.,* 2013), a tool specially developed to understand the composition and variations within a seed sector.

[1] SIMLEZA, Sustainable Intensification of Maize-Legume Systems for the Eastern Province of Zambia, is a project run by MAIZE and partners that aims to intensify maize and legume production by increasing yield through the use of better adapted varieties, by improving crop management, and by applying conservation agriculture and biological nitrogen fixation concepts.

2) Seed Value Chain Analysis (Audet-Bélanger *et al.,* 2013), which results in the understanding of the functioning of the seed value chain, flows of seeds, services, financial resources and knowledge.

Seed Sector Analysis (SSA) is a multi-stakeholder process tool used to understand the composition, distinctness and variations within a seed sector. SSA takes a systemic perspective in analyzing the role of different seed systems, both formal and informal, and their inter-relations. It helps to identify and describe the different seed systems. In the context of this research, SSA helps to describe predominantly the formal systems. Seed systems are the different pathways by which farmers' access seed, which together make up the seed sector. The tool characterizes seed systems by their domain of operation (farmers, public, private, NGO, others), crops and varieties, technologies, farmers targeted, seed quality assurance mechanisms, seed dissemination mechanisms, seed supply sources and service provision. SSA assists in identifying the strengths and weaknesses of different seed systems. This tool was applied to identify key factors which have been instrumental in the development process, as well as the preconditions for development to take place within a specific environment. It explores, in a qualitative way, the cause-effect relationship between maize seed sector development and the adoption of new germplasm.

The Seed Value Chain Analysis refers to the appraisal of the functioning of the chain; flows of the product, services, financial resources and knowledge are analyzed, to explore whether linkages between stakeholders are effective and efficient in terms of the performance of the entire value chain. It enables an understanding of the role played by various private and public actors in the development of the seed sector, and how the seed sector impacts the introduction of improved germplasm.

A snow-balling process was used to identify key informants to interview. Criteria for selection included relevance, diversity of stakeholders and role in the maize seed value chain. While it was not possible to meet with all the stakeholders identified as potentially important due to time and availability constraints, in total, 18 interviews were conducted with national and international seed companies, extension agents, agro-dealers, policy-makers, NGO staff and researchers. The interviews were held in Lusaka, Chipata, Saili and Chikube. A list of key informants can be found in the Annex.

To gather quantitative information, a household survey was developed and rolled out in two locations determined with the help of the local consultant. The first location was Kalunga Camp (Saili) about 35 km South of Chipata town. The second location was Kalichelo Camp 2 (Chikube), about 45 km north of Chipata town. The locations were selected as they represent two distinctly different contexts relevant for maize production in Chipata. In Kalunga Camp, the soils are generally sandy loam, while in Kalichelo Camp 2, the soils are clay loam and rainfall usually starts a month earlier. The 2two locations were 80 km apart.

Enumerators were trained and the tablet based quantitative survey tool tested in a single day with producers around Chipata. Based on the training and testing, the tool was adapted and tailored to the local context. Quantitative data collection lasted for 7 days. The first day of data collection is typically slower and less productive because enumerators have to get used to the tool. Hence, 4 days were spent around Saili, while 3 days were spent in Chikube for the household data collection.

To structure the daily data gathering, villages were selected based on a transect pathway. Each day, a different direction from the camp was selected on which four to five villages were selected for the study with the support of a local extension officer. The limited time allocated for the study did not allow for prior mapping or using lists for village selection. However, efforts were made to survey in villages which had at least 20 households that were representative of the area's agricultural practices. Villages were surveyed at various distance from the camp center using the transect approach. On average, in each village eight to 10 interviews were conducted. The selection of households within villages was based on a transect walk. Enumerators dispersed themselves in the village first, then interviewed one or two households in the area. For the

second, or sometimes third household to be interviewed, enumerators were asked to perform a transect walk to the right of the household and select the 3rd house they encountered for the following interview.

Each producer was asked to provide figures on seed use and maize production for the past two completed seasons (frequently referred to hereafter as 'the recent crops'). Further, they were asked to answer, in a more qualitative manner, questions regarding maize seed use and production 10 years ago - since it is generally more difficult to remember accurately such information over a long period of time. Each survey interview lasted on average for 40 minutes.

Additional to the household survey, three FGDs were held with producers, one in Saili (Kalunga Camp), two in Chikube (Kalichero Camp), near to a road and further away from a road, respectively. Some participants to the FGDs had been surveyed, some were not. The villages where the FGDs took place were selected with the support of two extension agents through the local consultant. Selection criteria included the general representativeness of the village and of the survey area's agricultural practices, as well as the ability to organize an FGD at short notice with a mixed group of men and women. In total, 42 men and women producers participated in the FGDs. FGDs helped understanding both the formal and the informal maize seed systems.

Where relevant, data have been disaggregated by gender to highlight any differences in practices between men and women surveyed and/or interviewed.

2.2 Limitations

Limited time and resources were available for each of the four country sites and the studies needed to be organized at relatively short notice. Therefore, it was not always possible to realize all ambitions regarding sample sizes and depth of data collections, as well as opportunities to engage with key informants for workshops and interviews. Nevertheless, through efficient planning, working with high quality local consultants and providing enumerators with interactive survey tools pre-loaded on tablets, a wealth of data could be collected and analyzed. Limited information was gathered regarding financial services available to seed multipliers and seed users, due to the limited knowledge of this subject by stakeholders met. The clear geographic division between the workshop and survey locations, led to speaking with actors in Chipata who did not have much information applicable to regions outside of their area of operation. This resulted in findings being more specific to the agro-ecology of the Chipata region. It was therefore quite complicated to triangulate the information on seed sector functioning gathered in Lusaka, and the survey data collected in Chipata.

An important constraint observed throughout fieldwork and across data sources, was the recall period of 10 years to identify major changes and their triggers in maize seed sector functioning. Major changes seemed to have occurred earlier, with market liberalization in the 1990s, and the start of subsidy schemes by FISP and FRA in 2003. Such developments represent important influences with regard to the adoption of improved maize varieties. The recall period proved to be difficult, specifically for producers. First of all, many of the producers interviewed were not producing 10 years ago, or were producing in a different setting (part of a different household, different geographic location, etc.). This makes it difficult to to compare with current data and introduces inconsistencies, even though very few quantitative questions were included in the part of the survey that looked back. For the workshop, due to the sometimes limited knowledge of participants regarding the sector as a whole, and the difficulty to recall events over the past 10 years, most of the analysis resulted in information on current seed sector functioning. The information gathered during the workshop only focused on the formal seed system because participants had limited knowledge of the informal system because of their background.

Within the survey, a few concepts have proven to be difficult for enumerators and respondents to disentangle. The type of variety used by producers (local, IOPV or hybrid) was difficult to distinguish from the immediate source of the seed sown (e.g. own field, agro-dealer, market,

neighbor etc.). The data analysis also revealed misunderstandings about seed renewal (the action of renewing one's stock of seed from other sources than one's own fields).

The survey data provides useful information for capturing, in quantitative terms, farmers' practices. However, a number of choices on questions had to be made in order to keep the survey to an acceptable length. Hence, only a few questions were asked about maize production in general and most questions focused on a producers' two most recent main plots of maize. The assumption behind this was that producers are likely to apply different practices (sowing, varieties, inputs) on different plots of the same crop, and that producers using improved varieties of maize would do so in particular on their main maize plot. Because of this however, it is difficult to capture through the survey the mix of strategies that farmers use when it comes to maize production in general. For example, it is was not possible to assess the coverage and the volume of different maize varieties on the whole farm.

The findings of this study, in particular those of the survey, are indicative but cannot be generalized to country level because of the limited size, the focus on the main maize plots and the specific location used for the household survey. Nevertheless, the results provide good insights into general seed sector functioning because of the diversity of stakeholders interviewed, and the mixed-methodology applied to collect information.

3 Seed Sector Functioning

3.1 The Maize Seed Value Chain

To understand seed sector functioning, it is helpful to analyze the operations in the seed value chain. Actors making up the seed value chain are inherent components of the seed sector. By looking more closely to their roles, functions and appreciation by the sector over the years, it is possible to draw conclusions for the maize seed sector as a whole. The results of the national level seed sector analysis workshop are summarized in Figure 2 and Figure 3. Participants were asked to score the functioning of the activity on a scale of one to five, one being low level functioning and five being excellent performance. The results of the workshop have been combined with insights obtained through interviews with key informants (Annex), and are discussed below.

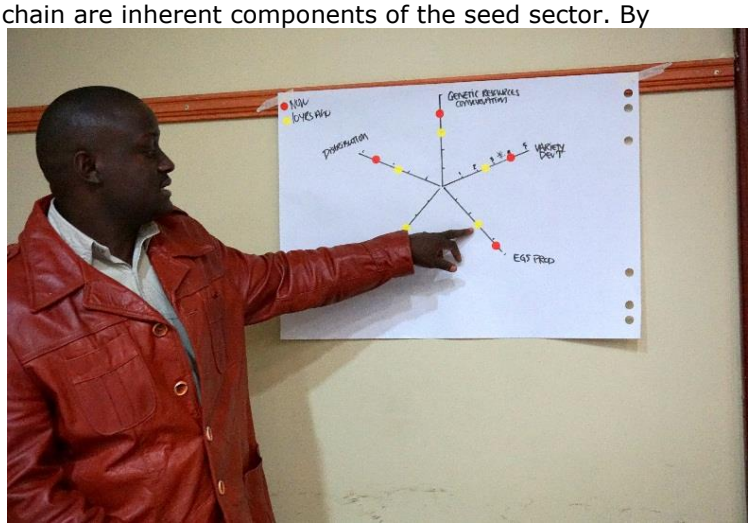

Photo 1 Workshop participant presenting SVCA

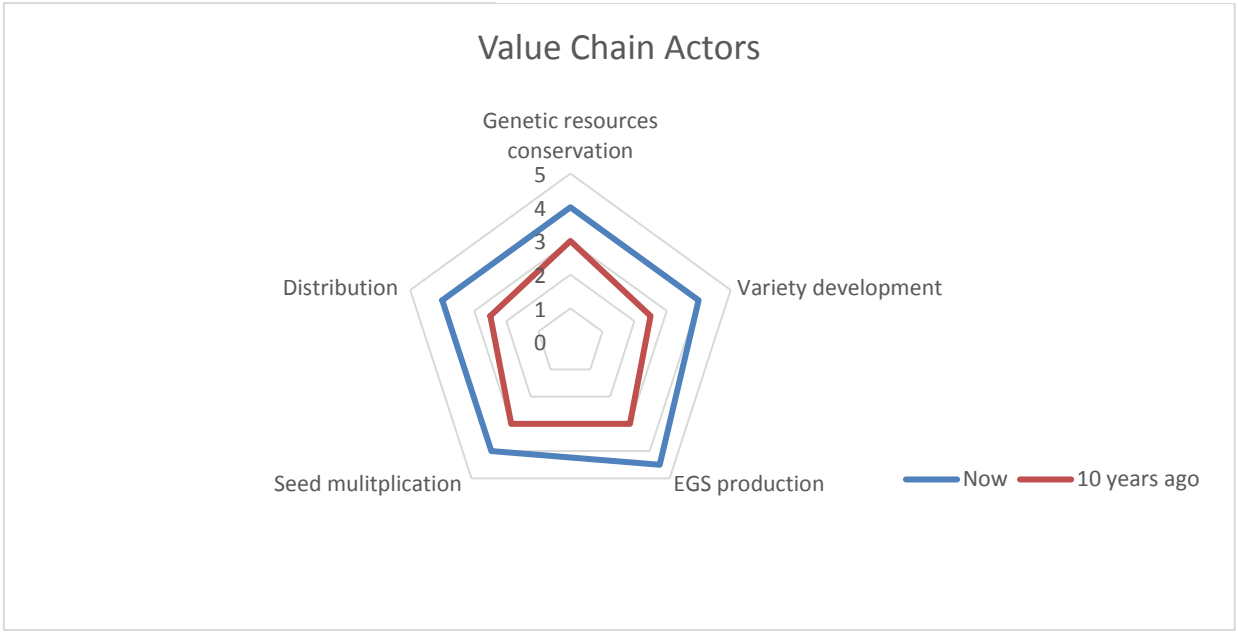

Figure 2 Value chain actors' functioning, ranked during the workshop discussion

Genetic resources conservation (GRC)
Zambia is host to the Southern African Development Community (SADC) regional gene bank, which preserves accessions from Zambia and its neighboring SADC member countries. Additional to the regional SADC gene bank, the national gene bank is hosted by the Ministry of Agriculture. The facility has a large catalogue of local varieties and materials used to develop varieties by the public sector, for a range of crops. Over the years, the gene bank has collected and stored germplasm from farmers, and regenerated its collected germplasm when necessary. This material is free to access. The public gene bank's mandate is food security, and it is thought to be playing its role effectively with a collection of material that has grown over the past decade. The private sector adds little to the content of the national gene bank, focusing on storing materials directly

relevant for variety development at their own research facilities. CIMMYT is a research partner of the national gene bank.

Variety development
The bulk of maize variety development is now done by the private sector and focuses on hybrid maize varieties. It is not anymore the mandate of the government to release maize varieties. The shift occurred with the liberalization of the market at the beginning of the 90's, and the privatization of the national seed company Zamseed. Private companies are fairly active in Zambia and a large number of varieties are developed to suit the different geographies of the country. Maize variety development is partly driven by the demand for hybrid seed which, in turn, is partly triggered by the FISP subsidies offered for hybrid seed and fertilizer and the government program FRA, which buys maize along with other significant buyers such as Cargill. Varieties developed generally fit the demanded traits by producers (for both dent and flint grains), with much attention on the development of drought tolerant varieties, linked to and/or inspired by the Drought Tolerant Maize for Africa (DTMA) program[2]. However, producers reported poor storage of the maize from hybrid varieties, the light weight of the product and a taste which is less appreciated than that of local maize. International seed companies sometimes source the germplasm used for variety development in neighboring countries and from CIMMYT, which is an important source of germplasm.

Production of early generation seed (EGS)
'Early generation' maize hybrid seed production means the production of adequate quantities of parental inbred lines, which are then crossed to produce hybrid seed for use by farmers. Because of the high quality requirements of this process, companies prefer to be responsible themselves. In fact, most popular hybrids grown in Zambia are three-way hybrids, which are a cross between a single cross F1 hybrid as a female parent, with an inbred line as the male parent (Peter Setimela, CIMMYT, *pers. comm*). EGS of IOPVs is less complicated, entailing the production of breeder seed, pre-basic and basic seed which can then be multiplied into certified seed at a later stage.

Because public policy strongly advocates the use of hybrid seed through FISP, IOPVs less prevalent in Zambia. The public sector produces some EGS for IOPVs, while the private sector focuses on hybrids when it comes to EGS.

Multiplication of seed
IOPV seed production is less frequent than hybrid. In Chipata, IOPV seed multiplication is an activity largely in the domain of seed producer groups which are supported by NGOs and some national companies. In this case, the planting material is sourced from the agricultural research system, and traded volumes are modest compared to hybrid seed. Private companies' interest in IOPVs is limited as the business case is a lot less attractive as compared to hybrids. These fetch higher prices and profit margins, cannot be recycled true-to-type, and are highly promoted as 'good agricultural practice'. However, some companies do offer IOPVs to their customers who wish to buy improved varieties but avoid the higher costs of hybrids. According to key-informant-interviews, IOPVs are cheaper, offer good yields and appreciated traits. Hybrid seed production is either done on companies' own grounds or by means of out-grower schemes overseen by the company. Hybrid seed production rarely takes place in Chipata because of the poor climatic conditions for seed production and the lack of irrigation infrastructure. At the time of the research, only one local company produced limited volumes of hybrid seed in the area. International companies tend to produce close to their headquarters in Lusaka where conditions are more favorable than in Chipata, and also in the Copperbelt area and Northern and Northwestern provinces. Additionally, some seed is produced in and imported from South Africa, Malawi and Zimbabwe.

[2] DMTA – Drought Tolerant Maize for Africa Program - http://dtma.cimmyt.org/

Seed marketing
FISP provides subsidized inputs (seeds: 10 kg of hybrid maize and fertilizer: 200 kg) to small producers for an area of 1 ha. The subsidy is distributed through farmer groups and farmers can request seed of certain maize varieties, although delivery depends on availability. This means that farmers who want subsidized inputs have to be part of a farmer group registered with FISP. Seed companies also commercialize their products through agro-dealers and at seed and agronomic fairs. Some companies are also reaching out to farmers which are located further from towns by opening seed depots in rural areas where farmers can access and purchase seed.

3.2 Services

Certification
There are different levels of seed certification in the country. While the most common is certified seed, which is very much used by large companies producing hybrid maize, quality declared seed (QDS) is also a certification option. Under QDS regulations, seed can be grown on multiple plots, and a sample (10-15%) of the seed plots is inspected and tested as a representative of all declared plots. The sample must meet certain standards to be declared QDS.

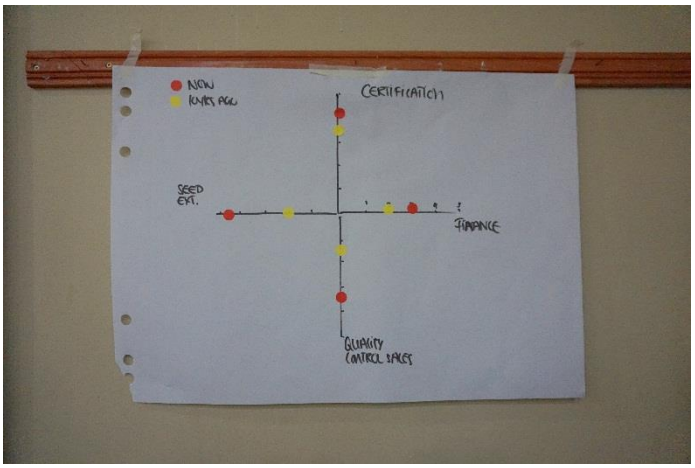

Photo 2 Services SVCA results of the workshop

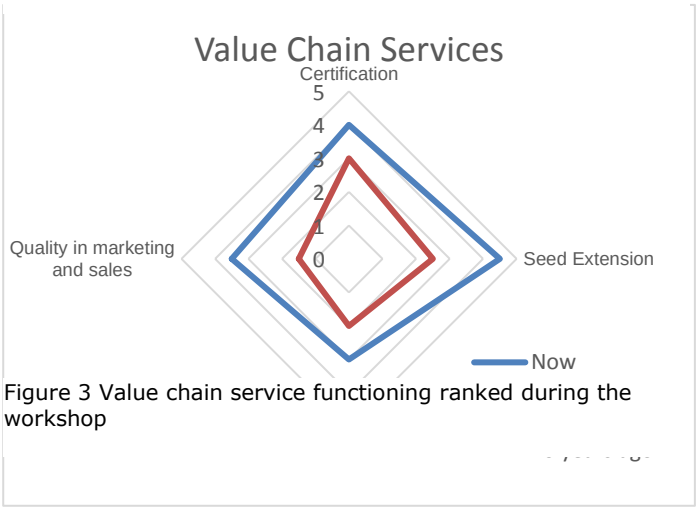

Figure 3 Value chain service functioning ranked during the workshop

Quality control is a decentralized service where personnel of private seed companies can also be licensed to conduct internal quality control of a companies' production. This is perceived as giving opportunities to companies to certify seed which may be of a sub-standard quality (because of the lack of external oversight). Because of the limited manpower of the Seed Control and Certification Institute (SCCI) and the limited capacity of its testing and control facilities, there is a pledge to increase the number of in-company quality control agents, so-called 'para-inspectors', which are certified by the SCCI. The para-inspectors have proved to be very instrumental in boosting the national capacity for seed inspection and this model is being replicated in Malawi (Mloza-Banada *et al.,* 2013), with the support of MAIZE. In the area of Chipata, most seed certification services revolve around cotton and seed control exercised for maize is limited. Only the quality of maize seed stock carried over by companies from one season to the other, is assessed.

Financial services
Like in many other countries of Africa, access to financial services remains a challenge for small producers wishing to access credits to purchase farm inputs like quality seed. While some finance schemes are operated by the government or NGOs to support smallholder producers, their outreach and impact on the use of improved varieties of maize is limited. The government FISP

program succeeds to fill that gap by means of subsidies. Similarly, there appears to be no adequate support mechanisms to provide credit to seed companies.

Seed extension
Agricultural advisory services to promote the use of quality seed and good agricultural practices are provided by a number of actors. Conservation agriculture is widely promoted by a number of NGOs, in collaboration with public extension services. The use of hybrid maize seed features as a component in the promotion of conservation agriculture. Private seed companies do not provide direct extension services to producers, but advertise and showcase their products through demonstrations and fairs. It is common to see demonstration plots on the road side where companies exhibit varieties with the most potential for the area.

Quality control in marketing
There is limited quality control in the marketing of seed. While seed gets tested and certified prior to distribution for sales, there is only sporadic control of the quality of the product sold to producers. With the SCCI already short on staff for the inspection of seed production, limited resources can be dedicated to the control of the products sold on the market. The problem is more acute near the borders where seed from neighboring countries can be imported illegally. For example, seed from Malawi is said to be imported and sold at much cheaper prices as it comes from the FISP subsidized system in Malawi. There are also issues around fake seed found in local outlets. While the agro-dealers are officially licensed by the SCCI to sell products, checks on the stocks they carry are rare.

3.3 The role of the public sector and the private sector in sector functioning

Currently, government policies favor the development of the private sector maize seed companies. This development has been on-going since the 90's and has supported the establishment of a strong private sector. With Zambia offering generally favorable climatic conditions for producing seed and favorable policies to export seed, the companies based in Zambia are developing fast. International seed companies also see Zambia as an interesting regional hub. Coupled with the strong focus on conservation agriculture, the advocacy for the use of hybrid seed and seed distribution through FISP, creates a supportive enabling environment for maize seed companies to grow and expand. Another important factor which is influencing the development observed in the seed sector is the FRA government program. In short, it entails the buying of large volumes (in some areas up to 60 to 80% of the production) of maize by the government at a higher price than the market, to encourage producers to grow maize and establish a national buffer stock.
During FGDs with maize producers, FRA was consistently cited as the best payer and biggest buyer of maize in the area of Chipata town. Because FRA buys the maize, producers are more inclined to grow hybrid varieties which they get at a subsidized rate through FISP, and can sell directly after harvesting rather than storing on-farm. Even if producers do not favor the variety for home consumption, they are assured of an output market. The combination of the FISP inputs program and the FRA purchasing program has created a favorable environment for seed companies to sell, and farmers to use improved varieties of maize – specifically hybrid maize varieties.
International public research also supports maize seed sector development. For example, the MAIZE CRP continues to provide capacity building opportunities, through training and technical backstopping in order to enhance the skills of private (including seed companies and agro-dealers) and public sector staff in seed marketing and promotion. Additionally, targeted sub-grants are provided to seed companies to help them establish demonstration sites, hold field days, and produce promotional materials for their seed. The Alliance for a Green Revolution in Africa (AGRA) and its Program for Africa's Seed Systems, specifically aims to strengthen seed company development, including in Zambia.

4 Evidence of use of improved varieties at farmers' level

4.1 Maize and livelihood strategies

Using the Progress Out of Poverty Index[3], it was possible to assess that close to 62% of the producer households interviewed are likely to be living on less than US$2.50 per day (at 99% confidence level). This calculation is made on the basis of 10 country specific survey questions related to the assets of the households (such as number of household members, schooling, house building materials, electronics and mattresses). Therefore, producers interviewed for the study are relatively poor, with a strong focus on food security when it comes to maize and agriculture (Table 1).

Likelihood of household to be living on US$2.50/day or less in percent	N	%	Cumul. %
100	18	6	6
100	28	9	14
99.8	38	12	26
99.8	63	19	45
99.6	54	17	62
98.8	58	18	79
98.0	32	10	89
95.7	14	4	94
91.3	10	3	97
81.1	10	3	100
41.9	1	0	100

Table 1 Likelihood of household to be under US$2.50/day 2005 Purchasing Power Parity (N household 326)

The majority of producers were found to rely on agriculture for over 50% of their revenue (Table 2). Maize contributes to income generated through agricultural activities; 44% of producers reported that maize derived income accounts for 50% or more of their agriculture derived income, which is the same as 10 years ago. However, in the research area, cotton is an important cash crop which is produced by most producers. Hence, maize is grown primarily for food consumption, with income generation from the surplus a secondary objective for some producers. Forty four percent of producers reported growing maize for consumption only (Table 6).

Share of income	Total agricultural activities now	Total agricultural activities 10 years ago	Share of maize in agricultural income now	Share of maize in agricultural income 10 years ago
Little (10 % or less)	19	15	41	51
A quarter (25%)	7	10	14	14
Half (50%)	13	8	23	16
Three quarters (75%)	10	9	14	12
Nearly all (90%)	13	14	4	2
Full (100%)	39	44	4	5

Table 2 Contribution of agricultural activities and maize to household income (N households 332)

The average farm-gate maize price for which maize was sold over the past two seasons was 1.31 Zambian kwacha (ZKW) per kg of maize (N recent sales 134). There are three main outlets for producers to sell their maize. The first is FRA which offers what is considered a remunerative price at 70 ZKW per bag of 50 kg to producers; but FRA often buy late and is known for delayed payment. The second outlet for producers is Cargill, which buys rather quickly but incur higher transport costs associated with bringing the maize to collection points. They buy at a price of

[3] The PPI is statistically-sound, yet simple tool to use: the answers to 10 country specific questions about a household's characteristics and asset ownership are scored to compute the likelihood that the household is living below the poverty line – or above by only a narrow margin. http://www.progressoutofpoverty.org/

around 60 ZKW per bag of 50 kg and pay relatively fast. Finally, the local market is the least preferred option by farmers, but provides cash quickly at 50 ZKW per 50 kg bag. Gross revenues varied greatly among producers surveyed. Of those who had sold their maize, farmers obtained only sporadically more than 10,000 ZKW per ha. Most producers obtained a gross revenue of between 1,000 and 5,000 ZKW which at the time of the survey equaled around US$90 to US$440. (Table 3)

Maize gross revenues from sales in ZKW	Freq.	%	Cumul.%
100 to 500	43	19	19
501 to 1,000	50	22	41
1,001 to 5,000	94	42	83
5,001 to 10,000	29	13	96
10,001 to 15,000	8	4	99
More than 15,000	2	1	100
Total	226	100	

Table 3 Gross revenues from maize sales in ZKW (seasons 20013-2014) (N = 226)

4.2 Site comparison

The data analysis revealed no relevant significant differences between the two survey locations when comparing important factors such as yields, and type of seed used (Table 4 and Table 5). Because these two variables are the most important for the study and did not show statistically significant differences between the two locations, it was decided to aggregate the data from both locations. Furthermore, a correlation of 0.49 was found between the yields of the two most recent crops surveyed per producer (Figure 4). This means the coefficient of determination (r-squared) equals 0.24, indicating that about a quarter of the variation in yield in the first season and the second season was determined by the farmer effect. This is not insignificant, but still fairly modest, and therefore it was decided to pool all harvest data.

Average yields at both locations for the two most recent seasons (kg/ha)	Mean	95% Conf. interval – low	95% Conf. interval – high	N plots
Chikube	2106	1940	2271	249
Saili	2126	1983	2269	353

Table 4 Average yields of recent crops according to location in kg/ha

Variety type	Chikube	Saili	Mean
Local variety	32	30	31
Recycled hybrid	12	14	13
Hybrid	57	57	57
N observations	*276*	*383*	*659*

Table 5 Type of seed used (%) for recent crops according to survey location

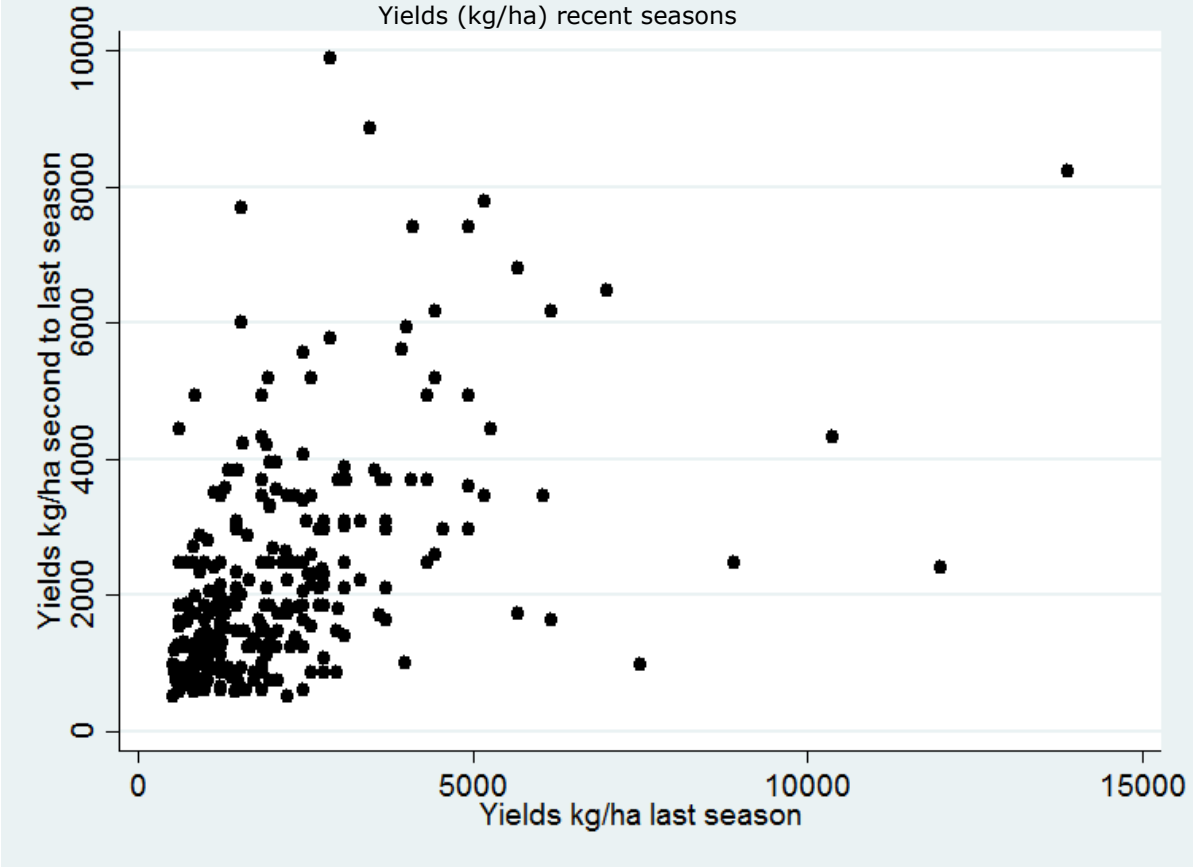

Figure 4 Correlation between yields of the last and second to last season of producers in both survey locations

4.3 General information

Maize is an important staple crop in Zambia with many interviewees indicating that there are few other options than to grow maize, as it is part of the basic diet of farming households. Over 40% of recent harvests were kept entirely for consumption, and of 59% of recent harvests three quarters of the maize was kept for home consumption (Table 6).

Ratio consumption to production	Freq.	Percent	Cumul.
No consumption	51	8	100
0-25% consumption	44	7	92
26-50% consumption	95	14	86
51-75% consumption	83	13	71
76-90% consumption	39	6	59
91-99% consumption	62	9	53
100% - consumption only	290	44	44

Table 6 Ratio consumption to production for the last two seasons (N harvests for recent crops 644)

Producers interviewed are producing maize once a year. Production in the short rains season is virtually impossible due to the climatic conditions and the lack of irrigation infrastructures.
The average land owned by producers is 2.1 ha (95% confidence interval: 1.9 – 2.2; N319) and the main plot dedicated to maize cultivation is on average 0.8 ha (N664), ranging from 0.1 ha to about 3 ha. Only 5% of the recent main maize plots were irrigated. Frequently, producers do not plant maize as a stand-alone crop, with 44% reporting to intercrop. Forty five percent of producers have reported receiving subsidized seed in recent maize seasons (Table 7).

Subsidies for inputs in recent maize seasons	Freq.	Percent	Cumul.%
No subsidy	334	50	50
Seed only	5	1	51

Seed and fertilizer	293	44	95
Fertilizer only	32	5	100

Table 7 Input subsidies (N subsidies, N plots recent seasons 664)

4.4 Maize varieties, variety selection and seed renewal

Varieties

Only one variety of maize was planted in most cases on the main plots; 21% of the plots were sown with more than one variety (Table 8). Although not surveyed in the household interview, other plots sown with maize by farmers are likely to be sown with different varieties of maize. During the FGDs, it appeared that in fact most producers grow a local variety for consumption alongside the variety they acquire through the subsidy system for sales (and mostly oriented towards the FRA). It is likely that the subsidized seed does not cover the entire plot/and or seed needs of households.

Data from the survey suggests that when farmers are asked about the variety grown, they report the hybrid variety and tend to leave out the fact that they grow local varieties on the side, on smaller plots. From the FGDs, it is clear that many producers rely on more than one variety and experiment with seed from various sources and types on a regular basis. While farmers are aware of the push to use hybrids seeds, farmers also reported growing local varieties for food security. While yields are lower, they offer a steady production at a lower cost, while hybrids are more risky due to the greater financial loss in the case of a bad harvest. The FISP program only distributes hybrid maize seed to producers for a plot area of one ha. Therefore in many cases, the subsidized inputs also don't cover the total area under maize cultivation by farmers. When asked why they were using more than one variety, 38% of farmers explained the practice as a risk mitigation strategy linked to climatic shocks, or to needing different varieties for different uses (e.g. food production versus production for the market). Another reason for sowing more than one variety on the main plot of maize, included not being able to access a sufficient quantity of the preferred variety to plant their whole main plot (18% of cases) (Table 9).

Number of varieties on main plot	Freq.	Percent	Cumul.%
Only 1 variety	522	79	79
2 varieties	132	20	99
3 varieties	10	1	100
Total	664	100	

Table 8 Number of varieties on one plot (N recent crops 664)

Reason for using more than one variety	Freq.	Percent
Risk mitigation strategy	29	38
Unable to access enough seed of one variety	14	18
Different varieties for different uses	20	26
Better yields	3	4
This is what I was given	3	4
Other	7	9
Total	76	100

Table 9 Reasons for using more than one variety of maize on the main maize plot (N answers 76)

Variety selection

When producers were asked which variety they had sown, the largest share (29%) answered 'local variety' without referring to a name. It emerged from the FGD that appreciated local varieties are Chibawe and Kapesi. Pannar's PAN 53 (24%) is the hybrid variety which is most used by producers as their main variety. The use of other hybrids from various companies varies between below 1% to 11% and these are less popular than PAN 53. Some 10% of producers simply do not know the variety they used (Table 10). Seed sources clearly identified as recycled hybrids are referred to not as a hybrid, but using the company name.

Variety	N	% of total	Variety	N	% of total
Local Variety	190	28.6	Pioneer 30G19	9	1.4

PAN53	156	23.5	Hybrid no spec.	5	0.8
Seed Co Various	44	6.6	Recycled Pannar	5	0.8
Pannar Various	38	5.7	Pool 16	3	0.5
SC513	31	4.7	Recycled Dekalb	1	0.2
Recycled Pioneer	28	4.2	Kamano	1	0.2
Zamseed Various	27	4.1	Orange maize (QPM)	1	0.2
Dekalb Various	24	3.6	Yellow maize	1	0.2
MRI Various	19	2.9	Don't know	68	10.2
Pioneer Various	13	2			

Table 10 Main Variety of maize used on recent main maize plots (N plots recent seasons 664)

Producers were requested to provide the two main reasons for selecting the variety they had chosen for their most recent main maize crops. Table 11 represents the answers most often given. Reasons varied greatly among producers interviewed. High yielding was the most important reason, with male producers acknowledging it as a factor of influence in 19% of cases and women in 17% of cases. The subsidy offered under FISP also influences greatly the choice of variety made by producers (around 14%), as did availability (11 to 16%). For example, a producer group under FISP can request to be allocated a certain variety, yet it is not certain that they will receive the specified variety, and may end up with another variety being delivered as a result of the system. Availability of the variety might also simply be what was previously sown, harvested, and recycled as seed. Other popular traits include early maturing characteristics, suitability for storage, drought tolerance and the type of grain (flint vs. dented, flint grain being easier to store). Ten years ago, the focus of producers was more on the varieties that were available (23% for men and 19% for women) and the availability of the seed through recycling (15%, 17%).

Generally, hybrid seeds are seen to offer a solution to low yields and provide a more optimal maturing period and drought tolerance, something CIMMYT has been working on specifically under DTMA. However, during the FGDs, producers reported that with regard to poundability and consumption of maize for food, hybrids do not compare to local varieties which are much more appreciated for their texture, weight and taste. Early maturity varieties are usually appreciated. Last but not least, local (in general flint) varieties result in maize that keeps on-farm for long periods and can be consumed when needed, while hybrids (generally dent grain) are mostly intended for sale straight after harvest since the maize tends to be attacked by weevils. Therefore, producers refer to hybrid varieties as being difficult to store and better to be sold off directly after the harvest for that reason.

Reason for selecting maize variety	Now men % answers	Now women % answers	10 yrs ago men % answers	10 yrs ago women % answers
I get better yields	19	17	9	13
These seeds were subsidized	13	14	5	5
It is the variety that was available at the time	11	16	22	19
Maturing characteristics	10	8	8	6
Drought tolerant	8	2	2	3
Type of grain	8	8	4	5
Recycled variety	5	5	15	17
Storability	5	7	8	13
I got the seeds of this variety for free	4	7	6	3
I trust the origin of the seed	4	4	6	7
Poundability	4	3	7	2
I can process this maize into food	2	3	3	3
I can easily sell this maize/appreciated by the market	2	0	3	1
I like the taste and/or texture for food	1	1	1	2
Flood tolerant	0	0	0	0
This variety is required by my contract	0	0	0	0
Other	4	6	0	2

N	355	262	223	157

Table 11 Reason for selecting main maize variety sown on main maize plot

Farmers were asked whether characteristics specifically related to the final use of the maize (food, processing, or price on the market), had played a role in their decision, additional to the principal reasons for why they had selected the variety (Table 11). For about half of the cases - 46% of the harvests, this had been the case. For those farmers, food characteristics were obviously much more important than market price. The type of grain (flint vs. dent) which has an important influence on the storability of the grain is the most important factor (29%), followed by poundability – processing for food (24%) and storability (16%) (Table 12).

Selection of variety based on use of maize	Freq. of answers	% of answers
Type of grains (dent vs flint)	85	29
Poundability	72	24
Storability	47	16
Taste	30	10
Price paid by buyers for the variety	20	7
Processing into flour	18	6
Dry mass	17	6
Other	8	3

Table 12 Selection criteria of varieties when producers select the variety based on the final use of the grain (N answers 297)

Respondents were asked which source of information was most influential for their variety choice. In the past, family members and social relations as well as own choice were more likely to convince the producers to use specific varieties. Nowadays, family and social relations still have a major influence, with 21% of producers reporting to have been convinced by these same people or to have made their own choice (34%). The subsidy system also has an influence on producers' use of varieties, with 13% of producers reporting to have used the specific variety because of FISP. Other sources of information like agro-dealers (4%) and extension agents (7%) have a limited influence on producers' choice for a specific variety. There were few differences between the reasons of male and female producers. However, women appear to be more influenced by family, friends and neighbors and less so by more formal associations, like producer groups or seed companies.

	Now			10 years ago		
Who influenced you?	Men	Women	**Mean**	Men	Women	**Mean**
Myself	36	33	**34**	43	43	**43**
Family, friends, neighbors	18	26	**21**	35	43	**38**
The subsidy	13	13	**13**	2	2	**2**
Producer group or association	13	13	**13**	7	3	**5**
Extension officer	7	7	**7**	6	4	**5**
Seed demo plot seed comp.	6	1	**4**	2	2	**2**
Agro-dealer	4	5	**4**	2	2	**2**
Seed company/agent	2	0	**1**	2	0	**1**
Contract farming requirement	1	1	**1**	0	0	**0**
NGO	0	1	**1**	1	0	**1**
Other	3	1	**2**	1	0	**1**

Table 13 Influence on variety used now and 10 years ago (N answers 332)

Type of seed

Hybrid varieties were sown by men on 59% of recent plots and by female respondents on 53% of plots. Over a 10 year period, an important shift has occurred from local varieties which used to be used on 68% of the plots, whereas now, only 30% of producers rely mostly on local maize varieties. The percentage of plots with hybrids has doubled for male respondents, and tripled for female respondents. Recycled hybrids are reported to be used on 13% of plots, but this variety type was also already used 10 years ago (on 7% of plots) when hybrids were less common.

It appears that often farmers recycle their hybrid seeds if they are left without subsidy for a season. This may be because they are unable or unwilling to purchase hybrids at the full market price, or they have not been able to save sufficient quantities of seed from local varieties. Almost no IOPVs were encountered in the household survey, although some companies do market this type of seed in Chipata. It is difficult to explain exactly why this situation was encountered. One hypothesis is that in the survey location, hybrids are simply more prevalent because of FISP. Another possibility is that IOPVs were classified by producers as local varieties because of their similar properties (recyclable, consumption characteristics), and therefore no differentiation was made between the two types. When IOPVs or composite varieties were discussed during the FGDs and during interviews, it also appeared that producers and stakeholders were not familiar with this type of seed.

Type of variety	Men (%)	Women (%)	Mean (%)
Hybrid	59	53	56
Local variety	28	33	30
Recycled hybrid	12	14	13
IOPV	0.6	0.3	0.5
Unknown type	0.3	0.3	0.3

Table 14 Type of varieties used by male and female farmers on recent main maize plots (N plots recent seasons 664)

Type of variety used 10 years ago	Men (%)	Women (%)	Mean (%)
Local variety, open-pollinated seed	64	74	68
Hybrid	28	16	23
Recycled hybrid	6	7	7
Unknown type	2	3	2

Table 15 Type of variety used 10 years ago by male and female producers (N plots 222)

Just a little less than two thirds of the plots sown with local varieties in the second to last season were again sown with local varieties the following season (66 plots), while 39 plots were sown with hybrid varieties and 6 plots used recycled hybrid varieties. Plots under hybrid cultivation were more frequently sown again with hybrids (Table 16).

	Last season			
Second last season	Local variety	Recycled hybrid	Hybrid seed	Total
Local variety	66	6	39	111
Recycled hybrid	4	25	10	39
Hybrid seed	18	13	146	177
Total	88	44	195	327

Table 16 Cross table variety type per season (N plots 327)

When producers reported not having access to subsidies, most frequently they used local varieties. Plots were sown with local varieties in a proportion of 43%; hybrids at 35% and recycled hybrids at 22%. Of all the plots sown with recycled hybrids, 87% had not received subsidies. Of plots under seed subsidy, all seed acquired was hybrid, while under fertilizer subsidy only, 69% of plots were sown with local varieties. Finally, the plots which had benefited from the subsidy for both seed and fertilizer, were sown with hybrid varieties in 83% of cases. Table 17 shows that producers who do not have access to subsidies do resort, in higher proportions, to using local varieties and recycled hybrids, than when they have received seed subsidies.

	No subsidy	Seed subsidy only	Fertilizer subsidy only	Seed and Fertilizer subsidy	Total
Local variety	43	0	69	12	30
IOPV	0	0	0	0	0
Recycled hybrid	22	0	3	3	13
Hybrids	35	100	28	83	56
Unknown	0	0	0	1	1

Table 17 Cross table variety type and subsidies (%), recent plots (N662)

Source of the seed

With about 30% of plots sown with local varieties, it is not surprising that a farmer's 'own field' is the main source of seed for 29% of the seed sown on recent main plots. This is an important reduction from 10 years ago, when 55% of plots were sown with seed sourced from farmer's own fields through recycling practices. FISP producer groups are an important channel through which producers' access (subsidized) seed, with 29% of plots reporting these groups as the immediate source of the seed they have used. Over the recall period of 10 years, it becomes clear that the recycling rate has diminished significantly, with producers now favoring producer groups and agro-dealers as their seed source (Table 18). Over 10 years, there has been a clear shift towards FISP as a seed source (from 4% to 28% source). Agro-dealers remain an occasional source, yet are of limited prevalence as a result of the subsidy distribution through farmer groups. Seed recycling remains important now but is less common than it was 10 years ago.

	Now (N plots 664)			10 years ago (N plots 332)		
Source	Men	Women	**Mean**	Men	Women	**Mean**
Own field - recycled seed	28	31	**29**	54	58	**55**
FISP farmer group, cooperative or association	31	25	**28**	5	2	**4**
Farmer group, cooperative or association (not FISP)	11	20	**15**	13	11	**12**
Neighbor, family or friend	14	13	**14**	16	22	**19**
Agro-dealer	12	9	**11**	8	5	**7**
Rural market	1	2	**2**	1	0	**1**
Supermarket	1	1	**1**	1	2	**1**
Local agent of a seed company	1	0	**1**	2	0	**1**
Certified seed producer	1	0	**1**	1	0	**1**
Direct distribution by FISP	0	0	**0**	0	0	**0**
Non-certified seed producer	0	0	**0**	1	0	**1**
Project or Program Government	0	0	**0**	1	0	**1**

Table 18 Source of seed used (%) by male and female farmers now and 10 years ago

Seed renewal

When looking at the amount of recycled seed according to the type of seed sown, the highest rates are found for local varieties, with on average 31 kg of seed kept for seed at the end of the harvest. This is followed by hybrid seed with 22 kg and recycled hybrids (i.e. seed harvested on already recycled hybrids), with 16 kg on average. It makes sense that the smallest quantities were found for the recycled hybrids, as they are likely to result in the most variable crops. Table 19 demonstrates that out of the 219 occurrences of seed recycling recorded, about a quarter were already recycled hybrids and a little less than a quarter were hybrids.

Volumes of seed recycled per type (kg/ha)	Mean	95% Conf. interval - low	95% Conf. interval - high	N plots
Local variety	32	28	36	117
Recycled hybrid	16	13	20	55
Hybrid	22	17	27	47

Table 19 Quantities of seed recycled according to variety type sown on recent main maize plots (N plots 219)

Distance to seed

The seed sown was sourced relatively close to farmers' households, with 55% of the seed sourced requiring no travel at all (catering for most of the recycled and gifted seed). Eighty nine percent of producers travelled less than 10 km (Table 20).

Distance to access seed (km)	%	Cumulative Percentages
0 km	55	55
0.1 to 0.4 km	3	58
0.5 to 1.4 km	13	71
1.5 to 1.9 km	1	71
2.0 to 4.9 km	10	82
5 to 9.9 km	7	89
10 km +	11	100

Table 20 Distance to seed travelled by producers in km for recent plots (N 664)

Seed prices
In 46% of the plots the seed wasn't paid for (either it was subsidized, recycled or given). When the seed had a cost, the average price was 7 ZKW per kg. The low number of recorded prices for local OPVs and recycled hybrids was expected, since most of this seed will be acquired through recycling instead of purchase. However, table 20 shows that in the cases where producers paid for these types of seed, the prices were very variable. The average price for hybrid seed can be seen to be more stable, at an average of 7 ZKW per kg. The average seed price for hybrids for producers having reported not having received subsidies was 8 ZKW per kg as opposed to 6 ZKW for producers having received the seed and fertilizer package.

Eighteen producers using hybrid varieties reported having not paid for the seed at all. The reasons for this is not known. Maybe they have used gifts or allocated all the subsidy from FISP to seeds or bartered fertilizer for seed. During interviews, companies reported selling seed at between 14 and 25 ZKW per kg. There are two hypotheses to explain why producers not having received a subsidy, have reported paying a lower price per kg than the market price gathered from seed companies. First, Chipata borders with Malawi, where seed is heavily subsidized. It is likely that subsidized seed from Malawi is illegally traded into Zambia and sold for profit at a lower price than Zambian unsubsidized hybrid seeds (K. B. Lweya CIMMYT, *pers. comm*). Producers who have not received subsidized inputs but who have paid for and sown hybrid varieties, have largely sourced their seed from agro-dealers (50% of cases) and from farmer groups which are not part of FISP (29% of cases). This seems to indicate that if the hypothesis is true, imported subsidized seeds from Malawi are available from agro-dealers and from farmer groups. Considering that services in the chain around quality control in sales and marketing of seed were deemed rather poor, with a score of 2.5 out of 5, the trade of such seed is thought to be quite likely.

The second option is that producers who reported to paying a lesser amount per kg of hybrid seed, may not have purchased the full quantity of seed sown[4] on their main plot. Of producers having received subsidies and used a hybrid as a main variety, 25% of the plots were sown with more than one variety, which may or may not have been purchased.

Average seed price/kg per type	Mean	95% Conf. interval - low	95% Conf. interval - high	N harvests
Local variety	6	4	8	30
Recycled hybrid	4	2	7	12
Hybrid seed (subsidy package)	6	6	7	201
Hybrid seed (no subsidy package)	8	7	9	91

Table 21 Average price paid (ZKW) for seed per kg for recent crops according to variety type (N harvests 334)

4.5 Inputs

With the exception of NPK (80% of plots over two seasons) and urea (91% of plots over two seasons), other fertilizers were not widely used on the plots surveyed. Both these fertilizers are part of the FISP subsidy scheme. Diammonium phosphate (DAP) was used on only 5% of the plots and calcium ammonium nitrate (CAN) not used at all. Manure was more common and used on 11% of plots, while compost was used on very few (2%) plots (Table 22). No significant difference was found between male and female farmers with regard to NPK and urea use.

	NPK	DAP	Urea	CAN	Manure	Compost
Male	81	3	91	0	12	2
Female	78	7	91	0	10	2
Mean	80	5	91	0	11	2

Table 22 Percentage of producers using fertilizer on recent main maize plots (N plots 664)

[4] Producers were asked about the quantity of seed used on the main plot and the price paid for the full quantity. An automatic calculation was performed to establish the price per kg of seed based on the total amount of seed sown and the total price paid.

Producers used on average 155 kg/ha of NPK and 162 kg/ha of urea. There is a limited difference between fertilization levels for the different types of seeds used, and the difference is not statistically significant (Table 23).

NPK (kg/ha)	Mean	95% Conf. interval - low	95% Conf. interval - high	N plots
Local variety	142	129	156	161
Recycled hybrid	180	156	204	60
Hybrid	157	145	168	285
Total	155	146	163	506
Urea (kg/ha)	Mean	95% Conf. interval - low	95% Conf. interval - high	N plots
Local variety	162	147	176	176
Recycled hybrid	179	154	205	69
Hybrid	159	149	169	332
Total	162	155	170	577

Table 23 Levels of NPK and urea fertilizers applied (kg/ha) according to variety type

4.6 Yields

Hybrids offer significantly (p-value<1%) higher yields (2,421 kg/ha) than local varieties (1,710 kg/ha) and recycled hybrids (1,589 kg/ha) (Table 24). No means were computed for the other types of seed due to the low number of data points.

From the survey data, it appears that IOPVs are in practice nearly absent in the seed landscape around Chipata. Only a few producer organizations specialize in, usually uncertified, IOPV seed production, assisted by NGOs. While appreciated by the producers making use of these IOPVs, IOPVS are not part of strategies to increase yields promoted by formal extension messages from the government or those from civil society. Most extension messages carry a strong emphasis on conservation agriculture and the use of hybrid varieties of maize. During FGDs and other interviews, producers and many other stakeholders did not know about IOPVs.

Yields according to type of variety (kg/ha)	Mean	95% Conf. interval - low	95% Conf. interval - high	N plots
Local variety	1710	1541	1893	279
Recycled hybrid	1589	1327	1852	66
Hybrids	2421	2273	2568	352

Table 24 Average recent yields according to type of variety (kg/ha)

T-test for yields according to variety type	Local	RH	Hybrids
Local variety		-121.3	710.2***
Recycled hybrid seed			831.5***
Hybrid seed			

Table 25 T-test for yield differences between types of varieties; column minus rows, *p-value<=10%, **p-value<=5%, ***p-value<=1%

The important role of the FISP program is underlined by the observation that farmers who had received the seed and fertilizer subsidy package consistently got higher yields than the producers who didn't on average and for local varieties as well as for hybrid varieties. Average yields for producers not having benefited from the subsidy were 1.8 t/ha; for local varieties the average yield was 1.6 t/ha and for hybrids 2.2 t/ha. When farmers received the seed and fertilizer package the average yield was 2.5 t/ha, 1.9 t/ha for local varieties and 2.5 t/ha for hybrid varieties. (Table 26)

	Average yield (kg/ha)	Confidence interval for yield (low)	Confidence interval for yield (high)	N plots	Average yields plots with Local varieties	N Plots	Average yields plots with hybrids	N Plots
No subsidy	1817	1676	1958	334	1594	125	2237	104
Seed & fertilizer	2450	2284	2616	293	1918	33	2532	237

Table 26 Average yields per ha according to variety type and subsidy for main plots in recent seasons

Yields reported in Table 24 do not take into account intercropping, which was practiced on 44% of the plots surveyed. It is difficult to estimate the impacts of intercropping on yields, but there is an average yield penalty of 200 kg/ha between plots which were intercropped and plots that were not. This difference is significant at p-value<8% (T-test). There was no significant difference in maize seed rate between pure-stands and intercropped plots (average 22 kg/ha), which indicates that the yield penalty is likely to be attributable to other factors, such as variety type or competition for nutrients and light between the crops. Of all intercropped plots, local varieties were sown in 48% of the plots and hybrids in 44% of the plots.

Yields according to planting practices (kg/ha)	Mean	95% Conf. interval - low	95% Conf. interval - high	N plots
Pure-stand	2203	2058	2348	340
Intercropped	2008	1846	2170	262

Table 27 Average yields (kg/ha) of pure-stand maize and intercropped maize on recent main maize plots (N 602)

Lower yields were also reported by women smallholders, which seems to be related to the fact that women get lower yields when using hybrid varieties compared to men (p-value < 5%; Table 28). The difference in average yields when using local varieties for men and women however, is not significant.

Average yields (kg/ha) recent seasons	Mean	95% Conf. interval - low	95% Conf. interval - high	N plots
Men - Average	2251	2093	2408	287
Local varieties	1715	1456	1974	82
Hybrid varieties	2564	2357	2772	205
Women - Average	1961	1818	2105	349
Local varieties	1707	1484	1929	202
Hybrid varieties	2221	2020	2422	147

Table 28 Average recent yields per gender (N plots 602)

5 Observations and Conclusions

The survey in Chipata indicated that more of the maize plots had been sown with hybrid varieties of maize as the main variety (56%), than with local maize varieties (30%). With many international companies based in Lusaka, favorable climatic conditions and a supportive policy environment, both local and international seed companies have been able to effectively target small producers of maize as customers for their products.

There are two major programs which are influencing farmers' practices with regard to maize. First is the FISP program, which provides subsidized inputs (seeds and fertilizer) to small producers for an area of 1 ha. The subsidy is distributed through farmers groups and while farmers can request certain varieties of maize seed, delivery is up to availability. Forty five percent of the recent harvests for which data was collected, had been grown with seed received through subsidy. The second program which dramatically influences the use of improved varieties of maize is FRA. By offering a secure output and paying higher prices than the regular market, there is limited risk to engaging in producing maize surplus at farm level.

In spite of the favorable environment for private seed enterprises and favorable circumstances for farmers to access improved seed, still, more than 40% of the main maize plots of farm households in the recent seasons were planted with either farm-derived seed or locally purchased seed of unknown origin. Clearly, there is still room for improvement in the use of high quality seed by farmers in the sample area. How to increase the use of higher quality seed is an important area for debate. It appears that the choice for local varieties and other recycled seed is not a result of poor availability of quality seed, as a large proportion of producers are able to access quality seed, either through the subsidy scheme or through agro-dealers. There are two possible main reasons for farmers not to invest in hybrid seed. The first reason is that when they have no access to subsidies, they do not feel that the investment outweighs the benefits. Or they simply cannot afford the investment, especially if they do not have access to subsidized inputs; inputs which are necessary to realize the full yield potential of hybrid varieties. The second possible reason is that the varieties offered do not meet their particular demand, which are better being met by other types of seed available through re-use, barter or the informal market.

The survey data shows that IOPVs are not used by many farmers. Throughout the study the theme of IOPVs was addressed and discussed with stakeholders, but resulted in limited information. Very few informants even knew about IOPVs or were able to discuss them in details. However, this does not mean that IOPVs are uncommon in all regions of Zambia. Since IOPVs could constitute an intermediary step for producers to engage in acquiring improved varieties of maize before engaging in production of maize using hybrids varieties, some companies, like K2 and Unity Seed, are including a few IOPVs in their portfolio. However, IOPVs are not part of the FISP subsidy scheme and hence, are much less in demand than hybrids. The NGO Self-Help-Africa, has been supporting farmer groups in the production of small quantities of IOPV maize seed for their own use. With some success locally, the access to EGS for such varieties for multiplication by the breeders, from the general public sector research institutes, remains limited, and more extensive marketing remains difficult. The seed produced by the farmer group is also not certified under the current quality control system, although under the Seed Act, there would be room for QDS certification if the seed were to be marketed outside of the community.

Most maize surplus at farm level available for sale, is thought to be the result of using hybrid varieties. The seed is subsidized and these varieties provide higher yields (2.4 t/ha as compared to 1.7 t/ha) than local varieties. However, they are less appreciated for consumption and the grain is regarded as difficult to store. Hence, producers grow the subsidized seed and sell the grain to FRA (or Cargill or the local market). For consumption, producers still prefer local varieties which have flint grains, are keeping better and result in larger volumes of dry mass when milled. Farmers having received the seed and fertilizer package have reached the highest yields with 2.5

t/ha as opposed to farmers not having benefitted from the package with average yields of 1.8 t/ha. Clearly, with the objective of increasing yields, the package is proving to be effective.

It was found that producers sow a mix of varieties and types of seed on their plots, and the reasons behind this are likely to be varied i.e: - because local varieties are preferred for consumption and hybrids are preferred for the market – growing a mix of varieties is a sort of a financial risk mitigation which is essential for smallholder farmers (local varieties may not provide high yields, but are steadily providing a harvest; - insufficient quantities of seed available of their preferred variety. However, limited information is available about this matter. The survey only covered the producers' most important maize plot, which might be expected to be the most pure crop; although for up to 20% of theses main plots, farmers indicated to have planted two or more maize varieties.

Of the maize kept for seed, 50% represented recycled seed from hybrid or from already recycled hybrid varieties. This provides an indication that the use of hybrid varieties of maize, combined with annual seed renewal, is not yet entrenched in farmers' practices. It is likely that currently, this practice is a direct consequence of the subsidized distribution, rather than a choice of producers to invest in the purchase of hybrid varieties of maize. The survey data also show that the practice of recycling hybrid maize seeds does not seem to result in dramatic low yield, as portrayed by the seed companies and extension services. Yields reported for recycled hybrids are similar to those obtained with local varieties. This might be partly explained by the fact that most of the hybrid seed used by the producers surveyed represents 3-way hybrids, which means a likely smaller difference in yield and homogeneity between hybrid and next generation than would have been the case for single cross hybrids. With some producers having purchased seed of recycled hybrids, it seems like there is even a market for such seed. However, the dynamics under which recycled hybrids are performing remain unclear, and it would be beneficial to have better insights into the conditions for performance of recycled hybrid varieties. Similarly, it would be useful to compare results with IOPVs.

One hundred and sixteen plots (31% of plots under hybrid varieties) were sown with hybrid seed and farmers reporting having not received subsidies. This is an encouraging indication that farmers do buy hybrid varieties even though they have not received the subsidy, and are therefore showing signs of adoption of improved varieties of maize. However, the average price paid per kg for these hybrids (8 ZKW) is in fact much closer to the subsidized average price of seed (6 ZKW), than it is to the market price of hybrids which varies between 14 and 25 ZKW per kg. One hypothesis to explain the price discrepancy between hybrid maize seed acquired without subsidy, and the actual market prices for hybrids, is that farmers could be buying subsidized seed illegally imported from nearby Malawi, which is sold at a lower price than Zambian hybrid varieties. Another option is that 25% of plots are in fact sown with more than one variety, which may result in the fact that only a fraction of the seed used in is fact paid for. This would result in a lower average price of the seed per kg used to sow the entire plot.

This study from Zambia suggests that in Chipata, the research area, most farmers are indeed using hybrid maize varieties since they are widely promoted under the FISP subsidy scheme, and grain is easily sold through the FRA program. While some producers do store and consume maize produced from hybrids and recycled hybrid varieties, it is likely that producers sow local varieties to complement hybrid production on their main plot, or on other plots and small home gardens for consumption. Under different circumstances it is not clear whether farmers would be using hybrid varieties in such volumes. When farmers are left without subsidy, they resort to recycling hybrids and they prefer local varieties for on-farm storage and consumption.

The importance of agro-dealers as a seed source is limited. This is a direct result of the choice for a subsidized seed distribution system through FISP farmer groups, who do not use of agro-dealers. The advantage of agro-dealers' involvement would be the building of a supplier-client relationship, based on trust and understanding of seed demand. Furthermore, agro-dealers are

likely to be more mobile as seed suppliers than farmer groups. Hence, strengthening the role of agro-dealers, for example involving them in the distribution of subsidized inputs, could be a first step towards a more market-based seed distribution system. This would help the seed sector sustain itself beyond the lifespan of seed subsidies. However, improving the quality control mechanisms in sales and marketing of seed is also crucial to ensure that quality seed and inputs are marketed by the agro-dealers. Apart from seed, agro-dealers are also the source of inputs which are crucial to make the most of hybrid varieties. In the case of the absence of a fertilizer subsidy, farmers also need to be able to access easily (distance, timing) quality inputs. Agro-dealer network development in Zambia is now starting to be supported by projects for maize and other crops, like Strengthening Agricultural Input and Output Markets in Africa – an AGRA project funded by the United States Agency for International Development.

Hence, although it remains to be seen whether they are contributing to the sustainable adoption of hybrid maize varieties, it is clear that FISP and FRA are important drivers of seed sector functioning in Zambia. They have led to the use of hybrid varieties by farmers and have changed the landscape of the maize sector in Zambia.

6 References

Dalberg Global Developments Advisors. 2015. Transforming Africa's Agriculture for Sustainable Inclusive Growth, Improved Livelihoods and Shared Prosperity, Background Note for High-Level Side Event on African Economic Transformation held in the margins of the Third International Conference on Financing for Development, 13-16 July 2015, Addis Ababa Ethiopia, Alliance for Green Revolution in Africa, accessed September 2016 http://www.dalberg.com/wp-content/uploads/2015/07/dalberg-A4-MR.pdf

Audet-Bélanger, G., Gildemacher, P., Subedi, A., De Boef, W.S and Heemskerk, W. 2013. Seed Value Chain Analysis. Technical Note 4. Centre for Development Innovation, Wageningen UR; KIT, Amsterdam and IFAD, Rome.

International Fund for Agricultural Development (IFAD). 2011a. Agriculture - Pathways to prosperity in Asia and the Pacific. IFAD, Rome, Italy

International Fund for Agricultural Development (IFAD). 2011b. Rural Poverty Report. IFAD, Rome, Italy

Louwaars, N.P. and de Boef, W.S. 2012. Integrated seed sector development in Africa: a conceptual framework for creating coherence between practices, programs, and policies. Journal of Crop Improvement 26:39–59

Mloza-Banada, H.R., Kandzu, G. and Benesi, I. 2010. Evaluation of the Malawi Seed Sector for the common market for Eastern and southern Africa (COMESA) harmonized seed regulations and policies, for the African Seed Trade Association. 70 pp

Subedi, A. and de Boef, W.S.; with Audet-Belanger, G., Gildemacher, P. and Heemskerk, W. 2013. Seed Systems Analysis. Technical Note 3. Centre for Development Innovation, Wageningen UR; Royal Tropical Institute, Amsterdam; and the International Fund for Agricultural Development (IFAD), Rome, Italy.

7 Annex: List of Interviews

The fieldwork was conducted in collaboration with local consultants for local coordination and facilitation of the workshop. Parkie Mbozi, research fellow/communication and media consultant Institute of Economic and Social Research University of Zambia was hired for the workshop in Lusaka and Davies Melele, agricultural researcher for the Government of Zambia, for the fieldwork in Eastern Province. Key responsibilities of the consultants included organization of the workshop, hiring and coordination of enumerators, facilitation of the identification process of key informants, organization of FGD and translation from local language to English when informants did not speak English. Locations for the household survey were also suggested by the local consultant.

Activity	Dates (2015)	Location	Participants
Stakeholder workshop	June 16th	Lusaka	9
Key interviews	June 18th –24th	Chipata, Saili, Chikuwe	19
Survey & FGDs	June 18th –24th	Saili, Chikuwe	332

National Workshop (Lusaka)

Douglas Mwasi	CRS	Unit Manager Agric Livelihood
Kelvin Simpasa	SEED CO.	Plant Breeder
Godfrey Mwila	ZARI/MAL	Deputy Director
Frank M. Kayula	National Union for Small Scale Farmers of Zambia (NUSFAZ)	Director General
Susan Chiluba	MRI/SYNGENTA	Maize Campaign Leader
Mwaka Kayula	ZNFU	Senior Manager Lima Services
Godwin Kaula	ZAMSEED	Agronomist

Interviews

Fransisco Miti	Chief Seeds Officer SCCI (Lusaka)
George Karga	Unity Seed
Lazarons Hara	Seed multiplier Unity Seed
Cosgin	SCCI
Ben Kanga	Klein Karoo
Miyanda Muchindu	Pannar
Janet Siwaba	Zamseed
Canicius Bwalya	Pioneer
Agent – anonymous	Monsanto Delakb
Nyati Mauro	Syngenta
Charles Mabbesu	Kamano
Robert Daka	Agricultural Facilitator
Henry Malwa	Seed Sector Researcher
Jembo Phiri	Stockist MSP Farmers shop
Edward M. Chibwe	Self Help Africa
Margaret	CRS
Gulam Banda	Saimoa project
Micheal Ngulube	District coordinator agriculture and livestock

FGDs

Gambla village (Kalichelo) Group 1 24-06-15
Mr. Lestion Mwanza
Mr. Mackion Mwanza
Mr. Alifari Sakdia
Mrs. Jane Mwanza
Mrs. Aliness Banda
Mrs. Tisainse Mwanza

Mrs. Geirude Mwanza
M. Tinedensi Mbewe
Mrs. Ruth Mwewe
Mrs. Lida Tembo
Mr. Valei Mwanza
Mrs. Leya Banda
Mr. Ruey Mwaie
Mr. Mabvuto Suko
Mrs. Gisi Chandhia
Mr. Andrew Chandhia
Mrs. Liveness Banda
Mr. Moses Banda

Mphanga Village Group 2 23-06-15 (Chikube)
Mrs. Faninell Baika
Mrs. Elizabeth Tembo
Mr. Patrick Mbulo
Mrs. Matsautso Banda
Mr. Patricia Tere
Mr. Robie Banda
Mr. Stephen Ngoma
Mr. Fackson Banda
Mrs. Elina Mbuko
Mr. Evon Sujumba
Mrs. Florence Mumba
Mrs. Fostina Banda
Mr. Nyangu Zulu
Mrs. Medelina Daika

Group 3 23-06-15 Chikube - supplement
Mr. Goden Banda
Mr. Ackim Mwale
Mrs. Jesi Tembo
Mrs. Naomi Nyambi
Mrs. Lozi Miti
Mrs. Tisayane Tembo
Mrs. Sesiliya Mwanda
Mrs. Chakufa Nkhom
Mr. Kalesi Tembo Weruza Banda