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*Full Length Research Paper*

# Improved seed variety value chains in Zambia: A missed opportunity to improve smallholder productivity

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**Sorghum and millet are very important sources of food and farm income for smallholder farmers, which can be enhanced especially if linked to new markets. Though viewed as minor traditional crops in Zambia, sorghum and millet remain important food crops for semi-arid areas of the country. Production and productivity of these crops is low and has been stagnant for over 20 years. In recent years, there have been new market developments creating incentives for farmers to increase productivity. This study uses a value chain framework to examine the challenges and opportunities for sorghum, millet, and maize in Zambia. Information from 130 smallholder farmers, 57 seed dealers, five private seed companies, and two research institutions was collected in Lusaka and Siavonga districts in 2008. Results showed that despite new market opportunities farmers were slow to adopt new technology. Development and release of improved varieties was very slow due to policy and institutional constraints. Also, significant productivity enhancements were impeded by poor access to high-yielding seed varieties, fertilizer, and by government policies and institutions. The value chains for these crops did not promote productivity gains due to low volumes traded, inadequate access to support services of extension, finance and roads as well as policies that subsidize maize to the exclusion of sorghum and millet. These constraints need to be addressed throughout the value chain to ensure productivity gains.**

**Key words:** Seed value chain, challenges, opportunities, maize, sorghum, millet, Zambia.

## INTRODUCTION

Sorghum and pearl millet rank second and third, respectively as important staple cereals in Zambia after maize. The most important characteristics of sorghum and millets are their ability to tolerate and survive periods of continuous or intermittent drought. Zambia produced an annual average of about 24,000 metric tons of sorghum and 42,000 metric tons of millets between 1987 and 2008 (CSO, 2008). This compares with an average production of about 1,100,000 metric tons of maize, the closest cereal substitute in both production and consumption. Sorghum and millet national average yields are very low, about 0.55 and 0.65 metric tons per hectare, respectively, compared to maize (about 1.5 metric tons per hectare) and yields have not increased for about 20 years.

However, there is potential for increased production of these cereals because of new market developments in

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the beer brewing, feed concentrates, and fortified food processing industries. The new markets have a potential to provide stability, reliability and higher value that will improve the profitability and income of sorghum and millet farmers. Such incentives are expected, in the end, to lead to increased demand for enhanced sorghum and millet production technologies. However, this has not happened as is demonstrated by the two crops' persistently erratic supply that is generally not responsive to increased demand (Larson et al., 2006).

One factor constraining supply is that sorghum and millet are grown in marginal, low rainfall areas by resource poor farmers who generally do not use new technologies such as improved varieties and fertilizers. Other factors impeding growth of the smallholder sorghum and millet sub-sector, which also discourage commercial traders from buying sorghum and millet from local producers, include handling and quality problems (for example, stones and dirt) and the ready availability of maize at cheaper prices. While improved varieties and hybrids have been released, the seed of these crops is not readily available from various seed producers and there appears to be low utilization of certified seed and improved varieties in these crops (Muliokela, 2005; Larson et al., 2006).

The ever increasing disparity between the supply and utilization of improved technologies, on the one hand, and (potential) demand, on the other, identifies the need to understand the two crops' input value chains. The lack of empirical evidence in this area stifles any prospects for informed decisions that can effectively accelerate the growth of the sorghum and millet value chains.

This study analyzes sorghum and millet seed value chains with the goal to identify policy entry points at the various loci of the chains. The study also seeks to identify the factors that determine the observed levels of improved technology use, and to identify opportunities for improving productivity. The idea is to understand the two crops' formal and informal seed systems, and to identify the institutions and policies that affect the performance of the sorghum and millet seed value chains. It is assumed that a high risk-to-return ratio in sorghum and millet production may be the problem limiting adoption of improved varieties. It is further hypothesized that reliable markets (as seen in the beer and feed industry for sorghum and millet) could create incentives that can significantly affect farm level access to improved and certified seed, and thus increase farm level utilization.

The chains for the two crops are also compared with that of maize, a much more established crop whose seed value chain has historically received massive public and private sector facilitation. The study focus was therefore on examining the structure and performance of the sorghum, maize, and millet seed chains in Zambia. Recommendations aimed at improving the competitiveness of sorghum and millet seed value chains are also identified.

## SORGHUM AND MILLET PRODUCTION IN ZAMBIA

Sorghum and millet have been produced in Zambia for centuries, compared to maize which was introduced in the 1900s by European colonialists. However, sorghum and millet production has stagnated over the past 20 to 30 years due in part to government policies, which have increasingly favored maize. Common interventions involved massive campaigns to grow maize, guaranteed prices and provision of market infrastructure. This policy bias has made maize popular even in areas where the soil and climate favor sorghum and millet. When the maize subsidies reached their peak in the late 1980s, the maize area cultivated exceeded one million hectares, and then declined to 600 to 700,000 ha in the 1990s and recently recovered to over 900,000 ha in 2008 (CSO, 2008). The maize area cultivated averaged 688,820 ha from 1987 to 2008. This compares to an average of 41,046 and 64,234 ha cultivated for sorghum and millet, respectively. Sorghum area cultivated ranged from a high of 55,245 in 1994 to a low of 24,349 ha in 2008. Millet area cultivated ranged from a low of 43,569 in 1987 to a high of 95,530 in 1999.

Maize, sorghum, and millet account for about 16% of Zambia's arable land area, of which 86% is under maize alone. The existing prominence of maize seems to suggest an agricultural sector that is seriously in need of crop diversification if crop failure risk is to be kept to the minimum.

Sorghum and millet today are mainly produced by resource-poor smallholder farmers and are generally regarded as subsistence crops. Production varies significantly from year to year depending on weather and prices of competing crops such as maize. Only small volumes of sorghum and millet enter marketing chains, and these transactions take place mainly in rural markets near areas of production and between neighboring households with very little traded beyond these areas (FAO, 2008). Domestic markets for sorghum and millet in Zambia are characterized by limited and variable trade volumes due to scattered and irregular supply, large distances to markets and high transportation costs (Larson et al., 2006). These characteristics make it difficult for commercial processors to obtain adequate supplies.

### Trends in Zambian improved varieties production

After independence in 1964, the Government of the Republic of Zambia (GRZ) implemented a major reorganization of the agricultural sector including the first National Development Plan (1966 to 1970) and

subsequent national development plans. In these plans, one of agriculture's important roles has been to aid in diversifying the economy away from a heavy dependency on copper mining. With regard to the seed industry, GRZ created a state monopoly that owned and controlled the seed industry. Crop varieties were released by public agricultural research institutions and distributed through a public seed company, the Zambia Seed Company (ZamSeed). This system also provided large seed and fertilizer subsidies and credit for maize only, including the provision of maize seed to farmers by the government (Wood, 1990). There was so much emphasis on maize that farmers were encouraged to grow the maize crop even in areas where it was unsuitable to grow, frequently at the expense of other crops.

The implication of this policy was that seeds of traditional crops were inaccessible, resulting in perennial household and national food insecurity (Van Der Walt, 2005). The situation changed in 1992 when the government launched economic reforms under the structural adjustment programme (SAP) under pressure from the International Monetary Fund (IMF) and the World Bank (WB). The changes entailed agricultural input and output market liberalisation, elimination of maize subsidies, and encouragement of private sector participation in the economy (Malope, 2011). This stimulated entry of private firms into the seed industry. The reforms created a seed sector in Zambia that is comprised of the formal and informal sectors and that encourages participation of both the private and public sectors. The SAP also encouraged diversification in crop production, including staples like sorghum, millet and cassava. However, the maize input subsidies and market support programs resurfaced in 2001 and were firmly in place at the time of this paper.

Improved varieties of sorghum and millet produced by seed companies are recorded by the Seed Control and Certification Institute. Whereas, the GRZ encourages sorghum and pearl millet seed production, much of this seed is produced in anticipation of drought relief emergencies. Production of improved varieties of pearl millet has been very low (less than 100 metric tons annually) from 1999 to 2007, whereas sorghum seed production has increased (from about 100 tons in 1999 to 3,500 tons in 2007) in response to the market developments in the brewery industries which have increased demand for improved varieties. Improved varieties for the two crops have been available in Zambia since 1989 through ICRISAT (International Crops Research Institute for the Semi-Arid Tropics) and national breeding programs.

Table 1 presents the sorghum and pearl millet varieties available on the Zambian seed market. The most widely adopted varieties of sorghum (*Kuyuma* and *Sima*) and millet (*Lubasi*) were released in 1989 and 1993, respectively. Some varieties were released in the late 1990s; however, no new varieties have been released officially since 1999. In sharp contrast, for maize, there are over 100 improved varieties available on the market in Zambia (Mungoma, 2008). The difference again is attributed to GRZ policies favoring maize production and substantially more private sector participation in maize seed markets; initially by Kamano, Maize Research Institute (MRI), Pannar, Seed Co. and ZamSeed. Pioneer Hi Bred and Cargill entered the seed market at the time of seed market liberalization but had left at the time of the study in 2008. Since 2008, Pioneer Hi Bred has re-entered the market but Cargill has not.

## MODEL AND METHODS

### Conceptual framework

#### *Why study seed value chains?*

Improved varieties are seed that has been developed by plant breeders. The use of improved varieties has a great potential to leverage the efforts of farmers. Borlaug's research in Mexico in the 1960s resulted in new wheat varieties resistant to a wide range of plant pests and diseases. When critical inputs were supplied, these new seeds produced two to three times more food than previously popular varieties. The most obvious result of improved varieties and inputs is a larger harvest, ideally leading to a greater profit.

By applying the value chain approach, inputs can be viewed as more than just a way to increase production. According to Guenette (2006), the combination of new markets and new inputs can result in what is essentially a new product. It is also about innovative ways to incorporate inputs into the value chain to make it more competitive.

### The concept of value chain

Value chain analysis is a concept that was first described and popularized by Porter (1985). Porter (1985) describes a value chain as a chain of activities for a firm operating in a specific industry. He identifies five competitive forces interacting within a given industry: the intensity of rivalry among existing competitors, the barriers to entry for new competitors, the threat of substitute products and services, the bargaining power of suppliers, and the bargaining power of buyers.[1] Analyzing these forces will reveal the industry's fundamental attractiveness, expose the underlying drivers of average industry profitability, and provide insight into how profitability will evolve in the future, given different changes among suppliers, channels, substitutes, competitors, and/or technologies.

The improved varieties value chain consists of a process with several activities: seed breeding and production, seed multiplication, seed certification, seed processing and seed marketing (Figure 1). The seed research and development process includes breeding new seed varieties and testing seed variety performance. Seed production includes releasing new varieties and increasing quantities for multiplication. Seed multiplication increases seed availability to commercial levels. Seed certification

[1]Other definitions have been developed such as that by Kaplinsky and Morris (2000) who describe a value chain as a "full range of activities required to bring a product or service through the different phases of production, including physical transformation, the input of various producer services, and response to consumer demand."

**Table 1.** Development of sorghum and pearl millet improved varieties, Zambia, 1989 to 2008.

| Crop | Variety name | Type of variety | Year of release | Maturity period (days) | Grain color | Yield potential (MT/ha) |
|---|---|---|---|---|---|---|
| Sorghum | 1. Kuyuma | OPV | 1989 | 100-110 | White | 3-5 |
| | 2. Sima | OPV | 1989 | 110-120 | White | 4-6 |
| | 3. MMSH-375 | Hybrid | 1992 | 110-120 | Brown | 6-10 |
| | 4. MMSH-413 | Hybrid | 1992 | 110-120 | Brown | 6-11 |
| | 5. WP-13 | OPV | 1996 | 145-170 | White | 3-6 |
| | 6. ZSV-12 | OPV | 1996 | 140-160 | White | 2-6 |
| | 7. ZSV-15 | OPV | 1998 | 110-120 | White | 3-7 |
| | 8.MMSH-1257 | Hybrid | 1998 | 110-125 | White | 6-10 |
| | 9.MMSH-1324 | Hybrid | 1998 | 110-115 | White | 3-6 |
| Pearl millet | 1. Kaufela | OPV | 1989 | 90-105<br>95-110 | Dark grey | 2.4 |
| | 2. Lubasi | OPV | 1993 | 115-125<br>115-125 | Light grey | 2.6 |
| | 3. Kuomboka | OPV | 1999 | 110-120 | Grey | 2.8<br>2.8 |
| | 4. Sepo | OPV | 1998 | | Creamy yellow/light | |
| | 5. Tuso | OPV | 1998 | | Grey mix<br>Grey | |

Source: Chisi (2008).

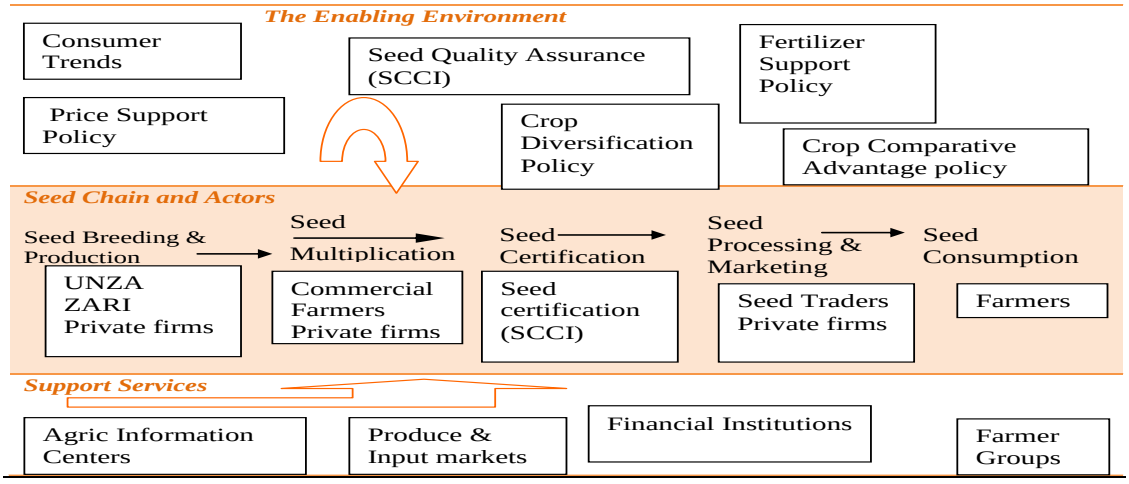


**Figure 1.** Model of the improved varieties value chain, Zambia, 2008. Source: survey data, 2008.

ensures that the quality of the variety is what it is purported to be. Seed processing consists of cleaning, sorting and bagging, while seed marketing and distribution involves distribution and selling of seed to farmer customers.


**Figure 2.** Map of Zambia with Lusaka and Siavonga Study Areas, 2008.

Private companies or 'parastatals' may perform all of these functions or they may specialize in selected parts of these activities. Large firms have the resources to perform all of the activities while smaller firms may choose to specialize in limited aspects such as marketing and distribution (Larson and Mbowa, 2004). The Zambian sorghum and millet seed value chains were for a long time controlled by a government 'parastatal', the Zambia Seed Company. The company's functions included all the activities from seed breeding to seed marketing. Today, the Zambia seed sector has been liberalized and the major source of certified seed, primarily maize, is the private seed companies. The informal seed sector supplies largely un-certified seed.

### *Factors affecting seed supply*

Establishing an efficient and sustainable seed supply system is a critical prerequisite for agriculture-led development as seeds are the single most essential input in crop agriculture. Seeds are the carriers of genetic potential of plants and determine the upper limit on yield while other inputs such as fertilizers and crop protection simply compliment and build on the seed potential.

Traditional African households often acquire planting material or new varieties through multiple channels: formal outlets, local (informal) merchants, exchange with family or neighbors, and/or farm-saved seed. Patterns of seed distribution can be influenced by communication and transportation links, trade or migration routes. Proximity to sources of new material, such as research stations, may also help. In addition, new plant material may appear as OPVs or hybrids in seed from off-farm, or new types mechanically mixed into off-farm seed (Jusu, 1999).

Social factors also shape seed introduction and exchange. The exchange of new varieties can involve social relationships, more often occurring within a particular cultural group, family, or local institution. Migration and marriage may help exchange seed across different clans or ethnic groups. The anthropological literature on farmers' varieties suggests that while there is rarely a monopoly on ownership, there can still be local customs of variety "ownership", which are linked to particular responsibilities (Cleveland and Murray, 1997). Sperling et al. (2006) showed that seed was given, bartered, inherited, and transferred at marriage in Mali. These same authors found that farmers preferred to rely on their own seed because they did not trust seed sources from outside their village networks. It was also considered humiliating for one not to have seed.

Wealth also plays an important role in seed supply and exchange. Farmers who purposefully seek, screen, and/or give out new seed varieties tend to be wealthier, while those chronically needing seed are often considered poor (Sperling et al., 2006). Poorer farmers may have less access to desired seed types because they cannot afford them. However, there is other evidence that poorer farmers may be able to access new varieties through their social networks (Sperling et al., 2006).

### Procedure

Data were collected using an informal checklist for all interviews with key informants and a formal, structured questionnaire for most other value chain actors. Additionally, secondary data were collected from various documents and organizations. Site visits of the study area particularly the input and out market facilities were made and in-depth interviews held with key informants. This helped to cross check data gathered through questionnaires. In summary, data were collected from 130 farming households, 57 seed dealers, all five private seed companies, and two research and development institutions. The study was conducted in Lusaka and Siavonga Districts of Zambia (Figure 2).

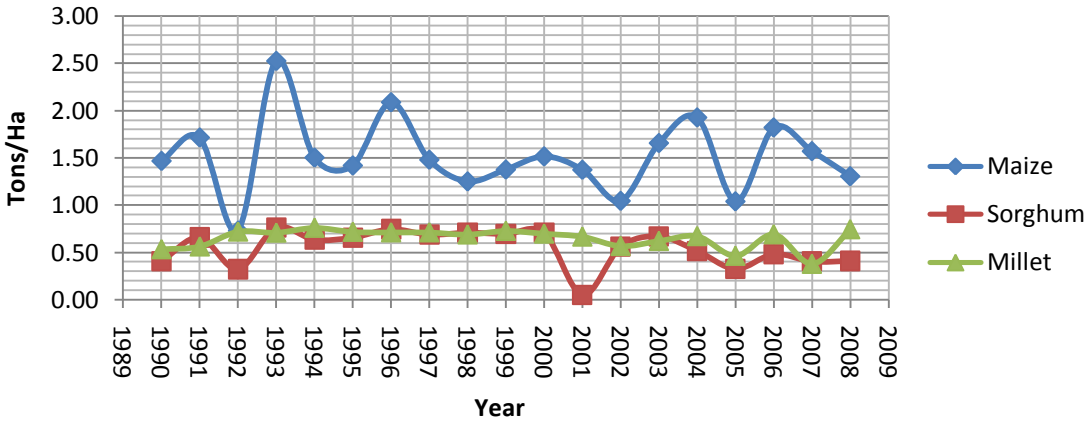


**Figure 3.** Maize, sorghum and millet yield trends, Zambia, 1990 to 2008. Source: MACO (2008b agricultural statistical bulletin).

Data analysis focused on describing the trends in the seed chain since the 1990s to determine the level of improved seed variety use and productivity over the years; and to identify the actors, their functions, value additions and constraints. This was intended to enhance our understanding of the factors affecting the competitiveness of the sorghum and millet seed value chains.

## RESULTS

### Yield trends in maize, sorghum and millet

According to MACO (2008a), the average yield for maize between 1990 and 2008 was 1.52 metric tons per hectare. The highest yield was 2.52 metric tons in 1993 whereas the lowest was 0.73 metric tons in 1992. Sorghum average yields during the same period were 0.55 metric tons with the highest yield recorded in 1993 at 0.76 metric tons per hectare and the lowest was 0.05 metric tons per hectare in 2001. Millet yields (80% is pearl millet) averaged 0.65 metric tons with maximum yield recorded at 0.76 metric tons in 1994 and the lowest yield was 0.38 metric tons in 2007 (Figure 3). The most striking feature about Figure 3 is that yields for all three cereals have been flat, no productivity gains, from 1990 to 2008.

One reason for higher yields in maize compared to the other two cereals was that maize tends to be grown in higher rainfall areas (average rainfall of 900 to 1,000 mm) and on a relatively commercial basis with higher levels of inputs, while sorghum and pearl millet were usually grown in drier (average rainfall less than 800 mm) and drought prone regions by subsistence farmers with low levels of inputs applied. As a production input, seed had strong complementarities with other inputs such as water and fertilizer. Agronomic complementarities among inputs was a major reason why packages of inputs and practices have been recommended to farmers, particularly during the Green Revolution, and by some integrated national seed, fertilizer and credit programs (Guenette, 2006). Zambian fertilizer use was highest in 1993/1994, the same season that recorded the highest maize yields (CSO, 2008). Furthermore, public and private sector plant breeding programs have focused on maize seed over the years and a number of high-yielding maize hybrids and open pollinated varieties have since been released and adopted.

It should be noted that the realized yield for all the crops was far below estimated potential. Maize average yields, for example, have never increased beyond 2.5 metric tons per hectare despite the introduction of hybrids with yield potential as high as 10 metric tons per hectare. The scenario was worse for millet and sorghum which have never gone beyond 0.8 metric tons per hectare compared to potential yields of 6 to 10 metric tons per hectare for improved varieties (Chisi, 2008). This yield gap identified a great need to identify and attend to the causes of agronomic under-performance on farms. Many reasons have been cited for the low yields on farms, including low improved varieties adoption levels, use of farm-saved seeds, lack of fertilizer use, and lack of reliable markets. Policies aimed at increasing use of complimentary inputs and improved varieties should be looked at if food security and increased farm incomes are to be attained.

### Farmer adoption of improved practices

#### *Fertilizer usage*

The GRZ plays a direct role with respect to fertilizer availability and use in Zambia despite various attempts to liberalize the input markets. Currently, Ministry of Agriculture and Livestock (MAL became the new name

for MACO, Ministry of Agriculture and Cooperatives in 2011) through the Farmer Input Support Program (FISP) estimates fertilizer requirements for the year and private firms' tender bids to source and supply the fertilizer in designated areas. The GRZ focus has been almost exclusively on fertilizer for maize production. Compared to maize, the percent of sorghum and millet area applied with fertilizer has been significantly lower over the years and was usually less than 10% except for the 1994/1995 cropping season when fertilizer use on sorghum recorded 13%. This confirms earlier findings by Rusike et al. (1997) and Chisi et al. (1997) in which the insignificant usage of fertilizer in the two crops was observed. The percent of households using fertilizer has also been insignificant in these crops, less than two percent for most years from 1990/1991 to 2008/2009, compared to maize, 30 to 40%, much higher because of the GRZ subsidies. Use on maize reached 63% in 1990/1991 before declining during the SAP.

In the 1990s, the GRZ removed fertilizer subsidies for maize that contributed to a decline in fertilizer used in maize production from 2.6 million 50 kg bags in 1993/1994 to 0.5 million bags in 1997/1998 (CSO, 2008). The percent of area applied with fertilizer declined from 63% in the 1990/1991 season to 35% in the 1997/1998 cropping season. This was during the SAP, when the GRZ ceased offering input subsidies, contributing to a reduced number of households using fertilizer.

The percent of all farmers using fertilizer fell from 31.4% in 1990/1991 season to 22.6% in 1999/2000 (CSO, 2000) and for maize alone, it fell from 44 to 22% during the same period. The largest shares of farmers using fertilizer were in the provinces of Lusaka, Central and Southern which were incidentally the provinces near the rail line where there was good infrastructure and markets.

From 2003 through 2006, the government distributed 45,000 metric tons of chemical fertilizer each year at a 50% subsidy rate under the subsidy program (Jayne et al., 2007). Although the program was scaled down in 2007, the subsidy rate was raised to 60%, which means that chemical fertilizer was then available at 40% of the market prices. Only cooperative members were approved to purchase chemical fertilizer at the subsidized prices. The cooperatives sold inputs to farmers in packages, each containing eight bags of chemical fertilizer (50 kg per bag) and 20 kg of improved maize seed, which corresponds to the requirement for growing maize on one hectare of land. The fertilizer consisted of four bags of Compound D (comprising 10% nitrogen, 20% phosphorous, 10% potassium, and 6% sulphur). The second four bags contained urea at 46% nitrogen for top dressing. This minimum one hectare size package effectively precluded any input purchase below one hectare per cooperative member, which is a constraint for many smallholders.

Farm manure and green manure were not used by surveyed sorghum and millet farmers. If available, they used it on higher value vegetable crops.

### *Improved varieties usage*

Few sorghum farming households in Zambia use hybrid varieties. Households have used more OPV's in crops over the years. As expected, hybrid usage is common among maize producers and is largely associated with the availability of seed subsides. During the SAP, when the GRZ reduced input subsidies, the percent of households using hybrid maize seed declined from 43% in the 1990/1991 season to 20% in 1997/1998. There have been no GRZ seed or fertilizer subsidies for sorghum and millet. The fluctuations observed in improved varieties and chemical fertilizer usage could possibly be attributed to GRZ policy changes and farmers' changing financial conditions, like availability of cash in certain years which can enable them use improved varieties and fertilizer. Sorghum growers reported a high use of OPV's; however, much of that seed may be farm saved seed from year to year and was not purchases of new seed. Since sorghum is a self-pollinating species, OPV's are "in-bred lines" that farmers can easily propagate, whereas pearl millet and maize are open pollinated species. Varieties are either open pollinated populations or hybrids. Farmers cannot propagate hybrids, such as maize, without a significant drop in yields.

## Actors in the maize, sorghum and millet seed value chains

This section defines seed chain actors, their functions in the value chain and describes the chain relationships. There are many players in the seed value chain from seed breeding to farm household seed users. Chain actors come from both formal and informal sectors. The formal sector refers to seed production by public organizations and domestic and foreign private companies using breeder seed, established protocols to maintain quality, and mechanical processing, yielding seed that is tested and labeled for commercial sale (Rusike et al., 1997). Hybrid maize is mainly distributed through the formal channels. The formal sector generally operates on a national scale, while the informal sector is more localized. The informal sector is composed of farmers producing and distributing seed among themselves. NGOs, farmer groups and commodity traders in Zambia control the supply of OPV's for maize, sorghum and millet. The government and NGOs continue to dominate the supply of seed to farmers in marginal areas through drought relief programs.

***The public sector***

The Ministry of Agriculture and Livestock (MAL) is the main public sector actor in the seed chain through the Zambia Agricultural Research Institute (ZARI). In seed production, ZARI works through its Soils and Crops Research Branch (SCRB). The SCRB is mandated to conduct crop research aimed at the development of varieties suitable to different agro-ecological conditions. SCRB is also responsible for the supply of breeders' seed to seed companies and other organizations involved in seed production. Other government departments involved in seed production and distribution are the Seed Control and Certification Institute (SCCI, 2010) and the Field Services department of MAL. The SCCI of Zambia has a mandate to certify seed and coordinate activities in the seed industry. SCCI's main functions include seed quality and certification which encompasses seed testing, seed inspection, variety testing and release. SCCI is also involved in training in seed systems, development of the informal seed sector, seed trade control, and coordination of the seed industry.

***Private seed companies***

The private sector seed companies operating at the time of the interviews included Kamano, Maize Research Institute (MRI), Pannar Seed Company, Seed Co. Ltd (or SeedCo). Zambia Seed Company (ZamSeed), and seed traders. Their main functions are seed production, multiplication and distribution of hybrid and OPV seed. They sell seed through regional distributors; the majority of whom have outlets in almost all farming communities. Most of them have their own breeding programs, do their own seed multiplication on-farm and/or through contracting commercial farmers.

SeedCo, (Headquarters in Zimbabwe) and Pannar (Headquarters in South Africa) are regional seed companies who compete with the national seed companies like Kamano, MRI, and ZamSeed for the seed market shares in the country. Hybrid maize seed production is their major business. However, SeedCo and ZamSeed also manage a range of field crops and vegetable seeds. The two companies mainly target crop hybrids for areas with good market access while OPVs are targeted for areas with relatively poor market access and poor communities. MRI and Pannar, on the other hand, indicated that they did not promote OPVs and in future would only do so if the OPVs can equal the least performing hybrid. As a result they do not handle sorghum, millet and maize OPVs. All of these seed companies contract out seed production to farmers as a way of reducing their work load and spreading risks.

For private seed companies, hybrids are of greatest interest in terms of market sales because farmers cannot use farm saved seed without a substantial drop in yields. For farmers, hybrids yield the most. OPV yields cannot compete with the hybrids.

***Non-governmental organizations (NGOs) and faith-based Organizations***

Non-governmental organizations (NGOs) are typically made up of activists who are devoted to working on particular issues according to a set of principled ideas or values (Gillespie, 2002). The World Bank defines NGOs as "private organizations that pursue activities to relieve sufferings, promote the interests of the poor, protect the environment, provide basic social services, or undertake community development" (World Bank, 2002). Their primary goals are to affect positive social change in societies, trying to fill the gaps that government either will not or cannot fill (Shah, 2001).

In the Zambian agricultural seed sector, their roles cannot be over emphasized. They are mainly involved in seed production and distribution of maize, sorghum and millet OPVs. They include Care International, Harvest Help, Program Against Malnutrition (PAM), World Vision International, Farmers' Warehouse, and other faith-based organizations such as the New Apostles Church. In the Siavonga study area, Harvest Help and the New Apostles Church were involved in seed multiplication and distribution. These two NGOs in Siavonga support seed multiplication projects and seed auctions to promote the circulation of both improved and local seed among farmers. They mainly work with farmer groups where they train farmers in seed multiplication, stocking and conserving of seed and they have been active in training farmers in improved on-farm seed multiplication techniques with extension support. Other activities of NGOs in the seed sector include community-based seed production, village seed stores and seed banks, and education on simple methods for ensuring and monitoring seed quality.

***Seed grower associations and cooperatives***

Seed Grower Associations and Cooperatives are mainly farmer groups involved in seed multiplication and distribution that were formed to supply inputs to farmers. In the study area, Lusitu Cooperative and Siavonga Growers Associations work in collaboration with GRZ and NGOs where they receive support in seed production and extension.

***Seed dealers***

Seed dealers are a vital link between farmers and seed

**Table 2.** Seed dealer types and type of seed, Siavonga Region, Zambia, 2008.

| Type of dealer | Frequency | Percent |
|---|---|---|
| Farmer selling surplus seed | 22 | 38.6 |
| Seed Trader | 5 | 8.8 |
| Seed companies and agents | 6 | 10.5 |
| NGOs and Faith based organization | 3 | 5.3 |
| Farmer seed producers | 21 | 36.8 |
| Total = N | 57 | 100 |
| | | |
| Type of seed involved | | |
| Maize hybrid | N/a | 35 |
| Maize OPV | N/a | 37 |
| Sorghum | N/a | 48 |
| Millet | N/a | 2 |
| Other | N/a | 15 |

Own survey data (2008).

**Table 3.** Quantities sold of improved varieties per dealer, Siavonga Region, Zambia, 2003 to 2008.

| Year | Mean quantities of improved varieties sold (kg) | | |
|---|---|---|---|
| | Maize | Sorghum | Millet |
| 2008 | 263 | 340 | 31 |
| 2007 | 235 | 224 | 28 |
| 2006 | 209 | 220 | 13 |
| 2005 | 191 | 237 | 15 |
| 2004 | 18 | 107 | 12 |
| 2003 | 16 | 100 | 14 |

Own survey data (2008).

supply from the public corporations and private companies. They are the retailers in communities and are able to cover large areas, given their knowledge of both formal and informal seed networks. Seed dealers in the study area also sell other agricultural inputs such as fertilizers and pesticides. Most seed dealers are also farmers (Table 2). In 2008, some seed dealers had been operating 10 for years, but most of them have been operating for an average of 8.3 years. Some dealers operated in their own stalls (14%) while the majority (82.5%) engaged in door to door sales. Others sold from road side stands. Most seed dealers (43.9%) obtained their supplies direct from their own production and other seed dealers (21%), from other farmers (19.3%) and from seed companies (15.8%). Seed dealers were mostly engaged in the sale of sorghum and maize seed, and only a small fraction (2%) were engaged in selling millet seed.

### *Seed distribution*

The average quantities of improved varieties distributed per dealer in Siavonga for the three crops under study from 2003 to 2008 are shown in Table 3. Distribution of improved varieties has increased for all the crops. The quantities of sorghum distributed per dealer were the highest in 2008. This reflects the increased demand for sorghum seed by the farmers over the years and this could be attributed to increased processor demand and to policies of diversification away from maize to those of other crops.

### *Seed users (farm households)*

Household heads were generally in their 40s with a mean age of 47.9 years. Most of them have at least some

**Table 4.** Smallholder use of improved varieties Siavonga Region, Zambia, 2008.

| Crop | Percentage (%) |
|---|---|
| Maize | 88.4 |
| Sorghum | 46.3 |
| Millet | 8.6 |

primary education. The oldest household head was 89 while the youngest was 20. Almost two thirds of surveyed household heads were male and one third were female. The mean number of persons living in each sample household was 6.3 with an average of 3.1 persons under the age of 15 and 0.39 persons above the age of 60. Most of the household heads were married.

**Sources of household income and livelihood strategies:** Apart from their own farming activities, the respondents were asked to indicate what they considered to be their other major income generating activities for the household. The survey results showed that the farm households in the study area have diverse sources of income. Major off-farm activities include trading, doing non-agricultural piece work, undertaking small businesses like arts and crafts, fishing, local beer brewing and sales, bricklaying and food for work. However, about 30% of households were not earning income outside their farming activities.

**Crops grown:** Households were asked to recall their cropping patterns during the 2007/2008 cropping seasons. The results showed that the average household's cultivated area for major food crops (sorghum, maize and millet), and seed cotton was relatively higher when compared to other crops. Maize had a mean cultivated area of 0.9 ha; sorghum had 1.2 ha, millet had 0.8 ha, and seed cotton had 1.0 ha in the 2007/2008 seasons. Other crops grown include groundnuts, soybeans, and cowpeas which had relatively small areas cultivated. Some of the households did not cultivate their land leaving it as virgin land or in fallow. Gardening is another land use activity that is usually done in the dry season. It should be noted that these results are probably an over-estimate of the absolute amount of land cultivated because the data are based on information collected on land area cultivated to different crops, some of which are inter-cropped.

**Seed variety use:** The frequency with which farmers replenished seed from external sources is known as the seed replacement rate. The seed replacement rate is further defined as the number of times a farmer has replaced the seed of a given variety of a crop grown in the study season since first growing that variety (Heisey and Brennan, 1991). This is commonly used by commercial seed organizations to forecast the demand for their varieties and a higher seed replacement rate is thought to be desirable for improved varieties. For sorghum, millet and open pollinated maize varieties, a maximum of 3 years is recommended for seed replacement (Chisi, 2008 personal communication). Seed replacement protects against genetic deterioration. Replacing seed for the purposes of changing varieties can enhance yield potential (Heisey and Brennan, 1991).

Seed replacement also buffers against pest and disease problems through maintaining genetic resistance or diversity in sources of resistance over time (Apple, 1977). To analyze improved varieties utilization, farmers were asked to indicate the maximum number of years that a variety has been grown and the maximum number of years the seed of that variety has been used. A farmer might grow a variety for many years but, each season, a new seed lot is planted. The age of varieties on farms measures the rate of variety change (Brennan and Byerlee, 1991; Heisey and Brennan, 1991). Farmers in the survey district have been using the same crop varieties and farm saved seed for several years, especially for millet which has an average replacement period of 14.5 years. Sorghum improved varieties and farm-saved seed were replaced an average of 4.7 years. When asked to state whether they used improved seed in the previous season (2007/2008), a high proportion of respondents (88%) used improved maize varieties compared to 46% in sorghum and less than 8% in millet (Table 4).

As expected, maize seed is replaced more often than sorghum and millet seed, with a replacement rate averaging about 1.1 years. Using farm saved seed does not create market incentives for seed companies to invest in new technologies for these crops. Private companies focused on maize which is replaced regularly and is profitable for private sector firms.

### *Policies and institutions affecting seed value chain competitiveness*

To succeed, the seed sector needs an enabling environment. Ideally, this would consist of the structures (national, provincial, local and research agencies), and institutions (policies, regulations and practices) that are beyond the direct control of economic actors in the value chain (Hellin et al., 2009). In particular, policies and access to institutions were singled out by the respondents as having had a major impact on the performance of the sorghum, millet, and maize seed value chains.

The restructuring of public sector services and liberalizing support services during the SAP enabled private firms to enter into the seed market, input supply

market and also to expand their investments in research and extension. These changes have not achieved the expected productivity gains and output, especially for the resource poor farmers. Market liberalization has adversely affected most smallholder farmers who depended on input subsidies and a stable market for maize. Frequent droughts over the past decade or so have also not helped matters.

However, in the late 1990s, government policy began to exert greater thrust on crop diversification with the aim to reduce the country's over-dependence on maize. Implementation of this policy has increased public sector and international agency research in crops such as cassava, sorghum, pearl millet, finger millet, cowpeas and sweet potatoes. Another crop policy initiated in the 2004 national policy was that of "comparative advantage", where a particular crop was promoted more intensely in the areas of its most comparative advantage. This policy was also aimed at removing the maize monoculture from areas where maize was not suitable but was promoted by large government subsidies (Muliokela, 2005).

Although crop diversification was expected to favor the competitiveness of non-maize crops, the re-introduction of maize subsidies and market support programs in 2002 has continued to affect the growing of crops such as sorghum and millet. Given the key role of smallholder farmers in maize production and their limited resources, the resumption of a subsidy program was driven by the fact that a majority of the smallholders cannot afford chemical fertilizers due to the high market prices (MACO, 2008a). The government distributed 45,000 metric tons of chemical fertilizer each year at a 50% subsidy under the fertilizer support program from 2003 through 2006 (Jayne et al., 2007). To date the GRZ agricultural policies continue to be targeted at maize.

On the other hand, the rising food inflation and cost of maize products (particularly maize meal) has encouraged many consumers to look for alternatives to maize meal. An important indicator is the increased availability of sorghum and millet processed foods to urban consumers on the retail market. A visit to Spars, one of the big retail shops, and other chain retail stores in Lusaka found stocks of millet meal on the shelves. This is not the usual case for urban consumers. Recently, the beer industry started using sorghum as the main ingredient in its Eagle brand clear beer and opaque beer brewing may offer the same potential. Government incentives to Zambian Breweries to use sorghum as a substitute for maize in beer brewing are increasing demand for sorghum at the industrial level.

### *Access to institutional support services*

Farming households and other chain actors need institutional support services or facilities to effectively gain access to improved varieties and also product markets. The services examined here included (a) access to input suppliers/markets, (b) membership in farmer organizations/associations, (c) access to product markets (d) access to financial or credit services and (e) access to agricultural information. In this study access to support services was looked at from the point of view of farmers while acknowledging that other users also need support services.

Most of the sorghum and millet growing areas are in remote areas of Zambia and Siavonga, the survey district, is a typical example of such areas. The study area is located 264 km from Lusaka, the capital city, and there is a tarred road that connects Siavonga to Lusaka. Lusaka is the major source of input and output markets for the district. The road network in the farming area is gravel and the hilly terrain makes access to most places difficult. Telecommunication services and electricity are available in the town only, even though some rural areas access cellular networks. A variety of tools and implements can be purchased from nearby districts, mainly Kafue and Lusaka. A visit to Siavonga town and Lusitu rural centre also showed that the retail shops only stock spare parts for implements like ox-drawn ploughs, and hand hoes. Local traders and the Lusitu cooperative sell farm inputs such as seeds, fertilizers, pesticides, and fungicides. Loans can be obtained from micro-institutions, and infrequently from commercial banks.

**Knowledge of location of support services:** Farming households were asked to indicate whether they knew the location of the facilities relevant for their farming business and consequently this might affect adoption of improved farming technologies such as use of improved varieties and fertilizers. Most farming households in the study sample reported knowing where the facilities were located. The commonly known facilities were input suppliers, agricultural information centers and financial service providers, while the locations of product markets were the least known by farming households. This indicates that most farmers were not marketing their products or were using their homestead for marketing their products.

**Percent of households using support services:** Although the majority of farming households in the study sample knew where the services were located, some did not use these services. Responses varied according to type of service. Financial services were the least used support services by farming households with 85% not using them. The second least used service was the input market with non users comprising 64.1% of the farming households. The farmer group information centers were most commonly used by 68.8% of households.

**Reasons for not using support services:** Of the respondents that knew the location of services, a follow

up question asked them to give the main reason why they were not using these services. Reasons varied from the location being too far, did not use support services, and other reasons. Respondents that were not using the financial services available in the area said the major reason for not using them was that they were too expensive. This is understandable considering that interest rates for borrowing are generally very high. The average interest rate observed was 25% per annum from commercial banks. The other major reason for not using financial facilities was that they did not qualify for credit as most of them were resource poor households with no collateral to use for borrowing (Larson et al., 2006). Other reasons given for not accessing credit are that the locations of the facilities were too far away, while others said they did not need credit.

For those households that were not using the input suppliers/markets, the major reason was that they did not see the need of using the input markets. This poses a great concern because successful adoption of improved varieties requires the use of complimentary inputs as noted earlier. This group of farmers who may not see the need of using other inputs may need extension education services. Distance was another major concern that was cited by non users of input markets.

A high proportion of farming households who were not using agricultural information centers (60%) or product markets (50%) indicated that they did not see the need. On the one hand, a reason for not using formal agricultural information centers for example could be that these farmers relied more on other farmers as a major source of information. On the other hand, public extension service has been the main source of agricultural information over the years, along with traditional mass media such as radio. However, farmers in this area, like many rural areas, lack information access due to the decline of the public information extension services. The challenges relating to human and financial resources have limited their capacity to effectively and efficiently provide information to small-scale farmers. In a survey of information needs of small-scale farmers conducted in two of the nine provinces of Zambia, Kalusopa (2005) found that constraints to information access were caused by weak human capital and technical infrastructure, lack of clear national information policy and lack of a coordinated agricultural support system for small-scale farmers. Those that did not see the need to use product markets either had no marketable surplus or buyers came to their homesteads.

**Distance to support services:** Farmers in Siavonga face difficulties in accessing support services because of their location. For instance, the distance to input markets ranges from 0 to 265 km and averaged 50.8 km and the distance to the financial suppliers ranged from 0 to 150 km with an average of 33.1 km. The nearest facility was the agricultural information centre, which averaged 0.87 km from the farming households. Distance to the nearest product market ranged from 0 to 200 km with an average of 7.87 km. For both input and output markets one could occasionally spot door to door operators roaming the villages to buy grains and sell seed, which is an indication that farmers in this area do not depend exclusively on formal markets for their products and inputs.

## CHALLENGES AFFECTING SEED VALUE CHAIN ACTORS IN ZAMBIA

This section looks at the factors that affect the competitiveness of the maize, sorghum and millet seed chains as pointed out by various chain actors.

### Challenges faced by producers of improved varieties (seed companies)

Several challenges were identified that affected the competiveness of the value chains at the seed distribution stage. Most challenges centered on low profitability of the seed marketing business, more so for sorghum and millet. For maize, competition was singled out as a major challenge for the seed companies. However, this could provide an opportunity for seed traders to lower their costs and to pass the gains down to the seed users (farmers). This in turn can increase the adoption of improved varieties.

Another problem faced by some seed companies was that they do not have the human capacity to undertake variety improvement research. This poses a challenge as quality issues arise when the crop cannot be improved. The high payments made to contract seed growers (farmers) for seed multiplication was another issue that was pointed out by seed companies. An important factor limiting the profitability of seed production was the apparent linkage of input prices to the United States Dollar (USD). The unstable exchange rate of the Zambian currency (Kwacha) often results in high and variable input prices because seed multiplication contracts were usually signed in USD. It was argued that the adverse cost implications arising from exchange rate fluctuations cannot be readily transferred down the chain, let alone the seed end users. As a result, seed prices were often below marginal cost of production. Lack of stable and reliable end user markets was another constraint cited by seed producers for maize.

For sorghum and pearl millet, seed companies cited lack of stable markets as a major constraint to improved varieties production. The major buyers of sorghum and millet seed are the GRZ and NGOs who normally buy the seed in anticipation of a drought in the country. Much of the production of seed for these crops was only planned

if seed companies were awarded tenders from GRZ and/or NGOs.

One huge constraint in sorghum and millet production was lack of breeder/foundation seed by some seed companies. As mentioned earlier, improved sorghum and millet varieties available on the market were released by the government in collaboration with ICRISAT. ZamSeed was given exclusive rights to market the varieties when it was a parastatal company. Upon privatization 20 years ago, ZamSeed was given ownership of the breeding material by the government. Twenty years later, ZamSeed still held exclusive rights to public breeder material for sorghum and millet varieties including at the time of the study. ZamSeed was not actively using the breeder seed for commercial purposes and did not release it to other seed companies. The social cost of not releasing the breeder rights (intellectual property rights) to other seed companies and to sorghum and millet growers who lost the opportunity to buy more productive varieties has undoubtedly been very high. In 2009, the variety release committee asked ZamSeed to select the varieties they would want to keep and make the rest of the public varieties available to all other seed companies. With this policy change, private seed companies can now market any new sorghum and millet varieties that are released by public research.

**Constraints faced by seed dealers/traders**

The main constraints faced by the seed dealers include high transportation costs (32%) and lack of stable markets (31%). Distribution of seed to the farmers was hindered by poor road networks in the rural areas particularly in Siavonga which has a hilly terrain. Some roads were impassable by vehicle during the rainy season making seed delivery impossible. However, there were dealers who indicated that seed transportation costs were shared with other commodities and therefore did not consider transportation as a major constraint. Lack of stable markets and low prices were also major constraints faced by traders, this is because many farmers rely on their own farm saved seed.

**Constraints faced by seed users**

Maize, millet and sorghum seed users were asked to identify and rate the challenges on a three point scale ranging from 1 (the constraint not being an issue) to 2 (when it is somewhat of an issue), and 3 (when the constraint is considered very challenging). Farmers were divided on how they perceived grain quality as a challenge in the maize seed varieties that they used. Almost an equal percentage of households perceived grain quality as an issue and others as not an issue. For sorghum and millet, the majority of farming households in the sample did not view grain quality as an issue in the varieties that they used.

Pests and diseases were perceived as very challenging by most of the farming households for sorghum and maize seed, while in millet, the majority of the households did not perceive pests and diseases as an issue. Availability of desired varieties was a major issue for sorghum and maize. For sorghum, lack of desired varieties might be a problem considering that the last developed improved variety was released about 20 years ago. Most of the sorghum varieties available are prone to bird attack and also have high tannin content (Mwandila 2008, personal communication). The majority of the households were content with the millet varieties used as most of them did not see the availability of desired varieties as an issue.

Most new seed varieties are developed for higher input conditions and are more responsive when used with fertilizer and better agronomic practices. Private seed companies must look at opportunities to increase seed sales. However, the new seed and fertilizer package means higher cash costs which pose a financial constraint for resource poor smallholders. They might adopt new varieties more rapidly, if the new varieties were more adapted to low rainfall and low soil fertility conditions. It is well known that seed varieties must be location specific. Participatory breeding programs have been used successfully in West Africa for sorghum and pearl millet to speed up adoption and improve smallholder productivity. Farmers are directly involved in priority setting for the breeding programs, variety identification, and variety testing (Weltzien et al., 2007).

Extension services were rated as very challenging by most farming households for all three crops. This may imply that the quality of technical support for farmers is also limited. There were a few NGOs as well as government agencies providing extension services and production advice in the area, but their outreach was limited. Public extension workers have very limited transport and therefore were not able to make frequent visits to farmers in the area. The GRZ therefore has to prioritize its activities so as to improve the extension services in the area by providing extension workers the necessary support to enable them reach most of the farmers.

Credit access and product markets alike were viewed by most seed users (farmers) for sorghum and maize as challenging while for millet they did not see them as an issue. It must be emphasized that farmers in this area do not grow millet to sell but only keep at the household for food security. That could be a reason why credit access and markets were not viewed as a challenge for them. The fact that markets particularly for sorghum were still viewed as challenging by most farming households shows that there was a weak market information system

in the area. Farmers have not taken advantage of market opportunities that existed in sorghum offered by Zambian Breweries' demand for sorghum as a raw material for clear beer (Larson et al., 2006). This also seems to suggest that initiatives promoting sorghum and millet have focused more on producing for household food security without a good understanding of true market needs and opportunities. Low volumes, inconsistent supply and quality problems are factors that prevented processors of sorghum from using sorghum sourced from smallholder farmers. This suggests that awareness and understanding of consumer preferences and market demand was limited among farmers in the area. This has resulted at times in the inability to successfully market sorghum and to take advantage of new market opportunities.

Processing technologies and distribution infrastructure were equally perceived as very challenging by a majority of farming households for all three crops. This is a challenge to policy makers and developmental actors alike if these crops are to be grown at a competitive level. There is a need to improve processing technologies which can enable farmers to add value to the products. Adequate infrastructure also leaves much to be desired, this is a problem which was also pointed earlier by the seed dealers.

Other constraints faced by farming households were poor germination of seed, high prices for improved varieties and lack of preferred packaging sizes for improved varieties. Many farmers prefer to buy package sizes of 5 kg or less but in most cases seed is packaged in 10 or 20 kg bags particularly for maize seed. The high cost of complementary inputs like fertilizer was also cited as a challenge. This was because subsidized fertilizer and seed package was only available for maize and it was not available for sorghum and millet.

## Conclusions

The study found that yield levels for both sorghum and millet have been stagnant at about 0.5 tons per hectare for about 20 years. Farmers depend too much on farm saved seed for planting the next season. The average seed replacement rate varied by crop (once every 1.1, 4.7 and 14.7 years for maize, sorghum and millet, respectively) and was low for sorghum and millet compared to a three year replacement rate recommended by researchers. Several higher yielding varieties of sorghum and millet, developed in the 1990s, have not been adopted by farmers. The most widely adopted varieties of sorghum (*Kuyuma* and *Sima*) and millet (*Lubasi*) were released in 1989 and 1993, respectively.

No new varieties have been released officially since 1999. This slow pace of release and adoption acts as a major disincentive for private seed companies to market new varieties of sorghum and millet. In sharp contrast, domestic and foreign private companies have introduced over 100 maize varieties in the same period. An important difference is attributed to GRZ policies favoring maize production and the substantially more private sector participation in the maize seed value chain. In 2008, the five private sector firms active in the seed value chain were Kamano, Maize Research Institute (MRI), Pannar Seed Company, Seed Co. and Zambia Seed Company (Zamseed). Pioneer and Cargill entered the seed market during the SAP market liberalization period but left prior to this study in 2008.

The GRZ maize policies, especially the fertilizer and seed subsidies of 50 to 60% and direct maize price support have contributed to the expansion of maize production, even in drought prone areas where sorghum and millet are superior crops to grow. The policy has created a near monoculture in maize, adversely affected crop diversity and increased the risk of crop failure in dry years.

There were a number of key actors in the seed value chains for maize, sorghum and millet. They included public sector agencies such as ZARI, SCCI, UNZA, and the Ministry of Agriculture and Livestock, who played key roles in varietal development, inspection, certification, and in providing extension services. Farmers' organizations, NGOs and faith-based organizations have worked closely with the GRZ departments and seed companies in seed distribution and extension services. Seed traders were also an important link. The most important seed end users were small-scale, mainly subsistence farmers. Seed companies identified lack of stable markets and low quantities of improved varieties purchases as key constraints in sorghum and millet markets. Constraints faced by seed traders in the selling of improved varieties in the area were low quantities of seed purchased by buyers, delayed payments by farmers and stiff competition among traders.

Limited access to input markets, extension services, lack of desired varieties and processing technologies were some of the challenges that farming households faced. In addition, despite the new markets for sorghum in the brewery industry, farmers still view marketing as a challenge.

## RECOMMENDATIONS

The fact that the use of improved varieties among the end users was low represents a major constraint to private sector investment in the seed value chain for new improved varieties in sorghum and millet. Extension services are necessary to stress the importance of a higher seed replacement rate compared to the current practice. There is also a need to develop varieties that

match farmers' needs. Participatory breeding programs that directly involve farmers from the very beginning of the seed process would likely lead to varieties better adapted to local conditions. This type of program has been used successfully in West Africa. This would likely contribute to increased demand for improved varieties and improve prospects for private sector participation. Varieties need to be bred for both higher input conditions and for lower input conditions.

Capacity building programs for smallholders are important. There is a need to develop an agribusiness extension package for sorghum growers to improve productivity and production. Smallholders and traders need to learn better business skills and better agronomic practices including fertilizer use and crop rotation to improve soil fertility. Education programs are needed to focus on product handling and quality improvements. Increased access to sources of financing can mitigate farmers' barriers to entry into new market developments in the processing sector such as the beer industry. There is also a need to improve feeder roads and marketing infrastructure; build storage facilities and link farmers to new markets via contracts, producer associations and/or out grower schemes.

Large and continuing maize subsidies contribute to a near-monoculture agriculture that is very dependent on one crop. Agriculture needs more crop diversity to lower crop failure risks. Given sorghum and millet's important roles in food security, there is a need to reduce or eliminate direct subsidies to maize production while also enhancing the competitiveness of sorghum and millets production.

The study also recommends focused value chain initiatives which will link farmers to new market opportunities to increase farmer incentives to adopt new technology that can increase productivity, incomes and food security.

## STUDY LIMITATIONS

Due to resource limitations, it was not possible to examine all actors in the seed value chain; however, all the key players and actors were interviewed. Furthermore, there was difficulty in acquiring confidential financial information among some seed dealers and traders. To mitigate these weaknesses, data with sufficient quality were also sought from secondary sources and expert opinions to allow both quantitative and qualitative analyses.

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