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SORGHUM AND PEARL MILLET IMPROVED SEED VALUE CHAINS IN ZAMBIA: CHALLENGES AND OPPORTUNITIES FOR SMALLHOLDER FARMERS

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SORGHUM AND PEARL MILLET IMPROVED SEED VALUE CHAINS IN ZAMBIA: CHALLENGES AND OPPORTUNITIES FOR SMALLHOLDER FARMERS

Abstract

Sorghum and millet are a very important source of food and farm income for smallholder farmers, which can be enhanced especially if linked to new markets. These two crops have been widely viewed as minor traditional crops in the Zambian food systems. The two crops were displaced by maize in the 1900s with the opening of the copper mines. However, they remain important food crops for semi-arid areas of the country. In recent years, there have also been new market developments requiring farmers to increase productivity and production. Unfortunately significant productivity enhancements are impeded by low access to improved technologies such as high-yielding seed varieties.

This paper reports the results of a sorghum and millet seed value chain study. Its main objective has been to understand the different actors in the chains, and to identify the factors that determine the observed low level of technology used. Information from 130 farming households, 57 seed dealers, five seed companies, and two research and development institutions was collected with the view to understand their characteristics, key roles, competitiveness, and constraints with respect to the improved seed value chain. Most seed value chain actors play multiple roles, ranging from varietal development, inspection and certification, seed production, processing, marketing, and provision of extension services.

Research results found that yield levels for both sorghum and millet have been stagnant at about 0.5 tons per hectare for over 20 years. Farmers depend too much on farm saved seed for planting the next year. The average seed replacement rate was 13.7 years 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 & Sima*) and millet (*Lubasi*) were released in 1989 and 1993, respectively. No new varieties have been released since 1999.

The government maize support programs, such as fertilizer and seed subsidies of 50-60 percent and direct 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 more recent diversification policy, and changes in consumer preferences were found to be some of the factors affecting the competitiveness of the chain. Seed companies identified lack of stable markets and low quantities of improved seed purchases as key constraints in sorghum and millet markets. Constraints faced by seed traders in the selling of improved seed 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. The study recommends developing and offering a range of improved seed varieties to farmers to increase demand, and also focus on initiatives which will link farmers to market opportunities through outreach, institutional improvements and further research.

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LIST OF ACRONYMS

CSO	Central Statistical Office
FAO	Food and Agricultural Organization
GRZ	Government of Republic of Zambia
HH	Household Head
ICRISAT	International Crop Research Institute for the Semi Arid Tropics
INTSORMIL	International Sorghum and Millet Research Program
MACO	Ministry of Agriculture and Cooperatives
NGO	Non Governmental Organization
OPV	Open Pollinated Variety
SCCI	Seed Certification & Control Institute
USAID	United States Agency for International Development
UNZA	University of Zambia
ZARI	Zambia Agricultural Research Institute
ZAMSEED	Zambia Seed Company

DEFINITIONS OF TERMS

Breeder Seed	Seed that is produced by a breeding unit in small quantities for multiplication to reach the desired volumes for sale to farmers
Pre-basic Seed	Seed produced by a multiplication unit that is one generation after breeder seed but will be multiplied again before being sold to farmers
Basic Seed	Seed produced by a multiplication unit that is one or two generations after breeder seed but will be multiplied one more time to produce seed that will be sold to farmers
Local Variety	A variety that has been developed by farmers and is grown by farmers without any formal plant breeding
Hybrid Seed	Seed produced by crossing two or more separate in-bred lines. Hybrid seed typically produces high yields the first year, but the yield drops if recycled for a second year.
Open Pollinated Variety	A crop variety that can pollinate and reproduce naturally (either through self- or cross-pollination) and whose seed can be saved, as opposed to hybrid seed.

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SORGHUM AND PEARL MILLET IMPROVED SEED VALUE CHAINS IN ZAMBIA: CHALLENGES AND OPPORTUNITIES FOR SMALLHOLDER FARMERS

1. INTRODUCTION

Zambia is endowed with a vast amount of land covering about 75 million hectares, of which 40-50 percent is suitable for the production of livestock and a range of both traditional and non-traditional crops. Although the potential to expand agriculture into relatively fertile lands is high, only about 20 percent of the country's arable land is cultivated (Kimhi and Chiwele, 1997). The area under cultivation for different crops has varied little over the last decade and is dominated by maize. Sorghum and pearl millet rank second and third, respectively, as important staple cereals after maize. An important characteristic of sorghum and pearl millet is their ability to tolerate and survive during periods of reduced rainfall or intermittent droughts. These two crops also have potential for increased utilization provided supportive policies are put in place.

Over the years, the markets for these two cereals have remained limited and confined to rural farming communities with very little trade beyond those areas. The government has paid disproportionately more attention to maize, the main staple cereal, through supportive polices such as the price and fertilizer support programs. This policy emphasis on maize has led to the displacement of sorghum and millet even in areas where they have a comparative advantage over maize. Maize has been the most important staple food crop for most Zambians during the past 40-50 years (FAO, 2008). Traditional food crops like cassava, sorghum and millet, which are better adapted to drought-prone agro-ecological conditions in Zambia and whose consumption was widely accepted in pre-colonial times, are in danger of extinction. Recent policy pronouncements that support diversification are rooted in this fear, acknowledging that maize-based national food security has become increasingly vulnerable to droughts and adverse weather conditions as well as economic factors such as the cost of chemical inputs (FAO, 2008). Studies have shown that unless sorghum and millet can be produced competitively with maize, their commercialization will be difficult to achieve (Chisi et al., 1997; Monyo et al., 2001).

Sorghum and millet are small but very important sources of food and farm income for small scale farmers that can be enhanced if linked to new markets. These two crops have been widely viewed as minor, traditional crops in the Zambian food systems over the years. However, they do remain important food crops for semi-arid areas of the country. Today, there are new market opportunities that have been identified in the country which offer significant opportunities for farmers to increase their productivity and income (Larson, Erbaugh, Hamukwala & Tembo, 2006). These opportunities are in clear beer brewing, feed concentrates and fortified food processing markets. These new markets have the potential to provide stability, reliability and higher value that will improve the profitability and income of sorghum and millet farmers. Improved markets will also increase the demand for enhanced production technologies.

However, inadequate and erratic supply of sorghum and quality problems, especially contamination and poor grading, and the ready availability of maize at a cheaper price, prevents commercial users from buying sorghum and millet from local producers. While improved varieties and hybrids have been released, the seed of these crops is not readily available from various seed producers and the use of certified improved seed for these two crops appears to be

low (Muliokela, 2005 and Larson et al., 2006). An analysis of the agricultural input chain, particularly the seed value chain, remains critical to the development of sorghum and millet markets.

Currently production of sorghum and pearl millet in Zambia is concentrated in the Northern, Western, North-western and Southern Provinces. Finger millet is commonly grown in Northern and North-western provinces, where there is a higher amount of annual rainfall, whereas sorghum and pearl millet are more widely grown in the drier areas of Eastern, Southern and Western Provinces. Zambia produced an annual average of 23.4 thousand metric tons of sorghum and 44,400 metric tons of millets between 1990 and 2008 (CSO, 2009), compared to about 102,000 metric tons of maize. Smallholder sorghum and millet yields have been generally very low, averaging 0.55 tones and 0.65 tones per hectare, respectively.

1.1 Objectives

This study aims to increase understanding of sorghum and millet seed sector operations and market developments, by placing special emphasis on the identification of weaknesses and points of intervention along the value chain. The study uses a "Seed Value Chain" approach to identify chain functions with the least value and to draw recommendations on ways to improve the competitiveness of the chain. The study also seeks to understand the formal and informal seed systems for sorghum and pearl millet, map out the actors in the chain that influence seed performance, and identify institutions and policies that affect the performance of the sorghum and millet seed sector. A seed value chain analysis of the maize seed sector was also conducted as a standard for comparison because maize has an effective seed value chain in Zambia.

This study adopts the premise that agricultural markets (as seen in the clear beer and feed industry for sorghum and millet) can significantly increase farm level demand and utilization of improved certified seed. By identifying the chain functions which create the least value in the sorghum and millet seed sector, recommendations aimed at improving the competitiveness of the chain are identified. Market and crop production risks and low return rates in sorghum and millet production may be a problem limiting adoption of improved seed varieties.

The overall objective of this study is to describe and examine the value chain for traditional and improved sorghum, maize and pearl millet seed in Zambia

Specific objectives are to:

i) Determine farmer adoption of improved seed and fertilizer and yields for sorghum, maize, and millet crops since 1990.
ii) Identify key players, their functions, and value added at each stage of the chain.
iii) Identify factors that limit adoption of improved seed varieties.
iv) Determine strategies to increase adoption and returns, and reduce risk in the value chain.

1.2 Rationale

The research provides empirical evidence on the effects of seed supply systems to the on-going research on the market and strategies developments. Constraints that prevent or slow adoption of new seed varieties will be identified and addressed. The results will be presented to policy makers including the Government of the Republic of Zambia and researchers such as the International Sorghum and Millet Program (INTSORMIL). The ultimate impact will be solutions leading to higher yields and incomes that will improve food security. This will benefit farm households, agribusinesses, rural communities and urban communities. As stated in the USAID agriculture strategy paper on linking producers to markets, "the long road to economic development begins with increasing productivity" (USAID, 2004). Developing linkages between producers and markets should provide the incentive for farmers to adopt new production-enhancing technologies developed by collaborating INSTORMIL research programs.

1.3 Study limitations

Due to resource limitations, it was not possible to examine all supply channels and actors in the seed sector. Furthermore, there was sensitivity in acquiring some financial information among some seed dealers and traders who failed to provide data relevant for understanding value addition at different stages of the chain. To mitigate these weaknesses, data were also sought from secondary sources and expert opinions.

2. IMPROVED SEED VALUE CHAIN

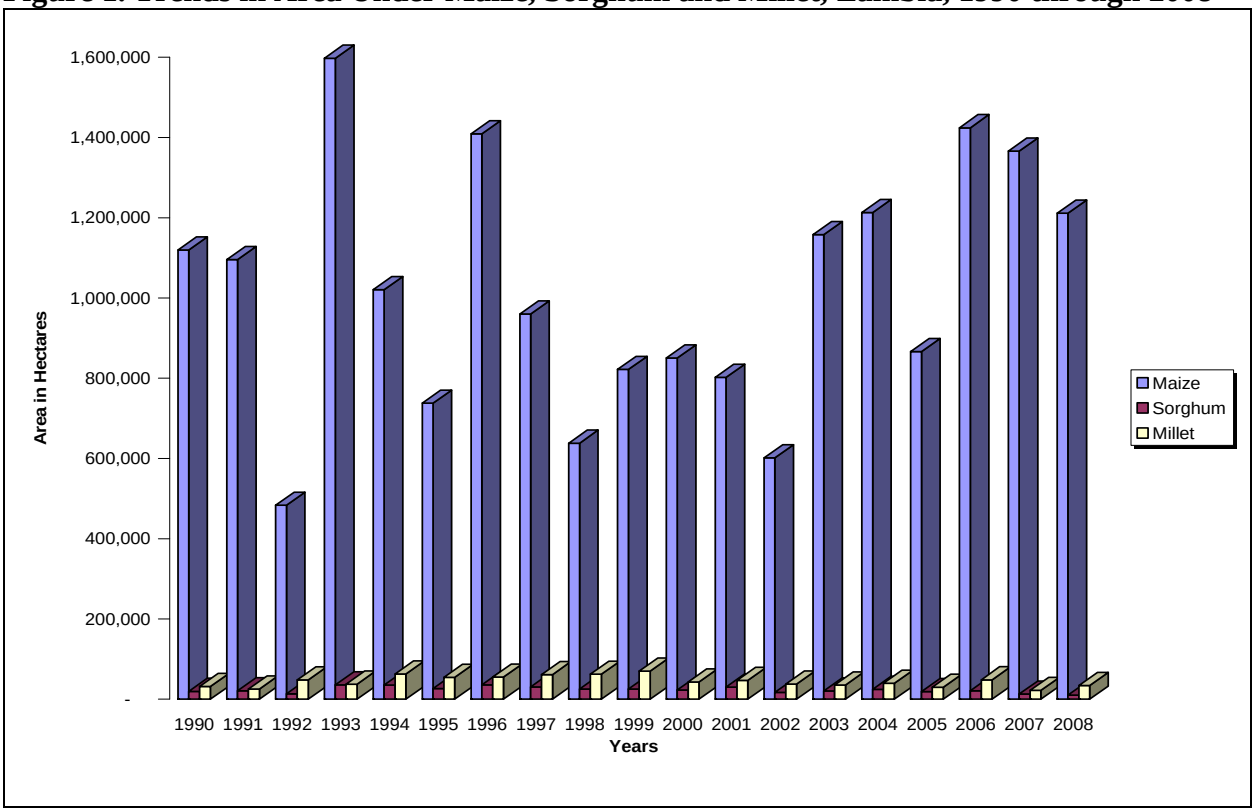
This section begins with a discussion of the trends in sorghum and millet production, and then discusses improved seed production in Zambia followed by a brief review of studies related to factors affecting seed supply. A discussion on the concept of value chain and its relevance to the seed sector is then presented. The section ends by looking at factors affecting the competitiveness of the value chain.

2.1 Sorghum and millet production in Zambia

Sorghum and millet make up about half of the total cereal production in Africa, and about 23 percent in Southern Africa. More sorghum and millet are grown in Botswana and Namibia than anywhere else in Southern Africa (FAO, 2008). Sorghum and millet have been produced in Zambia for centuries, compared to maize which was only introduced in the 1900s by European colonialists. However, sorghum and millet production has substantially declined over the past 20-30 years due in part to government policies which have increasingly favored maize. Common interventions involved massive campaigns to grow maize, guarantee prices and provide 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 area under maize cultivation was about 1 million hectares, accounting for 70 percent of the total area cropped in Zambia (FAO, 2008). This high percentage of area cropped in maize indicates a near monoculture agriculture that is very dependent on one crop creating an agriculture in need of more crop diversity to lower crop failure risks.

Sorghum and millet today are mainly produced by resource-poor smallholder farmers and are generally regarded as subsistence crops. Only small volumes 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. In addition, production varies significantly from year to year depending upon weather and prices of competing crops such as maize. Figure 1 shows the area under maize, sorghum and millet from 1990 to 2008. The area under sorghum and millet production has varied little over the years while that of maize, though fluctuating substantially, has remained higher despite government calls for diversification into other crops. Since the year 2000, area under maize production has trended upwards. CSO data (2008) shows that maize production averages 1.02 million metric tons annually compared to that of sorghum and millet which average 234,000 and 44,000 metric tons annually, respectively, for the same period.

Figure 1. Trends in Area Under Maize, Sorghum and Millet, Zambia, 1990 through 2008



Source: Data from the Agricultural Census Bulletin (2008)

2.2 Trends in Zambian improved seed production

After independence in 1964, a major reorganization of the agricultural sector was made, including the first National Development Plan (1966-1970) 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, Zambia came up with a monopolized government-controlled seed industry in which a formal seed supply system was maintained and controlled by the government. Crop varieties were released by public agricultural research institutions and distributed through a public seed company, the Zambia Seed Company (ZamSeed). This system also brought heavy subsidies and credit for maize only, including the provision of maize seed to farmers by 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**.** This stimulated entry of private firms into the seed industry. Among them were Pioneer Hi Bred, Cargill, Carnia Seeds, Seed Co, Kamano, and Pannar seed companies**.** 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 remain in place at the time of this report. The seed sector in Zambia today is comprised of both the formal and informal sectors. The formal sector comprises both the private and public sector.

Whereas the government encourages sorghum and pearl millet seed production, much of this seed is only produced in anticipation of drought relief emergencies. Improved varieties for the two crops have been available in Zambia since 1989 through ICRISAT and national breeding programs. Table 1 presents the sorghum and pearl millet varieties available on the Zambian seed market. All of these varieties have been on the Zambian market for almost 20 years and there have not been any new varieties released since 1999. For maize, there are over 50 improved varieties available on the market in Zambia (Mungoma, 2008). The difference again is attributed to policies favoring maize production compared to other crops.

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	Grain color	Yield Potential/ha
Sorghum	1. Kuyuma	OPV	1989	100-110 days	White	3-5 tons
	2. Sima	OPV	1989	110-120 days	White	4-6 tons
	3. MMSH-375	Hybrid	1992	110-120 days	Brown	6-10 tons
	4. MMSH-413	Hybrid	1992	110-120 days	Brown	6-11 tons
	5. WP-13	OPV	1996	145-170 days	White	3-6 tons
	6. ZSV-12	OPV	1996	140-160 days	White	2-6 tons
	7. ZSV-15	OPV	1998	110-120 days	White	3-7 tons
	8.MMSH-1257	Hybrid	1998	110-125 days	White	6-10 tons
	9.MMSH-1324	Hybrid	1998	110-115 days	White	3-6 tons
Pearl millet	1. Kaufela	OPV	1989	90-105 days	Dark grey	2.4 tons
	2. Lubasi	OPV	1993	95-110 days	Light grey	2.6 tons
	3. Kuomboka	OPV	1999	115-125 days	Grey	2.8 tons
	4. Sepo	OPV	1998	115-125 days	Creamy yellow/light grey mix	2.8 tons
	5. Tuso	OPV	1998	110-120 days	Grey	2.8 tons

(Source: Chisi, 2008)

2.3 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. They 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 build an enabling environment for plant production.

Traditional African households often acquire planting material or new varieties through multiple channels: formal outlets, local (informal) merchants, and exchange with family or neighbors, or from hybridization in their own field. Patterns of seed introduction can be influenced by communication and transportation links, roadways and trade, or migration routes. Proximity to sources of new material, such as research stations, may also help. In addition, new types of plant

material may appear as hybrids or off-types in the field or in seed supplied from off-farm, or they may be mechanically mixed into off-farm seed. The results of such mixtures and hybridizations may be important sources for novelty, even in crops that are largely self-pollinating (Jusu, 1999).

Social factors also shape seed introduction and exchange. The exchange or new varieties can involve social relationships, more often occurring within a particular cultural group, family, or local institution. Migration, or marriage exchange, however, may help move seed across different clans or ethnic groups. A survey of the anthropological literature on farmers' varieties suggests that while there is rarely a monopoly on ownership, there can still be local conceptions of variety "ownership," which are linked to particular responsibilities (Cleveland and Murray, 1997). Though seed is often given as a gift, this is rarely absolutely free, but serves to reinforce social ties. A study done by Sperling et al., (2006) in Mali showed that seed was given, bartered, inherited, and transferred at marriage. Barter was also observed in local markets, where grain of a known variety was occasionally sold as seed. These same authors found that farmers preferred to rely on themselves for seed because they did not trust seed sources outside their village network. 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 (they have less variety security, as well as seed security) because they cannot afford the terms of supply. However, there is other evidence that poorer farmers may be able to access new varieties through their social networks (KIT et al., 2006).

2.4 Concept of value chain

Several definitions of a value chain exist. Kaplinsky et al., (2000), describes 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." Keyser (2006) on the other hand describes a value chain as "all of the factors of production including land, labor, capital, technology, and inputs as well as all economic activities including input supply, production, transformation, handling, transport, marketing, and distribution necessary to create, sell, and deliver a product to a certain destination." A seed value chain in this study refers to the entire sequence of actions necessary to create, sell, and deliver improved seed to farmers.

For sorghum and millet, the seed value chain consists of a process with three main activities – seed production, seed processing, and seed marketing. The seed production process includes breeding new seed varieties, testing seed variety performance, releasing new varieties for multiplication, and increasing the seed variety amounts to commercial levels. Seed processing consists of cleaning, sorting and bagging while marketing involves distributing, and selling seed to end users. Private companies or parastatals may perform all of these many activities 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 selected aspects such as marketing and distribution (Larson and Mbowa, 2004). In Zambia seed production for sorghum and millet was for a long time controlled by government through its research and development to the marketing of commercial seed through ZamSeed. Today the seed sector has been liberalized.

The major source of certified seed is the private seed companies while the informal seed sector supplies largely uncertified seed.

2.5 Importance of seed value chain analysis

The use of improved varieties has a great potential to reward the efforts of farmers. When used appropriately, they can create a difference between a good and a poor harvest. Norman Borlaug, father of the Green Revolution, publicized the wonders of improved seed in the 1960s. His research in Mexico resulted in new wheat varieties resistant to a wide range of plant pests and diseases. When complementary inputs were applied, these new seeds produced 2-3 times more food than previously popular varieties. The most obvious result of improved inputs is a larger harvest, ideally leading to a greater profit.

Using a new fertilizer or a disease-tolerant seed variety can dramatically increase production. However, in 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. He explains that, using the right seeds and fertilizers can yield a product that can be certified new. While the product itself is the same, the market perception of it may be radically different. Guenette (2006) further explains that improving input supply is also about more than just new seeds and fertilizer. It is also about innovative ways to incorporate input supply into the value chain and make the chain itself more competitive. For instance, a value chain approach to improving access to inputs could identify input suppliers who have access to small-scale farmers and create a certification system that turns an input supply depot into an agricultural information hub. The small-scale producer will gain access to improved inputs, and the input supplier enjoys greater business through a new role. Value chain analysis can also help to explain the connection between all the actors in a particular chain of production and distribution and it shows who adds value and where, along the chain. It helps to identify pressure points and make improvements in weaker links where returns are low (Schmitz, 2005).

Value chains in general provide a unique way to manage risk by all players. In food value chains for instance, buyers are assured a supply of desired products and are able to trace the food back to the farm of origin, while suppliers are more assured of a market. Value chains can improve access to a market and reduce the time it takes to respond to changing customer demands. Agrifood value chains increase competitive advantage by linking producers, processors, marketers, food service companies, retailers and supporting groups such as transporters, research groups and suppliers. Companies link their field production practices with supermarket sales to form value chains with key suppliers of various agricultural products. They work with their suppliers over the long-term to improve quality, consistency and safety of food supply (FAO, 2008). The value chain also can help improve farmers' income through identification of enterprises that contribute to production, constraints and opportunities affecting progress, and identifying strategies necessary to compete and improve earnings (Baker, 2006)

2.6 Factors affecting the competitiveness of the value chain

Porter (1990) espouses that public policy affects the national competitive advantage of the businesses through influencing the operating conditions and institutional structures that surround firms. Thus, governments' most powerful roles are viewed to be indirect rather than

direct. That is, they are supposed to influence competition by shaping the business environment rather than by intervening directly. What are most often expected to be shaped in the business environment are the incentives for innovation such as provision of infrastructure and supportive policies. However, in reality, government policies have been shown to influence the competitiveness of the chain directly (see, for example, Hellin and Meijer, 2006). They found that in Mexico subsidies were undermining farmer's traditional seed recycling practices. With the subsidy, OPV seed was free so there was little incentive to continue growing landraces. Thus, the policy environment constituted the biggest influence on farmers' seed choice. A study by Monyo et al., (2001) in Mozambique, Zambia and Zimbabwe showed that almost all sorghum and pearl millet seed adopted by farmers was derived from free or highly subsidized seed distribution programs run by governments and non-governmental organizations (NGOs). The authors contend that availability and easy access to subsidized seed further limited commercial incentives to develop rural markets.

An impact study by Howard et al. (1993) found that adoption of improved maize varieties among small- and medium-scale farmers in Zambia was fast and high by any standard in the period 1989-1991. The area under improved maize increased from 52% to 58% in 1989-1991 periods, whereas it was 0% in 1983. The increased adoption was attributed to high maize subsidies and a regulated and guaranteed market for maize and other agricultural products during the same period. The study further revealed that 36% of the sampled area was under improved sorghum varieties; 27% of small scale farmers adopted improved sorghum varieties while medium and large scale farmer adopters were 71% and 100 % respectively. Muliokela (2005) cites national seed programmes and monopolistic seed agencies' focus on maize hybrid seed at the expense of traditional crops essential for household food security and seed security as one of the reasons for low utilization of improved sorghum and millet seed in Zambia.

The availability of service organizations and social networks surrounding the participants also influence the competitiveness of the chain. These include, among others, access to input and output markets, membership in farmer organizations/associations, and participation in government and NGO support programs (Hellin and Meijer, 2006). Farmer organizations can provide farmers with many services that are critical to their success in accessing facilities like markets thereby leading to active and effective farmer participation in value chains (Hellin et al., 2009). A study conducted by FAO (2004) in India showed that more than 70 percent of India's milk was produced by households who own only one or two milk animals, and these producers formed part of a nationwide network of dairy cooperatives. Hellin et al. (2009) in their study of farmer organizations in Central America found that collective action and farmer organizations among maize producers in La Fresca focused largely on accessing subsidized seed and fertilizer along with extension advice. In most cases, farmers will only access support services as groups rather than as individuals.

3. METHODOLOGY

This section discusses the approach to collecting data. It outlines the methods and procedures used to achieve the stated objectives. It gives information on how the seed chain was mapped, agro ecological regions of the study area, value chain actors surveyed, research design and sampling procedure.

To obtain a complete picture of the structure and performance of the sorghum and pearl millet seed value chains, a combination of qualitative and quantitative techniques was used. A carefully designed check list was used as a guide in all key informants while structured questionnaires were used to collect quantitative data. Secondary data were collected from various documents and organizations. The seed value chain analysis for sorghum and millet first began by mapping the chain for the crops and identified key informants at critical nodal points in the value chain and then followed these on to the next level. In addition, 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. Data analysis focused on describing the trends in the seed chain since the 1990s to determine the level of improved seed use and productivity over the years, actors and their functions, value additions and analyzing constraints. This was intended to get a clear understanding of the factors affecting the competitiveness of the seed.

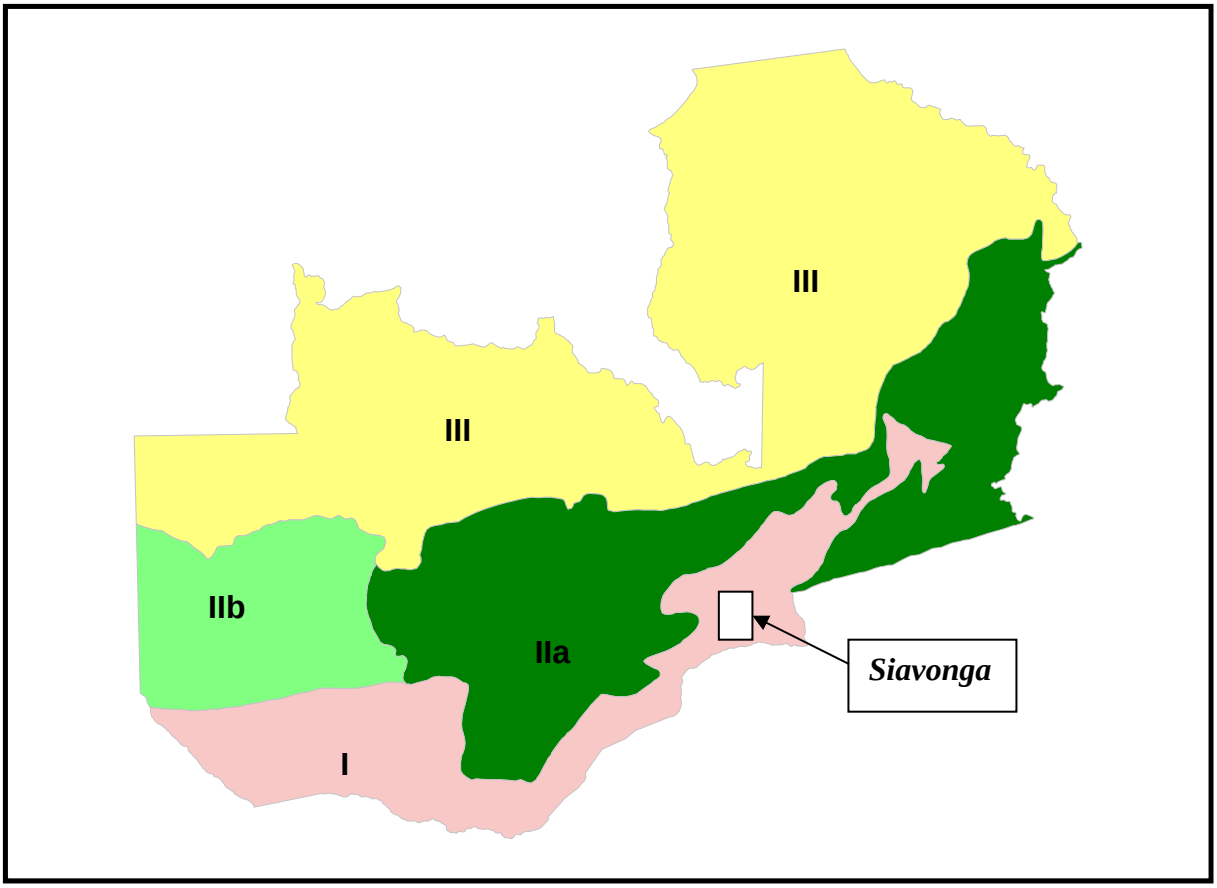
3.1 Study locations

The study was conducted in Siavonga and Lusaka districts, targeting farmers, seed companies, seed traders and dealers, and research institutions. Selection of Siavonga District in Southern Province for a study site therein benefited from extensive consultations with knowledgeable key informants and organizations, including the Ministry of Agriculture and Cooperatives (MACO). Lusaka was included mainly for key informant interviews with seed producers, most of whom are located in Lusaka. Siavonga is in Agro-Ecological Region (AER) I (Figure 2), where annual rainfall is less than 800 mm and the growing season is generally short constituting 60-90 days.. Minimum and maximum temperatures are 14°C and 31°C, respectively. Small-scale subsistence agriculture and livestock rearing are the major livelihood systems. Thus, crops are grown mainly for household consumption with limited local trade within the district and little to no exports outside the district. Cotton is the main cash crop and vegetable cultivation is an income source for some households during the dry season. The main livestock kept are cattle, goats and chickens and these are important income sources at household level. Cattle are also essential for plowing (CS0, 2008).

Figure 2 presents the four AERs of Zambia. Region I embraces the Southern and Eastern river valleys characterized by low rainfall, less than 800 mm, flat and steep topography with Haplic Luvisols (MACO, 2008) and Haplic Solonetz on the flat land and Dystric Leptosols on the hills and ridges. Region IIa constitutes the central plateaus with rainfall of 800 to 1,000 mm. The soils are mainly Haplic Lixisols (MACO, 2008), Haplic Luvisols, Haplic Acrisols and other soil types. These soils are productive, for cultivation of sorghum, maize, groundnuts, cow peas and a range of cash crops including tobacco, sunflower, irrigated wheat, soybean and horticultural crops. Region IIb constitutes the aggraded western plateau with rainfall of 800 to 1,000 mm. The soils are Ferrallic Arenosols which are infertile, coarse sands. Cassava, bulrush millet and Bambara nuts (Voandzeia) predominate on the upland with some maize and sorghum; in the flood plain

rice, maize and sorghum are grown. Region III includes the north and north-western plateaus characterized by high rainfall of 1,000-1,500 mm per annum. The soils are mostly Haplic Acrisols which are highly leached and acidic. Traditional farming systems are based on slash and burn. The main crops are finger millet, beans and cassava. Cash crops include maize, sunflower, coffee, tea, tobacco, irrigated wheat and soybeans (MACO, 2008).

Figure 2. Agro-Ecological Regions of Zambia



3.2 Value chain mapping

The value chain map, as identified by Hellin and Meijer (2006), is a conceptual and practical tool that helps identify policy issues that may be hindering or enhancing the functions of the chain and also institutions and organizations providing the services that the different chain actors need in order to make better informed decisions. Their study identified a market map which is made up of three interlinked components namely the value chain actors, the enabling environment (infrastructure, policies, institutions and the processes that shape the market environment) and the service providers (business or extension services that support the value chain's operations).

Therefore, in this study, chain mapping involved delineating the flow of seed from seed producers to seed users. The chain actors, who transact the seed as it moves along the chain, their respective roles, and the inter-relationships among them were identified. Value adding practices and returns thereof, constraints faced by supportive organizations and how they respond to the

promotional efforts and the prevailing enabling environment were explored. Other data collected included prices and quantities of seed at different stages of the chain, crop varieties found in farmers' fields, and the rationale behind the choice of these varieties. Data were collected using structured questionnaires and check lists.

3.3 Groups surveyed

Seed producers, seed users, and seed dealers/traders were surveyed in October 2008. Structured questionnaires and checklists were designed for each of the three groups. All questionnaires were pre-tested prior to the surveys to seek clarity in questions, identify possible gaps and inconsistencies. Based on the pretest results, relevant modifications were made.

3.3.1 Seed users

The seed user survey examined farmers' sources of seed and characteristics of seed, access to support services, perceptions regarding production and price risks, linkages with other stakeholders, as well as constraints to increased use of improved seed. Interviews were conducted with heads of households. These included information on household characteristics (age, sex, education, marital status and family size), resource endowments, crop production practices, and seed acquisition methods and challenges.

The farmers were selected based on their participation in a 2006 baseline survey which looked at market developments in sorghum and millet. The sample in the baseline was selected from a total of five agricultural camps believed to be sorghum and millet producing areas. A sample of 130 households was drawn from among the five camps. In each selected camp, a sample of about 26 households was drawn using simple random sampling, facilitated by the random number generator in Microsoft Excel.[1] A secondary list for 10 households from each of the five camps was selected at random to cover for members in the primary list (26) from each of the camps who could not be interviewed due to various reasons. The sampling frame for each of the camps was obtained from the farmers' register available at the district.

3.3.2 Seed dealers

The population of seed dealers in the area was not known especially from the informal sub-sector. Thus, snowball sampling was used. That is, known seed dealers were asked to identify other seed dealers that they knew who were then identified for interviews. Knowledgeable individuals from 57 seed dealers were interviewed using a structured questionnaire. These dealers ranged from local seed traders to individual surplus farmers. Data were collected on the

[1] To sample the households in each camp, the listed households were first assigned unique but sequential sampling serial numbers, starting from one. Thus, the total number of households in the camp was equal to the last serial number assigned. Following common practice by the Zambia Central Statistical Office (CSO), we assume a cluster take (i.e. the number of selected households per cluster or camp) of 26. The following steps summarize the procedure that was used to select sample households in each cluster/camp: i) Calculate the sampling interval for each category, $I_h = \frac{N_h}{n_h}$, where n_h is the number of households selected from camp *h*, N_h *is* the total number of households listed in the sampling frame of the selected camp *h*; ii) Generate a random number (R) between 1 and the Interval *I*; the first selection was hence R; iii) Add the interval to the random number to get the next selection; and iv) Add the interval repeatedly until you get your desired sample size.

profiles of the seed dealers (including number of years of operation, place and type of operation facilities), seed sales and purchases (by crop and variety type, quantities, cost, prices, seed sources, sales/purchase arrangements and promotions), constraints faced, and linkages with other seed dealers and various stakeholders.

3.3.3 Seed producers

A semi-structured questionnaire was administered to all the seven (7) formal seed producers, five (5) of whom were seed companies. The remaining two were sorghum breeders from the Zambia Agricultural Research Institute (ZARI) and the University of Zambia (UNZA). Information on their involvement in seed production, production costs, seed sources, service provided, linkages and constraints faced were collected.

4. RESULTS AND DISCUSSION

This section discusses trends in farmer adoption of improved practices for maize, sorghum and pearl millet crops in terms of yield, fertilizer and improved seed use from 1990 to 2008. It also looks at the characteristics of the improved seed chain actors in terms of their demographics and roles played in the seed value chains. The mapping of the seed chain which consists of actors and their interlinked functions is also discussed, as well as value additions at each stage of the chain for the sorghum, pearl millet and maize improved seed. The chapter ends with a discussion on constraints as perceived by chain actors in the seed value chain

4.1 Yield trends in maize, sorghum and millet

Figure 3 compares millet and sorghum yields to that of maize. According to MACO (2008), the average yield for maize between 1990 and 2007 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. The published data do not distinguish among the various species of millet but it is estimated that 80% of this is pearl millet (MACO, 2008). Millet yields 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.

One reason for higher yields in maize compared to the other two cereals is that maize tends to be grown in higher rainfall areas and on a relatively commercial basis with higher levels of inputs, while sorghum and pearl millet are usually grown in drier and drought prone regions by subsistence farmers with low levels of inputs applied. As a production input, seed has strong complementarities with other inputs such as water and fertilizer. Agronomic complementarities among inputs is 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). Table 2 shows that fertilizer use was highest in 1993, the same season that recorded the highest maize yields. Furthermore, plant breeding programs in the country over the years have focused on maize seed 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 in all the crops is far below estimated potential. Moreover, yield trends during the past 20 years depict no productivity gains for any of the three crops (Figure 3). Maize average yields, for example, have never increased beyond 2.5 tones per hectare despite the introduction of hybrids with yield potential as high as 10 metric tons per hectare. The scenario is worse for millet and sorghum which have never gone beyond 0.8 metric tons per hectare compared to potential yields of 4-5 metric tons per hectare for improved varieties. This identifies a great need to identify and attend to the causes of agronomic under-performance before anybody even looks at marketing challenges. Many reasons have been cited for the low yield on farms, including low improved seed adoption levels, use of recycled seeds, and fertilizer application rates. Policies aimed at increasing use of complimentary inputs and improved seed should be looked at if food security and increased farm incomes are to be attained.

Figure 3. Maize, Sorghum & Millet Yield Trends, Zambia, (1990-2008)

Data source: MACO, 2008 Agricultural Statistical Bulletin

4.2 Farmer adoption of improved practices

4.2.1 Fertilizer usage

The Government of Republic of Zambia (GRZ) has a direct role with respect to fertilizer availability and use in Zambia despite various attempts to liberalize the input markets. Currently the Zambian government through the Food Reserve Agency 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. Data on fertilizer usage in Zambia were difficult to find for most years especially for sorghum and millet. However several studies and expert opinions suggest that there has been no significant usage of fertilizer in sorghum and millet (Rusike et al., 1997; Chisi et al., 1997).

Tables 2 and 3 present quantities of fertilizer used in maize production from 1993-1998 and also the share of farmers using fertilizer in general by province in Zambia from 1990 to 2000 respectively. The results show that maize area and the number of households using fertilizer declined over the years. During the structural adjustment period, the GRZ disengaged from offering input subsidies, contributing to a reduced number of households using fertilizer. . The share of households using fertilizer fell from 31.4% in 1990/1991 season to 17.8% in 1998/1999. The provinces with the largest share of households using fertilizer Lusaka, Central and Southern are incidentally the provinces near the rail line where there is good infrastructure and markets.

From 2003 through 2006, the government distributed 45,000 tons of chemical fertilizer each year at a 50% subsidy rate under the 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 is now available at 40% of the market prices. Only cooperative members may purchase chemical fertilizer at the subsidized prices. The cooperatives sell 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 a hectare of land. This effectively precludes any input purchase below one hectare per cooperative member, which is a constraint for many smallholders.

Table 2. Fertilizer Usage for Maize Production, Selected Years, Zambia

Season	Fertilizer (50kg Bags)			% of Area Applied With Fertilizer
	Basal	Top	Total	
1993/1994	1,295,422	1,341,808	2,637,230	49
1994/1995	672,525	718,658	1,391,183	33
1995/1996	872,773	801,385	1,674,158	31
1996/1997	345,510	368,813	714,323	14
1997/1998	243,580	255,702	499,282	12

Source: Agriculture Census Bulletin, 2008

Table 3. Percentage of Farmers Using Fertilizer by Province for Selected Years (1990-2000), Zambia

Province	1990/91 %)	1993/94 (%)	1995/96 (%)	1998/99(%)	1999/00 (%)
Central	51.03	49.69	33.31	36.96	33.76
Copper-belt	23.47	12.83	33.14	39.09	32.90
Eastern	37.56	24.38	17.67	20.63	28.55
Luapula	8.94	15.51	13.43	6.60	7.76
Lusaka	53.03	58.73	26.39	23.64	37.13
Northern	39.4	29.04	22.64	15.82	16.91
North-western	15.4	18.20	13.01	6.45	4.93
Southern	42.96	33.22	26.66	25.95	38.95
Western	12.3	5.79	4.16	2.55	1.27
Zambia	**31.36**	**26.87**	**19.92**	**17.80**	**22.6**

Source: CSO, Post harvest Surveys

4.2.2 Improved seed usage

Data on the level of improved seed use for each of the crops was difficult to find. Table 4 below shows a share of farmers using maize hybrid seed for selected years from 1990 to 1998. The trend shows that the percent of household using hybrid seed has declined from 43 percent in 1990/91 season to 17.4 percent in 1998. This again was attributed to government reduction of input subsidies.

Table 4. Percentage of Farmers Using Maize Hybrid Seed by Province for Selected Years

Province	1990/91 (%)	1995/96 (%)	1996/97(%)	1997/98 (%)
Central	71.64	35.80	26.36	28.6
Copper-belt	27.93	29.26	12.59	13.37
Eastern	17.93	26.20	3.16	3.78
Luapula	40.76	9.06	12.09	13.06
Lusaka	85.9	39.34	29.04	22.04
Northern	65.16	13.49	21.02	15.94
North-western	24.44	6.44	3.91	4.77
Southern	62.6	50.65	49.01	44.73
Western	28.24	10.68	5.54	12.15
Zambia	**43.6**	**22.95**	**17.04**	**17.44**

Source: CSO, Post harvest Surveys.

4.3 Seed chain actors in the maize, sorghum and millet sub-sectors

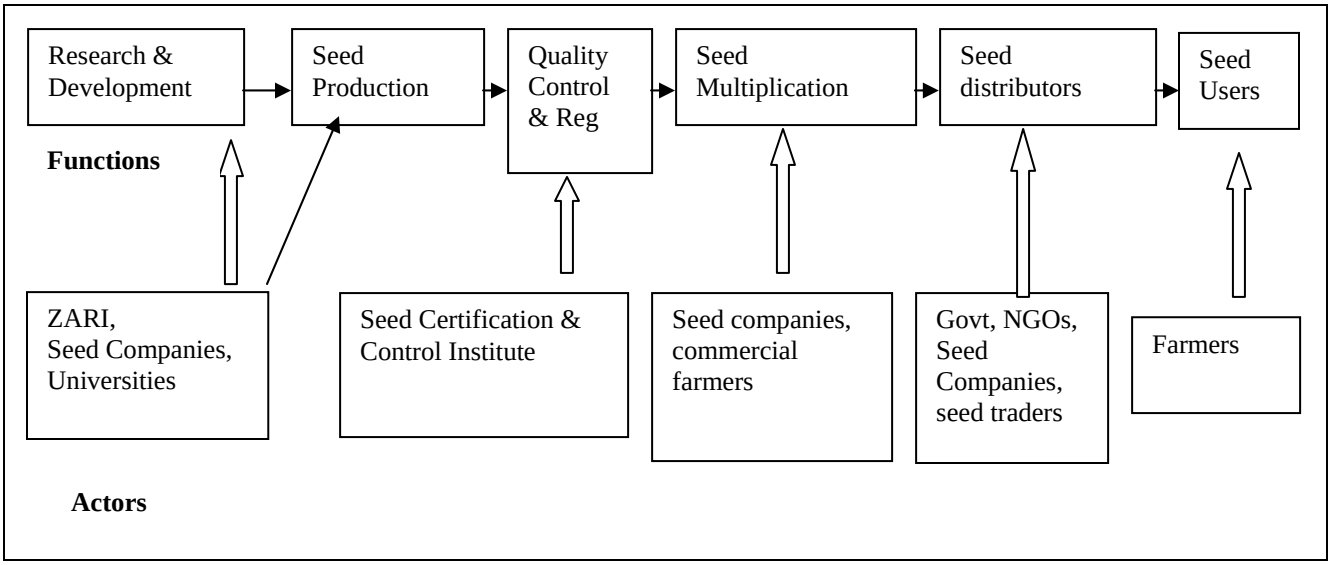
This section defines seed chain actors, their functions in the value chain and describes the chain relationships. A map of the seed value chain for maize, sorghum and millet is shown in Figure 4.

There are many players in the seed sub-sector from seed production to farm household seed users performing different functions ranging from seed production, quality assurance, processing and distribution. Chain actors come from both the formal and informal sectors. The formal sector refers

to seed production by public organizations and 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). The informal sector on the other hand is composed of farmers producing and distributing seed among themselves. The formal sector generally operates on a national scale, while the informal sector is more localized. NGOs, farmer groups and commodity traders in Zambia control the supply of open pollinated seed 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. Hybrid maize is mainly distributed through the formal channels. The simple formal sector chain actors for these crops constitute the government and universities, cooperatives, seed growers association, NGOs and private seed companies; while the informal sector constitutes of local seed dealers and traditional farmers.

Figure 4 shows the seed value chain map of actors and their functions in the formal seed sector. The actors for all the three crops are more less the same except for minor differences with hybrid maize which is mainly distributed through formal channels and has major end users as mostly the commercial farmers. Open pollinated maize varieties, sorghum and millet varieties on the other hand are distributed from the seed companies through NGOs and government relief programs to smallholder farmers.

Figure 4. Seed Value Chain Actors & Their Functions, Zambia, 2008



Source: Survey data, 2008

4.3.1 The public sector

The Ministry of Agriculture and Cooperatives (MACO) is the main public sector actor in the seed chain through the Zambia Agriculture 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) and the field services department of MACO. The Seed Control and Certification Institute (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. For the regulation of seed production, SCCI has the following four technical units:

a. Variety testing and registration: This unit carries out post control analysis of varieties to be released by conducting the Distinctiveness, Uniformity and Stability (DUS) test.
b. Seed inspection: The seed inspection unit is responsible for rural seed coordination in the country to ensure that seeds produced are of good quality.
c. Seed testing: The seed testing unit undertakes testing of seed lots in the laboratory before a certificate is issued permitting the seeds to be sold.
d. Capacity building: The capacity building unit conducts training courses for stakeholders in the seed industry on seed production and in some cases seed inspection. (NAP 2005)

The Department of Field Services is responsible for seed extension services. Other research institutions involved in agricultural research are the University of Zambia through the School of Agriculture Sciences and Golden Valley Agricultural Research Trust (GART).

4.3.2 Private seed companies

The private sector seed companies are Zambia Seed Company (ZAMSEED), Maize Research Institute (MRI), Pannar Seed Company, (Z) Ltd., Seed Co. Ltd. Seed Company and seed traders. Their main functions are seed production, multiplication and distribution of hybrid and OPV seed. The seed is sold through official 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.

Seed Co., (Z) and Pannar are regional seed companies who compete with the national seed companies like Zamseed, Kamano and the Maize Research Institute (MRI) for the seed market shares in the country. The major business of all these companies is in the hybrid maize seed production. However Seed-Co Zambia and Zamseed deal with 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 are not promoting 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 and millet and maize OPVs currently. All of these seed companies contract out seed production to farmers as a way of reducing their work load and spreading risks.

4.3.2.1 Pannar Seed Company

Pannar deals only in hybrid maize and the company started developing its own maize hybrid seed varieties in 1988. The latest maize variety released was in 2008. Pannar breeding experts come from international sources. The seed is bred for maturity period (suitable to each of the agro ecological zones of Zambia), pest/disease resistance, storage pest resistance, plant height, drought tolerance among others. The potential yield for Pannar maize hybrids averages 10 tons per hectare. The source of breeder, pre-basic and basic seed is from their own production and for the 2007/8 season breeder seed and pre- basic seed quantity was 900 kg each with a value of K13,000 /kg while the basic seed quantity was 15 metric tones with a value of K20,000/kg.

4.3.2.2 Zambia Seed Company (ZAMSEED)

Zamseed is the oldest seed producing company in Zambia and it has remained a major player in the seed industry. At one time Zamseed was government owned and the sole seed company in Zambia. . It currently markets 11 hybrids and six open pollinated maize varieties, and enjoys a 30-50% market share. Hybrids account for some 75% of maize sales. Zamseed conducts independent variety breeding activities in its 1,000 ha experimental farm on the outskirts of Lusaka. It sells 30% of its seeds through NGOs especially the Program Against Malnutrition (PAM), 20% through the government, 30% to commercial farmers and the remaining 20% through farmers' representatives/agents in the various provinces. Zamseed has continued to sell all the varieties that were released by public research before privatization of the seed industries and this include the maize, sorghum and millet varieties. Furthermore, it does its own breeding activities and started developing its own crop varieties in 1999. It has concentrated more in developing maize varieties and the latest maize variety was released in 2008. The latest varieties for sorghum and millet that it sells were released in 1999. Like other seed companies, varieties for sorghum, millet and maize are bred for a range of both biotic and non-biotic characteristics and they include yield potential, grain size, drought tolerance, and pest and disease resistance among others. Zamseed sources its breeding material for the three crops from various sources. For the 2007/8 season breeder, pre-basic and basic seed for the three crops came from its own production as well as breeding stations from other countries. The quantities and values for the seed sourced are shown in the Appendix Table A1.

4.3.2.3 Maize Research Institute

The Maize Research Institute (MRI) was established as a company in 1998. Like Pannar Seed Company it does not deal in sorghum and millet but only in hybrid maize seed. MRI produced its first variety in 1999 and has developed and released at least 15 different hybrid maize varieties for cultivation throughout Zambia. The latest variety to be released was in 2007. Hybrid maize varieties are bred for yield potential, pest/disease resistance, performance under poor rainfall, yield stability, resistance to lodging and drought tolerance. MRI performs most of the value adding functions in the value chain from research to distribution. MRI is a large-scale seed producer that is currently limiting its range of seeds to hybrid maize as mentioned earlier. Limited quantities of soybeans have been produced but this was only 60 metric tons in the year 2004. Concentrating on maize hybrid varieties seems to be a technological and marketing strategy aimed at delivering quality, but the firm has breeding rights to several other types and varieties of seed.

4.3.2.4 Kamano Seed Company Ltd.

Kamano Seed Company specialises in non-hybrid seed even though it also produces hybrid maize seed. So far they have been producing a wide variety of Open Pollinated Varieties (OPVs) crops. The company is the latest local seed company in the country. Its main clients are the NGOs and government agencies involved in relief –type seed procurement tenders. Most sales are made directly to its main clients - relief agencies (Government and NGOs). It started producing improved maize varieties (both hybrid and OPVs) in 2006 and the latest variety to be released was in 2008. Kamano markets sorghum and millet open pollinated varieties. It started developing these varieties in 2006 and the latest variety to be released on the market for sorghum was done in 2008 and for millet in 2009. Like other seed companies its breeding experts are

sourced locally and also internationally for maize but for sorghum and millet breeding experts are sourced locally only. The services offered by Kamano include seed multiplication, marketing and extension services. The company sourced its maize breeder seed from breeding stations from other countries amounting to 1,000 kgs, while 1.5 tons of breeder seed came from its own production for the 2007/08 season. Pre-basic and basic maize seed came from its own production amounting to 2 tons and 10 tons respectively. For sorghum and millet Kamano sourced its basic seed from public research within Zambia. The results are shown in Appendix Table A2

4.3.2.5 Seed-Co Ltd. Seed Company

Seed-Co is a multi-national seed producing company that originally had its base in Zimbabwe but recently re-located to Zambia. It is the largest producer of seed in Zambia with one of the largest selection of varieties and types of seed on the market. While hybrid seed, especially maize seed, is the dominating product, OPV seeds are also produced especially for other types of seed crops. The company develops its own maize hybrid and OPV varieties as well as sorghum open pollinated varieties. However the company does not deal in any millet seed. The intended users of these varieties range from government programs and NGO programs to farmers. The seed attributes for hybrid and OPV maize are high yield potential, performance under poor soils and rainfall, maturity, drought tolerance and yield stability. For sorghum OPV the attributes are early maturity, taste and yield potential. Breeding experts come from both local and international sources. Like other seed companies, Seed-Co performs most of the chain functions of maize and sorghum seed except for seed extension services. For the 2007/8 season Seed Co. Ltd. was engaged in the procurement of breeder, pre basic and basic seed for both maize and sorghum. Appendix Table A3 shows the quantities and the values of the type of seed it procured. Data shows that Seed-Co sources its maize and sorghum seed from mainly its own production as well as from international research.

4.3.3 NGOs & 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). There are thousands of NGOs in the world today whose programs are focused either domestically, internationally or both. 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 OPV. 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.

4.3.4 Seed Grower Associations & Cooperatives

These 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.

4.3.5 Seed dealers

Seed dealers are a vital link between farmers and seed supply from the public seed 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. There were 57 dealers surveyed from both the formal and informal sector. Seed trading businesses were established 10 years ago and most of them have been operating their businesses for an average of 8 years (Table 5). Some dealers operated in their own stalls while the majority engaged in door to door sales. Others sell from road side stands. Most seed dealers (43.9%) obtained their supplies direct from their own production and other seed dealers (21%); while others bought from other farmers (19.3%) and from seed companies (15.8%). Seed dealers were mostly engaged in the sale of sorghum seed and maize OPV and only a small fraction (2%) were engaged in selling millet seed.

Table 5. Seed Dealers Types and Selected Characteristics, Siavonga Region, Zambia, 2008

Type of Dealer	**Frequency**	**Percent**
Farmer selling surplus seed	22	38.6
Seed Trader	5	8.8
Seed companies & agents	6	10.5
NGOs & Faith based organization	3	5.3
Farmer seed producers	21	36.8
Total=N	57	100
Place of Operation		
Own stalls	8	14.0
Road side stand	2	3.5
Door to door operators	47	82.5
Total=N	57	100.0
Sources of Seed		
Own Production	25	43.9
Other farmers	11	19.3
Seed Companies & agents	9	15.8
Other seed dealers	12	21
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
Years of Operation: 8.32 years		

Data source: Own survey data, 2008

4.3.5.1 Seed distribution

The average quantities of improved seed distributed per dealer in Siavonga in the three crops under study from 2004 to 2008 are shown in Table 6. Distribution of improved seed has increased for all the crops. The quantities of sorghum distributed per dealer are highest of the three crops. This reflects the increased demand of sorghum seed by the farmers over the years and this could be attributed to policies of diversification away from maize to those of other crops.

Table 6. Seed Quantities Distributed per Dealer, Siavonga Region, Zambia, 2008

Year	Mean Quantities of Improved Seed distributed in kilograms		
	Maize	Sorghum	Millet
2008	262.92	340.27	31.02
2007	234.69	224.19	27.57
2006	208.65	219.91	13.23
2005	190.96	236.47	14.66
2004	17.69	107.13	12.16
2003	16.34	99.79	14.23

Source: Survey data, 2008

4.3.6 Seed users (farm households)

Seed users' information was obtained from a sample of 130 farming households from Siavonga District. After data cleaning, 129 households were considered for the analysis. Appendix Table A4 shows the profile of the households interviewed. Household heads were generally in their 40s with the mean age of 47.9 years. Most of them have at least some 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 was female. The mean number of persons living in each sample household was 6.28 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.

4.3.6.1 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 show that the farm households in the study area have diverse sources of income (Appendix Table A5). In addition to farm sales, households also depended on off-farm activities for their income. The major off-farm activities were 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 quite a high number of household were not earning income outside their farming activities.

4.3.6.2 Farm size & land preparation

The survey results show that the average total cultivated area was slightly larger than 2.0 hectares per household. The main tillage method was using animal draught power (Adp), and in a few cases some were using mechanical tillage (Table 7). Conventional and conservation tillage were commonly practiced by the sample households.

Table 7. Land Area Cultivated & Tillage Methods Siavonga Region, Zambia, 2008

	N	Min	Max	Mean	Std. Dev
Total Area Under Crop Production in (Ha)	128	0.25	10.5	2.42	1.81
Total Land Area Prepared By Animal draught power	129	0	10.5	1.30	1.91
Total Land Area Under Conventional Tillage	128	0	6.0	0.41	0.82
Total Land Area Under Conservation Tillage	129	0	5.25	0.55	1.0
Total Land Area Prepared By Mechanical Tillage	129	0	1.5	0.01	0.13
Valid N (List wise)	126				

Source: Survey data, 2008

4.3.6.3 Crops grown

Households were asked to recall their cropping patterns during the 2007/2008 cropping seasons. The results show that the average household's cultivated area for major food crops (sorghum, maize and millet), and seed cotton were relatively higher when compared to other crops. Maize had a mean cultivated area of 0.9 hectares; sorghum had 1.2 hectares, millet had 0.8 hectares, and seed cotton had 0.99 hectares in the 2007/2008 seasons (Table 8). 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 and this is usually done in the dry season. It should be noted that these results are probably an overestimate of the absolute amount of land cultivated. This is because the figures are based on information collected about land area cultivated to different crops, some of which are inter-cropped.

Table 8. Crop Area Usage by Households Siavonga Region, Zambia, 2008

Crop	No. of Hh	Percentage (hh)	Min Area (ha)	Max Area (ha)	Mean Area (ha)	Std. Dev Area (ha)
Maize	83	64.84	0.13	4	0.95	0.82
Sorghum	115	89.84	0.25	10	1.19	1.13
Millet	50	39.06	0.25	6.5	0.78	0.97
Sunflower	1	0.78	0.5	0.5	0.50	
Groundnut	6	4.69	0.12	0.5	0.30	0.13
Soybean	8	6.25	0.5	2.0	1.09	0.50
Seed Cotton	28	21.88	0.25	2.5	0.99	0.64
Cowpeas	7	5.47	0.12	0.50	0.30	0.14
Other crops	1	0.78	0.25	0.25	0.25	
Garden	7	5.47	0.03	0.13	0.10	0.04
Natural fallow	13	10.16	0.25	2	0.69	0.50
Virgin land	1	0.78	3	3	3	
Area under other uses	1	0.78	1	1	1	
N	128					

Source Survey data, 2008

4.3.6.4 Seed Variety Use

The frequency with which seed is replenished by farmers 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 seed. 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 seed 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 (Table 9). 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 type of crop varieties for several years. On average each crop variety for sorghum, millet and maize has been used for 16 years and seed has been recycled for an average of 13.6 years. This shows that farmers in the survey district have not been changing varieties for many years and have been using recycled seed for many years. This explains the low yield trends observed over the last 20 years as shown earlier.

Table 9. Seed Variety Use by Farm Households Siavonga Region, Zambia, 2008

Variable	N	Minimum	Maximum	Mean	Std. Deviation
Max No. of years a crop variety has been grown	124	1	69	16.02	13.966
Max No. of years seed of a crop has been recycled	115	0	68	13.62	13.162
Valid N (listwise)	115				

Source Survey data, 2008

4.3.6.5 Sources of seed

Farmers' major sources of seed for the three crops came from their own production for the 2007-08 cropping seasons. This shows that farmers have been using the same type of varieties for all the three crops (Table 10) The second major seed source for farmers in maize and sorghum crops was from relief seed distributed by the government and NGOs, while for millet it was from other farmers. It must be realized that pearl millet is only considered as a household food security grain in this area and therefore not marketed, hence millet was not sold by traders on the market but was only found and circulated among farming households.

Table 10. Farmers' Sources of Seed, Siavonga Region, Zambia, 2007/8 season

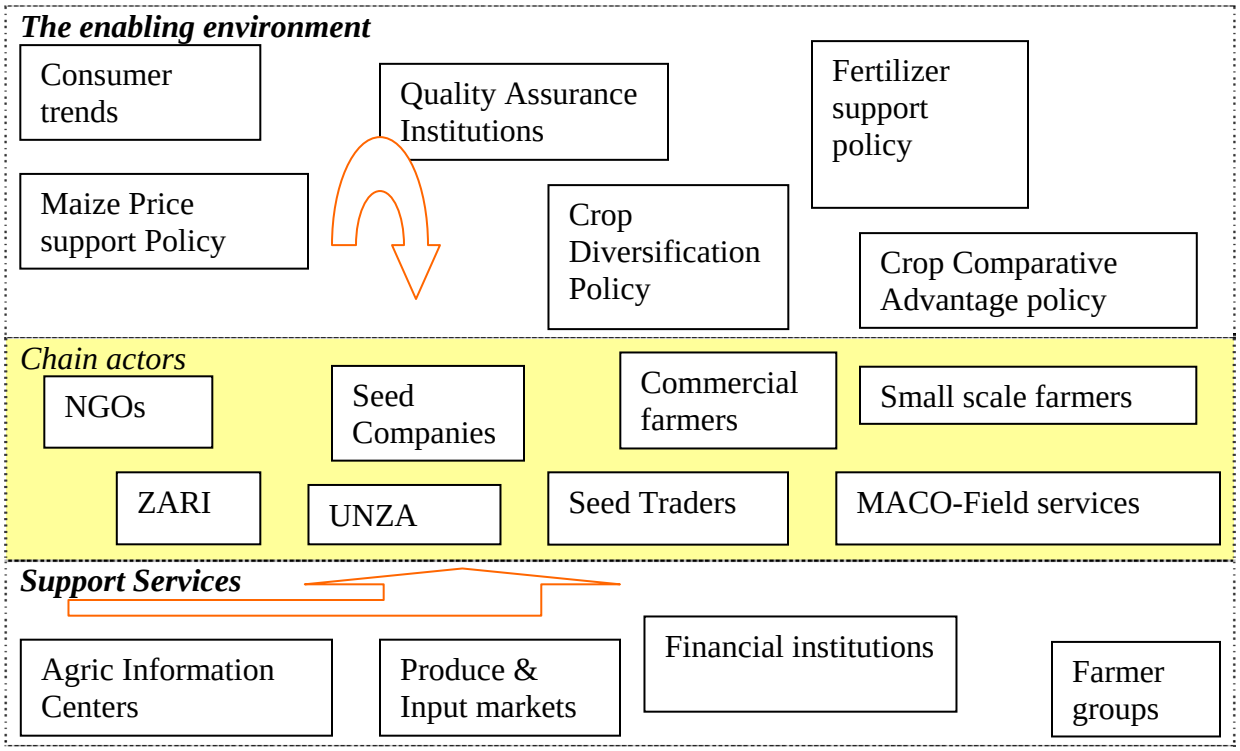
Source of Seed	Maize (%)	Sorghum (%)	Pearl Millet (%)
Own Production	55	60	95
Relief seed	25	23	0
Other farmers	15	12	5
Traders	3	4	0
Other	2	1	0

Source Survey data, 2008

4.4 The market map

In seeking to understand more about the factors that affect some of the farmers' decision such as the types of maize, sorghum and maize seed that they purchase a market map was made of the value chain actors (as discussed above), the enabling environment and availability of support services. This section looks at the enabling environment and access to support services as they affect the performance of the seed value chains for sorghum and millet particularly the adoption of improved seed and varieties by farmers.

Figure 5. Market Map of the Seed Value Chain, Zambia, 2008



Source: Survey data, 2008

4.4.1 Enabling environment

The enabling environment consists of the critical factors and trends shaping the value chain environment and operating conditions which could be improved. These 'enabling environment" factors (Hellin et al., 2009) are generated by structures (national and local authorities, research agencies), and institutions (policies, regulations and practices) that are beyond the direct control of economic actors in the value chain. When analyzing the seed value chain enabling environment for sorghum, millet and maize, the policy environment and access to facilities were singled out as having had a major impact on the performance of the chains.

4.4.1.1 Policies & Economic Trends Affecting Seed Value Chain Competitiveness

The restructuring of public sector services and liberalizing support services during the Structural Adjustment Programs beginning in the 1990s enabled private firms to enter into the seed market,

input supply and also to expand their investments in research and extension. These changes have not met the expected outputs especially for the resource poor farmers. The market liberalization has affected adversely most smallholder farmers who depended on input subsidies and a ready market for maize and who could not cope with the high input costs. In addition, frequent droughts over the past decade affected maize production in Zambia. The effect of this has been a significant shift in the cropping patterns amongst smallholder farmers away from maize towards alternative food staples like sorghum, millet and cassava (FAO, 2008).

Although diversification is 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. The subsidies on seed and fertilizer and guaranteed marketing have tended to cause farmers to reduce sorghum & millet growing in favor of maize. These subsidies are provided through the Fertilizer Support Program in the form of selling chemical fertilizer at a 50 percent discount through agricultural cooperatives. The cooperatives sell inputs in packages, each containing eight bags of chemical fertilizer (50 kg per bag) and 20 kg of improved maize seed. This package is for one hectare of maize production.

Maize is Zambia's staple food crop and it is mainly produced by the small scale farmers to meet the national requirements. Given the key role of small scale farmers in maize production and their limited resources, the resumption of a subsidy program was driven by the fact that majority of the small holder farmers can hardly afford to utilize chemical fertilizer due to the high market prices (MACO, 2008). From 2003 through 2006, the government distributed 45,000 tons of chemical fertilizer each year at a 50% subsidy under the fertilizer support program (Jayne et al., 2007). To date the fiscal policies and monetary allocations to the agriculture sector continue to be targeted at maize.

On the other hand, the rising food inflation and cost of the maize products (particularly maize meal) has encouraged many consumers to think of alternatives to maize. 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 to urban consumers. The opaque and the clear beer industry also is using sorghum as an ingredient in beer brewing. Government incentives to Zambia Breweries to use sorghum as a substitute for maize in beer brewing is creating increased demand for sorghum at the industrial level.

The Government's recent national agricultural policy promotes more crop diversification. This policy is essentially aimed at removing the country's over dependence on maize. The implementation of this policy is seen in increased public sector research and international agencies in crops such as cassava, sorghum, pearl millet, finger millet, cowpeas and sweet potatoes. Another crop policy initiated in the 2004 national policy is that of "comparative advantage", where a particular crop is promoted more intensely in the area of its most comparative advantage. This policy is also aimed at removing the maize monoculture from areas where maize is suitable but was promoted by large government subsidies (Muliokela, 2005).

4.4.2 Access to institutional support services

Farming households, who are also seed consumers and other chain actors alike, need institutional support services or facilities to effectively gain access to improved seed and also product

markets. The services examined here include (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 the survey district is a typical example of such areas. The study area is located 264 km from Lusaka- Zambia's capital city, and there is a tarred road that connects Siavonga to Lusaka- the major source of input and output markets. The road network in the farming area is gravel and the terrain is hilly making it difficult to get to places. Telecommunications 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 the town in Siavonga and Lusitu rural centre also found out the retail shops only stock spare parts for implements like ox-drawn plough, hand hoes, etc. Local traders and Lusitu cooperative sell farm inputs such as seeds, fertilizers, pesticides, and fungicides. Loans can be obtained from micro-institutions, and infrequently from commercial banks.

4.4.2.1 Knowledge of Location of Support Services

Farming households were asked to indicate whether they knew the location of some of the facilities relevant for their farming business and consequently this might affect adoption of improved farming technologies such as use of improved seed and fertilizer. Most farming households in the study sample admitted knowing where facilities were located (Table 11). The commonly known facilities were input suppliers, agricultural information centers and financial services providers, while the location of the product markets were least known by farming households. This indicates that quite a reasonable proportion of farmers was not marketing their products or was using their homestead for marketing their products as noted by the study team during the survey.

Table 11. Knowledge of Location of Services Siavonga Region, Zambia, 2008

Facilities	Knowledgeable (%)	Not Knowledgeable (%)	N
Input suppliers	94.6	5.4	92
Financial service providers	86.6	13.4	67
Agric information	94.3	5.7	106
Product market	56.4	43.6	117
Farmer groups	82.4	17.6	117

Source Survey data, 2008

4.4.2.2 Distribution of Households Using Support Services

Although a majority of farming households in the study sample knew where the services were located, there were some among them who did not use these services. Responses varied according to type of service. Financial services were the least used support services by farming households which had 85 percent of the respondents as non users (Table 12). The second least used facility was the input market which had 64.1 percent of non users. The produce markets and

farmer group centers were the commonly used facilities with 84.6 percent and 68.8 percent of users respectively.

Table 12. Percentage of Households Using Support Services, Siavonga Region, Zambia, 2008

Service Type	Users (%)	Non-users (%)	N
Input suppliers/markets	35.9	64.1	92
Financial service providers	14.3	85.7	63
Agricultural information	41.5	58.5	106
Product market	84.6	15.4	65
Farmer groups	68.8	31.3	16

Source Survey data, 2008

4.4.2.3 Reasons for Not Using Facilities

Of the respondents that knew where the services were but were not using them, a follow up question asked them to give the main reason why they were not using these services (Table 13). Reasons varied from the location being too far, no need of use and other reasons. Of those that were not using the financial services available in the area, the major reason given for not using them was that they were too expensive. This is understandable considering that interest rates for borrowing were way too high for most of these farmers. 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 s 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 s credit (Table 13).

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 seed 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, community groups (60%) and product markets (50%) indicated that they did not see the need. One 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 (Larson et al., 2006). 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 in other rural areas are 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 out that constraints to information access were caused by weak human capital and technical infrastructures, lack of clear national information policy and lack of coordinated agricultural support system for small-scale farmers.

For those that did not see the need to use product markets, they may not have any marketable surplus or buyers came to their homestead.

Table 13. Reason for Households not Using Support Services, Siavonga Region, Zambia, 2008

Type of Service	Reason for Not Using Services	Percentage of Households (%)
Financial services	Too far	3.8
	Too Expensive	24.5
	Did not see the need	32.1
	Did not qualify	39.6
Input suppliers	Too far	33.9
	Did not see the need	52.5
	Others	13.6
Information centers	Too far	8.3
	Did not see the need	63.3
	Others	28.3
Produce markets	Too far	33.3
	Did not see the need	50
	Others	16.7
Community groups	Too far	0
	Did not see the need	60
	Others	40

Source Survey data 2008

4.4.2.4 Distance to Support Services

Farmers in Siavonga face difficulties in accessing facilities because of the hilly terrain. 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 (Table 14). The nearest facility was the agriculture information centre which was averaged 0.87 km from the farming households. Distance to the nearest produce 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.

Table 14. Distances to Support Services, Siavonga Region, Zambia, 2008

Type of Facility	N	Minimum	Maximum	Mean	Std. Dev
Distance to the nearest agric input suppliers in km	92	0.00	265.00	50.7609	74.47197
Distance to the nearest financial services providers in km	67	0.00	150.00	33.1269	25.73471
Distance to the nearest to nearest agric info services provider in km	105	0.00	75.00	7.7714	11.95967
Distance to nearest produce mkt in km	65	0.00	200.00	7.8692	27.45341
Average distance to major market where product was sold	42	0.00	159.00	8.2421	28.55670
Valid N (list wise)	42				

Source: Survey data, 2008

4.4.2.5 Mode of Access to Services

Farming households used various transportation means to get to facilities that are relevant for their socio economic development. The major means of accessing these facilities included walking on foot, public vehicles, bicycles or a motor cycle. As shown in Table 15, most of them indicated that walking on foot was the main mode of getting to all of these facilities.

For those that walked on foot to get to the input suppliers, many (38.1%) of them took less than 30 minutes while another (33.3%) took more than an hour. Only 28.6% of the households took between 30-60 minutes to get to the input suppliers. Of those that used public transport and other means of transport, most of them were taking more than an hour to get to the input suppliers. This latter group of farmers would be those that are sourcing inputs outside the district, hence the justification in the means of transport used and the length of time taken to reach the input suppliers. As indicated earlier, only a limited number of farm inputs such as fertilizer, pesticides and spare parts for implements are found within the districts. For major farm implements, one has to travel to nearby districts like Kafue and Lusaka to purchase them.

A majority of farming households in the sample take less than 30 minutes to reach product markets when walking, using public transport and other means of transport. The situation is similar to those that walk on foot to reach agricultural information centers. This indicates that these services are relatively close to farmers. For those that use a public vehicle to get to agricultural information centers, a majority of them take 30-60 minutes indicating that a high proportion of households who live far away from agricultural information centers and extension services need these transport services. As expected community groups are within the farmers' locality and most of them walk on foot and take less than 30 minutes to reach there.

Table 15. Mode of Transport by Time Taken to Support Services, Siavonga Region, Zambia, 2008

Type of Facility	Mode of Transport	Percent of HH using Services	Percent of households by time taken to get to Support Services			
			<30 mins	**30-60 mins**	**> I hour**	Total
Input Suppliers	Walking on foot	59.2	16 (38.1)	12 (28.6)	14(33.3)	42 (100)
	Public Vehicle	32.4	1 (4.3)	6 (26.1)	16 (69.6)	23 (100)
	Others	8.5	1 (16.7)	2 (33.3)	3 (50)	6 (100)
	Total	100				
Financial Services	Walking on foot	52.9	5 (55.6)	2 (22.2)	2 (22.2)	9 (100)
	Public Vehicle	41.2	0	3 (42.9)	4 (57.1)	7 (100)
	Others	5.9	0	0	1 (100)	1 (100)
	Total	100				
Produce Market	Walking on foot	87.5	32 (65.3)	11 (22.4)	6(12.2)	49(100)
	Public Vehicle	8.9	3 (60)	0	2((40)	5(100)
	Others	3.6	2 (100)	0	0	2 (100)
	Total	100				
Agric info centers	Walking on foot	75.6	27(45.8)	22(37.3)	10 (16.9)	59(100)
	Public Vehicle	10.3	1(12.5)	3(37.5)	4(50)	8(100)
	Others	14.1	0	4(36.4)	7(63.6)	11(100)
	Total	100	28(35.9)	29(37.2)	21(26.9)	78(100)
Community Groups center	Walking on foot	90.9	7(70)	1(10)	2(20)	10(100)
	Public Vehicle	9.1	0	0	0	0

	Others	0	1(100)	0	0	1(100)
	Total	100	8 (72.7)	1 (9.1)	2 (18.2)	11 (100)

Source Survey data, 2008

4.5 Seed Value Addition

This section looks at the value added at the key stages of the seed chains for maize, sorghum and millet. It first looks at value added at seed production which begins with research and development and this stage goes up to the point where seed is made commercial, the second stage looked at the value added by traders as they take it to end seed users. Value added for each of the study crops are looked at separately as shown below. The seed value added for the three crops was observed at research- seed production, seed processing and distribution stages. Actors at each stage of the chain were asked to indicate the value added both qualitatively and quantitatively and they are discussed as follows:

4.5.1 Maize Seed Value Chain Addition

Value added at varietal development from public research institutions and seed companies include the development of varieties that are resistant to non-biological stresses such as aridity, low nitrogen, lodging and low pH, as well as to biological stresses like grey leaf spot, leaf blight and stored products pests. Bio-fortification issues related to zinc, iron and vitamin A are also being conducted and tried. Other additions in value include cob size, growing period, among others. The potential yield of maize varieties for farmers according to research ranges from 4 to 10 tons per hectare.

Maize varieties bred for the length of growing season are categorized into the early, medium- and late-maturing varieties, which are given series numbers of 400, 600 and 700, respectively which is a classification according to length of the growing period and adaptability to the three agricultural ecological zones found in Zambia as earlier identified. The 400 series would be suitable in region one, 600 series region two and 700 series in region three. The variable cost of seed production at this stage is estimated at K10 million per hectare by Pannar while other institutions could not give an estimate of variable costs. Research yield for hybrid seed was estimated to be 10 tons per hectare, while that for OPV was estimated to be 4 tons per hectare. At the stage of use by small scale farmers, the mean yield per hectare was found to be 0.8 tons which is only 20 percent of research yield (Table 16).

Table 16. Maize Value Chain Stages, Key Players, Services, and Value Added, Zambia, 2008

Value Chain Stage	Key Players	Services	Value Added
Seed Production	ZARI,UNZA,SCCI, Private seed companies, farmers	Variety development Seed production	Hybrid seed Yield:10 tons/ hectare OPV seed yield: 4 tons/hectare
Seed multiplication & Processing	-Seed Companies -Commercial farmers -Small scale farmers -NGOs	-Seed multiplication -Seed treatment -Packaging	
Trading & Transportation	-Seed Companies & Agents - Seed Dealers -Farmers	-transport -sell	

Seed Consumption	-Government -NGOs -Commercial farmers -Small scale farmers		Small-scale farmers ' yield 0.8 tons/ha

Source Survey data, 2008

4.5.2 Sorghum Value Chain Addition

At the research stage sorghum value added include yield potential, pest/disease resistance, performance under poor soils and poor rainfall, superior storage pest resistance, grain color, plant height, yield stability, resistance to lodging, early maturity and drought tolerance. Sorghum varieties are ideal for various end uses such as forage, food and brewing. Research yield for sorghum OPVs ranges from 3 to 5 tons per hectare but the study found a mean sorghum yield of 0.3 tons per hectare on the farmers' field which is less than 10% of the research yield (Table 17).

Table 17. Sorghum Value Chain Stages, Key Players, Services, and Value Added, Zambia, 2008

Value Chain Stage	Key Players	Services	Value Added
Seed Production	ZARI,UNZA, SCCI, Private seed companies, farmers	Variety development Seed production	Seed yield: 3 to 5 tons/hectare
Seed multiplication & Processing	-Seed Companies -Small scale farmers -NGOs	-Seed multiplication -Seed treatment -Packaging	
Trading & Transportation	-Seed Companies & Agents - Seed Dealers -Farmers	-transport -sell	
Seed Consumption	- Government -NGOs -Commercial farmers -Small scale farmers		Small-scale farmers' yield is 0. 3 tons per hectare

Source Survey data, 2008

4.5.3 Pearl Millet Value Chain Addition

The pearl millet value chain is similar to sorghum. The value added to pearl millet from the variety development to commercial seed distribution includes yield potential, drought tolerance, shorter growing period, performance under poor soils, grain size, grain color particularly the white grain color which is the most preferred one by the consumers. The mean yield of pearl millet varieties at this stage will normally range from 2.4 tons to 2.8 tons per hectare. At the farmer's level, average yield reduced to less than 10 percent of research yield (See Appendix Table A6).

4.6 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.

4.6.1 Challenges facing Seed Producers (Seed Companies)

Several challenges were identified factors affecting the competiveness of the value chains at the seed producers' stage. However, they all centered on low profitability in seed production for the three crops and this was more prominent in sorghum and millet. On the one hand, maize seed producers pointed out stiff competition as a major constraint to seed production and this was indicated by almost all seed companies. On the other hand, competition could be regarded as an opportunity to seed traders and end users in that competition can bring about lower costs nd ultimately lower prices paid by the seed users (farmers). This in turn can improve the adoption of improved varieties.

The other problem faced by some seed producers is that it was difficult to improve the crop due to lack of their own maize breeding expert. This posses a challenge as quality issues arise when the crop cannot be improved. The high payments made to seed growers for seed multiplication is another issue that was pointed out by seed producers. As mentioned earlier, seed companies contract out farmers for most of their seed multiplication. An important factor limiting the profitability of seed production in the country is the apparent linkage of input prices to the United States dollar. The exchange rate of the Zambian currency which is the Kwacha is usually unstable resulting in high and variable input prices and seed multiplication contracts are usually signed in United States Dollars. The cost is rarely passed to seed end users (farmers) when the Zambian Kwacha loses value as most farmers cannot afford the seed cost and the end result is that seed prices are reduced below marginal cost of production. Lack of stable markets was also another constraint cited by seed producers for maize as most farmers rely on recycled seed.

For sorghum and pearl millet, seed companies cited lack of stable markets as a major constraint to improved seed production. The major buyers of sorghum and millet seed are the government and NGOs and they would normally buy the seed in anticipation of drought in the country. Much production of seed for these crops is only made if seed producers are given tenders from government and/or NGOs.

One huge constraint faced in sorghum and millet production was lack of breeder seed/ foundation seed by some producers. 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 still a parastatal company. Upon privatization, Zamseed was given ownership of breeding material by the government for a limited number of years. Twenty years later, present, Zamseed still had exclusive rights to breeder material for sorghum and millet varieties. The social cost of the intellectual property rights issue to sorghum and millet growers in terms of lost opportunities to buy more productive varieties has undoubtedly been very high. Today, 20 years later, seed companies are now free to market any new sorghum and millet varieties that are released by public research.

4.6.2 Constraints faced by seed dealers/traders

The main constraints faced by the seed dealers were high transportation costs (32%) and lack of stable markets (31%). Distribution of seed to the farmers is hindered by poor road networks in the rural areas particularly in Siavonga which has a hilly terrain. Some roads are impassable by vehicles during the rainy season making seed delivery impossible. Some dealers also indicated that seed transportation costs are 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 most of the farmers rely on their own farm saved seed.

4.6.3 Constraints faced by seed users

Seed users for sorghum, pearl millet and maize were asked to rate the challenges faced in the seed they used with respect to the three crops under consideration. This was done on a three point scale ranging from one (1) as the constraint not being an issue to three (3) as the constraint being very challenging (Table 18). Farmers were divided on how they perceived grain quality as a challenge in maize seed varieties that they used. Almost an equal percentage of households perceived grain quality as challenging and others as not an issue in maize seed varieties while a smaller proportion viewed grain quality as somewhat challenging. For sorghum and millet, a 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, a majority of households did not perceive pests and diseases as an issue, even though quite a high proportion cited pests and diseases as very challenging. Availability of desired varieties was a major issue for sorghum and maize. For sorghum, it might be true considering that the last developed improved variety was released more than 15 years ago and most of the sorghum varieties available are prone to birds eating seed and also high tannin content (Mwandila, 2008, personal communication). A majority of households were content with the millet varieties used as most of them did not see the availability of desired varieties as an issue.

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

Credit access and product markets alike were viewed by most seed users 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 household for food security. That could be a reason why credit access and markets are 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 is still a weak market information system in the area. Farmers have not taken advantage of market opportunities that exist 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 are focusing more on producing for household food security without a good understanding of true market needs and opportunities. Larson et al., (2006) study highlighted low volumes, inconsistent supply and quality problems among other issues, as 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, and remains, limited among farmers in the area. This has resulted at times in the inability to successfully market sorghum as well as the inability to take advantage of market opportunities that exist in the sorghum markets.

Processing technologies and distribution infrastructure were equally perceived as very challenging by a majority of farming households for all the 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 venture into processing technologies which can enable farmers to add value to the products at farm level. 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, unaffordable prices for improved seed and also the packaging size available for improved seed is not the one preferred. Many farmers prefer to buy package sizes of 5 kg or less but in most cases seed is packaged in 10 kg or 20 kg bags particularly for maize seed. The high cost of complementary inputs like fertilizer was also cited as a challenge. This is because subsidized fertilizer is only available in maize (and it is only enough for a hectare) but not for sorghum and millet.

Table 18. Challenges Faced by Seed Users by Crop, Siavonga, Zambia, 2008

Type of Challenge	Degree of a challenge	Maize (%)	Sorghum (%)	Millet (%)
Grain quality	Very challenging	42.1	29.7	17.9
	Somewhat challenging	13.1	18.6	12.6
	Not an issue	44.9	51.6	69.5
Pests & Diseases	Very challenging	61.6	57.7	33.7
	Somewhat challenging	29.5	29.3	23.5
	Not an issue	8.9	13	42.9
Availability of desired varieties	Very challenging	92.9	46.8	23.2
	Somewhat challenging	4.4	16.9	8.1
	Not an issue	2.7	36.3	68.7
Extension services	Very challenging	73.6	66.4	60
	Somewhat challenging	13.2	12.8	8
	Not an issue	13.2	20.8	32
Credit	Very challenging	48.6	38.5	32
	Somewhat challenging	23.4	18	14.4
	Not an issue	27.9	43.4	53.6
Markets	Very challenging	58	50	27.6
	Somewhat challenging	14.3	12.3	12.2
	Not an issue	27.7	37.7	60.2
Processing Technologies	Very challenging	58.6	51.2	48.1
	Somewhat challenging	6.3	9.1	3.1
	Not an issue	35.1	39.7	48.9
Distribution infrastructure	Very challenging	61.6	50.8	54.1
	Somewhat challenging	8.9	12.3	8.2
	Not an issue	29.5	36.9	37.8
N=129				

Source Survey data, 2008

5. CONCLUSIONS AND RECOMMENDATIONS

.

5.1 Conclusions

The study found that sorghum and millet farm yields are low (about 0.5 ton/ha) and have been stagnant for over 20 years. Maize yields are higher but more variable from year to year which increases the food security risk among smallholder households. Government of Zambia subsidies for fertilizer, seed and price supports for maize growers have expanded the area planted to maize even in regions of the country that are drought prone where sorghum and millet are more suited crops to grow.

This study found that adoption of improved seed and fertilizer is very low among sorghum and millet growers and relatively low for maize growers. Growers are using the same sorghum and millet for an average of 13.7 years when the recommended replacement rate by researchers is about three years. Research station yields for sorghum OPVs range from 3 to 5 tons per hectare in contrast to a mean sorghum yield of 0.3 tons per hectare on farmers' fields which is less than 10 percent of the research station yield. The gap between research station yields and farm yields is very large. Public institutions lack documentation of improved production practices by sorghum and millet growers. The responsible institutions should make it a priority to collect data of improved practices along with other data so as to understand current practices and to improve farm productivity results.

There are a number of key actors in the seed value chains for maize, sorghum and millet. They include public sector agencies such as ZARI, SCCI, UNZA, and the Ministry of Agriculture and Cooperatives who play key roles in varietal development, inspection and certification, and in providing extension services. From the private sector, there are five seed companies who mainly deal in maize hybrid seed even though sorghum and millet are also sold by three of the private companies. Most of these companies perform multiple functions which include varietal development, seed production, seed processing and distribution. Farmers' organizations, NGOs and faith based organizations work in close collaboration with the government departments and seed companies in seed distribution and extension services. The most important seed end users are small scale farmers who are mainly subsistence. Access to support facilities relevant for agricultural development was rated poor by these farmers. These included poor access to agricultural information, modern inputs, and poor quality of seed, lack of processing technologies and lack of stable markets.

Improved maize hybrid seed is distributed mainly through formal channels while sorghum and millet and OPV maize seed are distributed through both the formal and informal channels. Millet is largely distributed through informal channels and mainly between farming households. The study also found that formal seed companies viewed investment in sorghum and millet as unprofitable due lack of stable markets and low demand for the improved seed. The rate of seed replacement among seed users (13.7 years) was too low compared to the research recommendations (three years). The reasons for low farmer adoption of improved varieties must also be assessed in future research but poor linkages to supporting organizations like extension and availability of markets appear to be significant factors. Farmers lack awareness and understanding of consumer preferences and market demand. . This has resulted in their inability to take advantage of market opportunities that exist in the sorghum markets.

The seed traders surveyed indicated that most small businesses in the sample were established more than eight years ago. Seed dealers ranged from farmers selling surplus seed to seed companies selling through their agents. The places of operation for the seed dealers included owned stalls, roadside stands and door to door operations. Typically, the seed dealers who owned stalls stocked other merchandize along with seed. Because the amount of seed farmers purchased was low, seed traders stocked small quantities. Costs were spread over many items. Most traders advised seed buyers on the suitability of seed and how seed of specific varieties should be planted. According to seed traders interviewed, the most serious constraints to the selling of improved seed trade in the area were low quantities of seed purchased, delayed payments by farmers and stiff competition among traders.

Formal sector seed producers for the crops under consideration were mainly private seed companies. Their core business is hybrid maize seed. The seed is sold through official regional distributors the majority of whom have outlets in almost all farming communities. Most seed companies have their own breeding programs, do their own seed multiplication on-farm; largely through contracting with commercial farmers. Seed producers get basic and pre-basic seed from various international sources and from their own production. The major complaints seed companies face in sorghum and millet is low quantities of seed demanded by farmers and lack of stable markets. Major buyers of seed from seed companies for sorghum and millet are government and NGOs who only buy in the years when they anticipate a drought.

Factors affecting the competitiveness of the seed value chain include the enabling environment such as the crop diversification policy, comparative advantage policy, changes in consumer trends, especially urbanization, when consumers may shift to rice and wheat products and the maize fertilizer and price support program.

One huge constraint faced in sorghum and millet production was lack of breeder seed/ 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 still a parastatal company. Upon privatization, Zamseed was given ownership of breeding material by the government for a limited number of years. Twenty years later, Zamseed still had exclusive rights to breeder material for government developed sorghum and millet varieties. The social cost of the intellectual property rights issue to sorghum and millet growers in terms of lost opportunities to buy more productive varieties has undoubtedly been very high. Today, over 20 years later, seed companies are free to market any new sorghum and millet varieties that are released by public research.

5.2 Recommendations

The fact that the use of improved seed among the end users is low represents a major constraint to private sector participation in the investment of developing new improved varieties in sorghum and millet. Extension messages 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. This would contribute to increased demand for improved seed and improve prospects for private sector participation. There is also need to develop an agribusiness extension package for sorghum, including sources of financing. There is need to teach farmers

and traders better business skills; provide feeder roads and marketing infrastructure; build storage facilities and link farmers to finance, out grower schemes, and markets.

When the maize subsidies reached their peak in the late 1980s, the area under maize cultivation was about 1 million hectares, accounting for 70 percent of the total area cropped in Zambia. This high percentage of area cropped in maize indicates a near monoculture agriculture that is very dependent on one crop and agriculture in need of 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 which competes with sorghum and millets production. Alternatively there should be consideration of equal subsidies to maize, sorghum and millet production.

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APPENDIX. TABLES

Table A - 1. Source and Value of Seed Procured in 2007/8 by Zambia Seed Company, Zambia, 2008

Crop	Type of Seed	Source	Quantity (Kg)	Value ZMK/Kg
Maize	Breeder	International research	10	14,000
		Own Production	1000	14,000
		Public Research stations	1000	14,000
		Breeding stations from other countries	10	14,000
	Pre-basic	Own Production	1000	14,000
	Basic	Own Production	10 tons	10,800
Sorghum	Breeder	International research and own production, breeding stations from other countries, public research, universities	60	10,000
	Pre-basic	International research and own production	60	10,000
	Basic	International research and own production	5 ton	7000

Source: Survey data, 2009

Table A - 2. Source and Value of Seed Procured in 2007/8 by Kamano Seed Company, Zambia, 2008

Crop	Type of Seed	Source	Quantity (Kg)	Value ZMK/Kg
Maize	Breeder	Own Production	1.5tons	12,000
		Breeding Research stations from other countries	1000kgs	12,000
	Pre-basic	Own Production	2 tons	12,000
	Basic	own production	10tons	11,000
Sorghum	Breeder	Nil	Nil	
	Pre-basic	Nil	Nil	
	Basic	Public research	365kg	4,500
Millet	Breeder	Nil	Nil	
	Pre-basic	Nil	Nil	
	Basic	Public research	1000kg	4,000

Source: Survey data, 2009

Table A - 3. Source and Value of Seed Procured in 2007/8 by Seed Co., Zambia, 2008

Crop	Type of Seed	Source	Quantity (Kg)	Value ZMK/Kg
Maize	Breeder	International research	20	12,000
		Own Production	1300	12,000
		Public Research stations	1000	12,000
	Pre-basic	Own Production	1300	12,000
	Basic	Own Production	12 tons	10,000
Sorghum	Breeder	International research and own production	500	9,000
	Pre-basic	International research and own production	400	9,000
	Basic	International research and own production	1 ton	6000

Source survey data, 2009

Table A - 4. Descriptive Statistics of Farm Households Surveyed Siavonga Region, Zambia, 2008

Variables	Min	Max	Mean
Household size	1.00	15	6.28
Proportion of female headed households	0.00	1	0.29
Age			
Age of the household head	20.00	89	47.95
Average age of household members	11.33	78	24.12
Average age of male hh members	2.00	93	22.79
Average age of female hh members	0.00	78	26.17
Number of children 14 years and below	0.00	9	3.10
Number of male members 15-30 years	0.00	4	0.76
Number of female members 15-30 years	0.00	3	0.57
Number of male members 31-45 years	0.00	1	0.36
Number of female members 31-45 years	0.00	1	0.36
Number of male members 46-60 years	0.00	1	0.20
Number of female members 46-60 years	0.00	1	0.20
Number of members 61 years and above	0.00	4	0.39
Average number of months household members have been living at home in the last 12 months	0.83	12	10.48
Effective dependency ratio	0.00	1	0.56
Education	Frequency	Percent	Cumulative Percent
Illiterate	24	18.75	18.75
Primary	81	63.28	82.03
Secondary	20	15.63	97.66
Post Secondary	2	1.56	99.22
Adult Education	1	0.78	100
Total	129		
Marital Status			
Married	126	97.7	97.7
Unmarried	3	2.3	100
Total	129		
Variables	Min	Max	Mean
Household size	1.00	15	6.28
Proportion of female headed households	0.00	1	0.29

Source: Survey data, 2008

Table A - 5. Off-Farm Income Sources, Siavonga Region, Zambia, 2008

Type of off-farm income HH member is earning	Freq.	Percent	Cum.%
Trading	31	24.22	24.22
Teaching	2	1.56	25.78
Beer Brewing	5	3.91	29.69
Brick laying	4	3.13	32.81
Art and craft	7	5.47	38.28
Fishing	3	2.34	40.63
Farm labor	1	0.78	41.41
Piece work	29	22.66	64.06
food for work	5	3.91	67.97
Other	4	3.13	71.09
N/A	37	28.91	100
Total	128	100	

Source: Survey data 2008

Source: Survey data, 2008

Table A - 6. Millet Value Stages, Key Players, Services and Value Added, Zambia, 2008

Value Chain Stage	Key Players	Services	Value Added
Seed Production	ZARI, SCCI, Private seed companies, farmers	Variety development Seed production	Yield:2-2.8 tons/hectare
Seed multiplication & Processing	-Small scale farmers -NGOs	-Seed bulking -Seed treatment -Packaging	
Trading & Transportation	-Zambia Seed Company - Seed Dealers	-transport -sell	
Seed Consumption	-Small scale farmers		0.02 tons/hectare (10% of research yield)

Source: Survey data, 2008