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South Africa's Seed Systems: Challenges for food sovereignty

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The African Centre for Biosafety (ACB) is a non- profit organisation, based in Johannesburg, South Africa. It was established to protect Africa's biodiversity, traditional knowledge, food production systems, culture and diversity, from the threats posed by genetic engineering in food and agriculture. It has in addition to its work in the field of genetic engineering, also opposed biopiracy, agrofuels and the Green Revolution push in Africa, as it strongly supports social justice, equity and ecological sustainability.

The ACB has a respected record of evidence based work and can play a vital role in the agro-ecological movement by striving towards seed sovereignty, built upon the values of equal access to and use of resources.

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TCOE – Trust for Community Outreach and Education was established by the late Steve Biko in 1983. TCOE is a national organisation that operates mainly in the rural areas of South Africa. TCOE has six affiliates and these regional operations have their own governance structures and regional support staff. Fundraising is done both by the national office and at the regional level.

The main work and experience of the organisation in the past ten years has been to stimulate the building of local organisations, local leadership and assist these associations to access land and productive assets to improve their livelihoods.

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Contents

Acronyms and abbreviations

AGRA	Alliance for a Green Revolution in Africa
ANSO	Association of National Seed Organisations
ARC	Agricultural Research Council
ARC-GCI	ARC Grain Crops Institute
ARC-SGI	ARC Small Grains Institute
ARC-VOPI	ARC Vegetable and Ornamental Plant Institute
Bt	*Bacillus thuringiensis*
CGIAR	Consultative Group on International Agricultural Research
CIAT	International Centre for Tropical Agriculture
CIMMYT	International Maize and Wheat Improvement Centre
Comesa	Common Market for East and Southern Africa
DAFF	Department of Agriculture, Forestry and Fisheries
DFID	Department for International Development (UK)
DST	Department of Science and Technology
GM	genetic modification/genetically modified
GTZ	German Technical Co-operation
ha	hectares
IAASTD	International Assessment of Agricultural Knowledge, Science and Technology for Development
IMAS	Improved Maize for African Soils programme
IPR	intellectual property rights
KARI	Kenyan Agricultural Research Institute
KKSM	Klein Karoo Seed Marketing
KZN	KwaZulu-Natal
NPGRC	National Plant Genetic Resource Centre
OECD	Organisation for Economic Co-operation and Development
OPV	open-pollinated variety
PBR	plant breeders' rights
PBRA	Plant Breeders' Rights Act No 15 of 1976 as amended
PIA	Plant Improvement Act No 53 of 1976 as amended
PPP	public-private partnerships
R&D	research and development
SADC	Southern African Development Community
Sansor	South African National Seed Organisation
t	tons
UPOV	International Union for the Protection of New Plant Varieties
VKB	Vrystaat Ko-operasie Beperk
WEMA	Water Efficient Maize for Africa programme

1. Introduction

This study provides an overview of the structure of the seed system in South Africa, the types of seed in use and their pros and cons, the legislative and policy environment, and the role of the public sector in seed production and distribution in South Africa. It aims to identify the trends in the seed sector and consider possible points of intervention to advance the agenda of strengthening small-scale resource-poor farmers in control over and access to appropriate seed for sustainable agriculture.

It offers a background to situate work with small holder black farmers on improving access to appropriate seed, including seed production and distribution. Seed sovereignty sits at the heart of food sovereignty. The latter refers to the ability of producers to make socially and ecologically sustainable decisions about what and how to produce. Farmers have been improving seed through trial and error for thousands of years, but in recent decades these processes have been removed from the hands of farmers and placed in laboratories with limited or no direct farmer input. As corporations have poured resources into adapting seed, they have also reoriented the focus to yield maximisation with an eye on increasing farmer incomes in order to cover the costs of proprietary (privately-owned) seed technologies. This undermines food sovereignty as patented commercial seed based on a few underlying varieties pushes alternatives to the margins. The granting of intellectual property rights (IPRs) on seeds that farmers previously had free access to forces farmers to buy seed from a narrow range of choices. The ability of farmers to make decisions based on the most appropriate seed for their agro-ecological context is diminished at the same time as resources are concentrated in the hands of corporations that have no knowledge of any specific context. The struggle for seed sovereignty goes hand in hand with the struggle for food sovereignty.

A lot of existing research tends to focus on maize, since this is the most important crop in southern Africa and seed research and development has focused on the sector for decades. This is an example of a narrowing of research and development (R&D) to some crops that are more easily standardised and that are profitable. Published research also tends to focus on a handful of crops identified by corporations as commercially viable. This study, which is currently mainly drawn from desktop research, thus also tends to focus on maize, although reference will be made to other important sectors where information is available.

The study starts off with an overview of seed technologies, looking at the history of seed production and how multinationals came to dominate seed production after many centuries of this being a farmer-based activity. It looks at what open pollinated varieties (OPVs) and hybrids are and shows how genetically modified seed fits into the picture. It indicates the extent to which South Africa's seed system still relies on OPVs and to what extent hybrids have become dominant. The study then looks at seed systems and describes the characteristics of formal and informal systems. A brief history of the South African seed system is presented, concluding with the current structure of the seed system and the extent of concentration of ownership, using proxy measures of ownership of seed varieties and plant breeders' rights. A value chain approach is adopted, and each node in the seed production chain is considered, from research and development (R&D), through production, processing, packaging and storage and ending in distribution. In the process, the relevant laws and policies regulating seed production in South Africa are indicated, with particular emphasis on their implications for small holder and resource poor farmers. A few comments on seed pricing follow, and the conclusion highlights key issues requiring further research, possible components of a seed campaign and potential steps towards developing small holder seed production and distribution under the direct control of the farmers themselves.

This study does not cover all these issues exhaustively. Practical interactions with small holder farmers are required to fill in many gaps in our knowledge, and further steps can only be concretised following structured interactions with these farmers. The aim of the study is primarily to get the ball rolling on developing a framework for practical interventions. As such, it should be considered a work in progress, the focus of which can be sharpened further and which can be improved on over time as practical work unfolds. Appendix 3 provides a list of contacts developed in the course of the research. This can also be developed as practical and conceptual work proceeds.

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policies regulating seed production in South Africa are indicated, with particular emphasis on their implications for small holder and resource poor farmers and proposed legislative changes with regard to farmers' rights. A few comments on seed pricing follow, and the conclusion highlights key issues requiring further research, possible components of a seed campaign and potential steps towards developing small holder seed production and distribution under the direct control of the farmers themselves.

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3. The art and science of seed production

Harvesting of seed from preferred plants is the basis of crop domestication over the 10,000 years of agriculture, leading La Via Campesina (2011:1) to say that "all industrial seeds are the product of thousands of years of selection and breeding by our peoples". Exploitation of chance mutations and natural selection processes were the main form of plant improvement for most of this time until the last 80-100 years. The development of the science of genetics at the end of the 19th century led to the rise of scientific research into the inheritance of traits in plants and crops. After 1945, other advances in science such as *in vitro* technologies and mutagenisis led to the development of 'high-yielding' seed varieties (Schenkelaars *et al*., 2011:15). Later genetic modification (GM) and molecular markers extended these technologies further. About half of the yield gains since the 1940s are attributed to genetic improvements by plant breeders, and the other half to mechanisation, irrigation and chemicals (Schenkelaars *et al*., 2011).

Commercial seed firms and private breeders only emerged in the 1930s. Prior to that, farmers saved seed from their own crops and governments funded plant breeding research and development (R&D). The introduction of intellectual property rights (IPR) and plant breeders' rights (PBR) in the middle of the 20th century brought private sector interest, including from petrochemical and pharmaceutical companies (Schenkelaars *et al*., 2011). PBRs guaranteed a return on investment in plant breeding activities. However, as yield became the most important point of differentiation between seed brands, regional companies were able to compete effectively with the large multinationals who aimed for standardisation. Most of the multinationals exited the seed sector, but those with large investments in biotechnology, and specifically GM, consolidated their power in seed sectors across the world. This took the form of vertical integration of R&D (genetic modification) and germplasm assets, the seed and plant material itself (formerly owned by seed companies) (Schenkelaars *et al*., 2011).

Today, formal seed systems are dominated by private corporations which profit from ownership of germplasm and the technologies used to modify it. But a very significant base of germplasm and plant selection techniques still resides in the hands of farmers. There is a direct relationship between producer ownership of seed and techniques of reproduction on the one hand, and the economic importance of agriculture to the economy. Those economies which remain highly reliant on agriculture as an economic activity (i.e. less industrialised countries) have not developed corporate or formalised systems of seed ownership and reproduction. Conversely, highly industrialised countries tend towards a separation of seed ownership from agricultural production.

South Africa has a bifurcated system, with a highly industrialised core, where seed ownership is in the hands of multinational companies separated from agricultural producers, and a large, marginal periphery where seeds are often saved on the farm from season to season. However, in South Africa, unlike other African countries where an industrial agricultural system hardly exists apart from enclaves of export-oriented production, the corporate-industrial seed system has encroached significantly into the peripheries. This has led, over time, to the decay of indigenous knowledge about seed and a greater reliance on the formal system than is the case in other African countries.

3.1 Open-pollinated varieties (OPVs)

Open-pollinated varieties (OPVs) are the basic material from which all seed cultivars are developed. They arise from landraces – crop species that evolved from wild populations due to selective pressures from farmers over time[1]. OPVs are broad populations with many parents (Setimela *et al*., 2006). This broadness of the genetic base is a strength, especially when faced with climate change, where diversity is a strength, and uniformity a weakness (La Via Campesina, 2011).

OPVs can be divided into two categories. One category is of those crops that cannot be hybridised and OPV seeds are therefore used in the mainstream commercial market. These crops self-pollinate and it is not commercially viable to try to control pollination. The most important in South Africa are wheat, soya bean, groundnut, barley and dry bean (Table 1). Most commercial vegetable crops are mainly OPV. Forage/pasture seed produced in South Africa is almost entirely OPV except forage sorghum which is majority hybrid, and small amounts of hybrid triticale and babala (Sansor, 2011d). The other category of seeds is of those that can be hybridised. In commercial systems, there is a tendency towards hybrid seed in such cases, especially of commercially important agronomic crops like maize, sunflower and grain sorghum, and sweet corn, zucchini, cauliflower and broccoli, and to a lesser extent onion and carrot, amongst the vegetable crops.

TABLE 1: Seed type distribution of crops by volume in the formal system in South Africa, 2010/11

	Seed type	Crop
100% OPV	Agronomic	Barley, cotton, dry bean, dry pea, groundnut, soya bean, sugar beet, wheat
	Horticultural	Broad bean, coriander, curly kale, garden bean, garden pea, kohlrabi, leek, lettuce, parsley, rape, swiss chard
>50% OPV*	Agronomic	Canola, cotton, yellow maize
	Horticultural	Cabbage, carrot, celery, cucumber (field), brinjal, garden beet, garden radish, onion, paprika, pepper (hot), pepper (sweet), pumpkin, spinach, squash (general), tomato, watermelon
>50% hybrid*	Agronomic	Grain sorghum, sunflower, tobacco, white maize
	Horticultural	Broccoli, brussel sprouts, cauliflower, cucumber (tunnel), squash (zucchini), sweet corn, sweet melon

(Source: Sansor, 2011c, b)

**Mix of OPVs and hybrids*

Soya bean and cotton seed are 100% OPV, but almost the entire amount of both crops is GM. The seed cannot be hybridised, but genetic insertions are possible. For maize, there is a mixture of OPV and hybrid seed, and hybrids are genetically modified[2]. Most OPV maize is produced for sale into Africa. In South Africa, hybrid maize seed (and GM variants) is overwhelmingly the most used seed commercially (more detail below).

OPVs can be improved without hybridisation, although plant breeding is limited to selection of the seed-bearing plants. Hybridisation is just one technique amongst others to improve seeds (see below for more). But for more than 99% of the 10,000 years of agriculture (domestication of plants and animals), seed has been improved based on plant selection from the field. This was mainly in the hands of farmers until 60 or 70 years ago, when plant selection and breeding moved into laboratories in a significant way.

In Southern Africa, OPVs are most readily associated with resource-poor smallholder farmers because they are easily accessible, do not require high levels of external input and can adapt to local ecologies over time. OPVs can be saved on the farm from one season to the next with limited loss in yields. Although they may end up crossing with other varieties of the same plant that neighbouring farmers have planted, this should not automatically be seen as negative. While crossing may result in the inheritance of inferior traits, local crossing can also allow for adaptation to local conditions, resulting in greater robustness.

Studies have shown that maize OPVs ideally can be recycled for three seasons without significant yield loss. Thereafter, the seed should be refreshed if the same traits are to be maintained. According to MacRobert (2009:47) farm-saved seed of improved OPVs yields about 95% compared to fresh seed of the same variety. A study in Zimbabwe showed that recycled OPVs resulted in an average yield decline of 5%, compared with an average decline of 32% for recycled hybrid seed (Pixley and Banziger, 2001:25). Yield declines are attributed to the mixing of pollen from neighbouring fields where weak varieties are present (Setimela *et al*., 2006:7). However, the traits of crossed plants will be dependent on the other types of cultivars in the fields. Even though generally lower yielding than hybrids on a season-by-season basis, OPVs are more stable in low-yielding or stressed environments (Setimela *et al*., 2006:5). The IAASTD[3] (2009:106) says that long-term stability and resilience in the face of unknown stresses are more important issues than yield maximisation at present. Gordon Conway (1997:188) adds that farmers may place greater emphasis on ability to market, resistance to pests and disease, or labour requirements and there are gendered and cultural differences in selecting varieties for taste, ability to store or preparation issues. All of these values are incorporated into farmer decisions about what type of seed to use. Seed saving, which is most effective with OPVs, thus has the benefit of a high level of farmer independence and of incorporating other traits farmers may value beyond yield.

Still, yield remains important, even if it is just one amongst a number of considerations. For smallholder farmers who end up producing mainly for their own household use, the ability to increase yields makes a big difference to household food security. The main issue is what the cost is of producing those yields. Sometimes it is simply an unaffordable financial cost, in improved seed, fertilisers and pest and disease remedies. For commercial farmers, those oriented to and regularly producing surpluses for sale on the market, yield is also of high significance. This is especially so when the produce is sold as an undifferentiated commodity. All markets, including commodity markets, have certain preferred characteristics. In agricultural commodity markets, a high level of standardisation, and conformity for storage and processing, are required. Per hectare yield increases when selling into standardised markets can be the difference between surviving as a producer or not. Here we are talking mainly of maize and other agronomic crops where standardisation for processing and storage is a key issue. But retailers also require standardised sizes, colours and storage requirements for vegetables, and only hybridisation will enable the levels of standardisation required.

A commonly cited break-even yield for the use of hybrids for commercial maize production is 1.5t/ha. To give a sense of what this means, regional average maize yields in Southern Africa (excluding South Africa) are around 1.2t/ha (Langyintuo *et al*., 2008:2). In South Africa, average commercial maize yields were 4.1t/ha in 2009/10 (Department of Agriculture Forestry and Fisheries, 2011a:7). Yields for resource-poor smallholder farmers in South Africa are likely to be at or below the average African yield. There are no large scale studies on yields of resource poor farmers in South Africa, and definitely no systematic collection of data for official agricultural statistics.

The price of seed in relation to maize is a significant factor in determining market profitability. Pixley & Banziger (2001) propose that OPV maize might be a better option than hybrids where yields are below 1.5t/ha, and where the cost of hybrid seed and fertiliser is high relative to the price of grain. Given a grain : OPV seed : hybrid seed price ratio of 1:7:14, and a yield of 1t/ha, they propose that recycling (saving) OPV seed for two or three years will be the most profitable option (after which time fresh seed will be required to maintain yields). Recycling hybrid seed is the least profitable option in any circumstances, since yields decline dramatically after the first season. These calculations are dependent on the relative prices of seed to grain. If there is overproduction of grain, prices will drop and the price of purchased seed relative to grain will increase. This must take into account the effects of global markets. In all open economies, including South Africa's, grain prices are strongly influenced by global commodity prices. The smaller the national economy is relative to other economies, the greater will be the influence of global prices. Where grain prices are low, OPVs can be a profitable option up to 3.5t/ha before it makes economic sense to adopt hybrids (Pixley and

Banziger, 2001:27). The authors do note, however, that they are assuming that farmers are growing maize as a cash crop. Once we consider production for own use, as discussed above, profitability is less of an issue and the calculations will change.

MacRobert (2009:49) concurs with Pixley and Banziger, arguing that from a financial/commercial point of view, "in general, if maize farmers produce more than 1.5t/ha, it is to their advantage to use hybrid seed." But this does not deal with other aspects of hybrid seed, in particular its increasing reliance on agrochemicals and irrigation and its negative impact on agricultural biodiversity. While the number of seed varieties of some key crops (e.g. maize) on the formal market is increasing across Africa, the extent of diversity between these varieties is increasingly narrow.

The value of OPVs is thus more significant for smallholder producers who rely on their production to meet their own food needs, at least in part. This may come at the cost of improved genetic materials, seed treatment and seed quality control, and the presence of a viable seed sector that provides access to new genetic materials (Pixley and Banziger, 2001:23). OPVs may still require improvements, especially those susceptible to diseases and pests. These do not have to be synthetic improvements. They can also be plant breeding programmes that choose the best of the OPVs through natural crossing (by locating plants near one another, for example), thus producing natural hybrids, something distinct from an industrially-oriented scientifically produced hybrid. An important question is the extent to which these processes are removed from the hands of farmers.

Since the majority of agricultural production in Africa is on small farms, mainly by resource poor farmers, it is not surprising that OPVs still dominate. This goes for maize as well as other crops, although hybrid maize seed is expanding on the continent. According to Pixley and Banziger (2001:22) less than 30% of maize area in sub-Saharan Africa was planted to hybrids in 2001. In a survey of 107 seed companies in nine southern and eastern African countries[4] (Langyintuo *et al*., 2008), OPVs constituted 22.3% of seed sales for maize seed. In a number of countries, OPV maize seed still outsold hybrid maize seed: in Uganda, Malawi, Angola and Mozambique. These four countries constituted 17% of all seed sales in the sample, and 55% of OPV sales (Langyintuo *et al*., 2008). So while they are small countries (from a maize seed point of view) relative to their neighbours, they still have some regional significance from the angle of OPV maize. The research specifically surveyed companies that sold seed, which means there would be a bias towards the formal market and commercial production. According to MacRobert (2009), 66%–85% of seed used by resource-poor farmers in sub-Saharan Africa is derived from informal markets, which means the majority of seed would not be reflected in Lanyintuo *et al*.'s survey. South Africa is an important supplier of seed to the region, especially maize seed. As indicated above, this is primarily of OPVs to meet the demand for these types of seed where other external inputs are not available.

3.2 Hybrids and the Green Revolution

Hybrid seeds were developed from the 1920s for maize in the US (of which Pioneer Hi-Bred was literally the pioneer), and later for other crops, to cross desired traits identified in different varieties into a single plant. For example, one plant might have high drought tolerance and another might have higher natural pest resistance. These traits are deliberately crossed in hybridisation. This could be, and was, done in the fields prior to the development of what we know today as hybrids. But hybridisation raised the scientific accuracy of the process, and eliminated unwanted variables from the process by isolating the plants to control cross-pollination. However, the downside is that the seed is taken out of its specific context. Science by its very definition, is based on the notion of abstraction, moving away from the specifics and dealing only with the common. It necessarily requires a centralised control structure to collate pieces of information coming from many different places.

Hybrid seeds are produced from naturally out-breeding crops, from which inbred lines are produced by repeated self-pollination[5]. F1 hybrids refer to agricultural cultivars derived from two different parent cultivars, which are first inbred for selected characteristics (e.g. early maturity, disease resistance or drought tolerance) and then crossed with one another and evaluated for yield potential and other desired characteristics[6]. Crosses between two unrelated parents are known as single crosses. Those from three parents are known as three-way hybrids, and those from four parents are double-cross hybrids. The female product of a three-way hybrid is a single-cross hybrid and the male is an inbred line. The parents of a double-cross hybrid are both single-cross hybrids (which must first be produced as indicated above). In a top-cross hybrid, one of the parents is an OPV and the other is a single cross or an inbred line (Setimela *et al*., 2006:1).

The original cross usually has to be performed every season to retain the desired characteristics of the hybrid. The seed can be saved, but the characteristics it was bred for will decline steeply after the first year. The rapid yield declines of hybrid seed were mentioned above. According to MacRobert (2009:47), "farm-saved seed of a three-way hybrid yields about 68% that of fresh first generation (F1) seed of the same variety." Single-cross hybrids suffer greater yield losses on recycling (replanting saved seed) than three-way or double-cross hybrids (Setimela *et al*., 2006:4).

Hybrid seeds are no less organic than OPVs. The main difference is that a saved OPV will reproduce the traits of the parent, whereas a saved hybrid seed will not reproduce the combined traits of the parents. This is not intentional; it is a physiological limit to hybrids. Control over the 'pure lines' that were crossed to make the hybrid is thus important, because the hybrid can only be reproduced from season to season by going back and crossing the pure lines. Therefore ownership of the germplasm is essential for corporations to make a profit. In South Africa ownership is protected by the Plant Breeders' Rights Act, which we will look at in more detail later.

It is costly to produce hybrids, and companies only invest in areas where they estimate purchasing frequency and sales volume can ensure profitability (Pixley and Banziger, 2001:22). Hence the 'Green Revolution', which was built on seed hybridisation techniques, focused on improvement in crop varieties with commercial potential (defined by ability to consistently sell for a profit). The emphasis was on pest and disease resistance, drought resistance, and a variety of other beneficial characteristics, primarily with the purpose of increasing yields (for farmers) or profitability (for farmers, traders and processors). This meant resource-poor smallholders and those remote from distribution points were not served by the commercial seed market, or only indirectly so. This remains the case today, when hybrid seed is at the centre of commercial seed ventures.

Yet hybridisation cannot be achieved for all crops, and this creates "bottlenecks in the formal supply system" for cross-pollinated crops (e.g. beans), vegetatively propagated crops (e.g. potato or sweet potato) and crops with limited seed demand (e.g. indigenous crops). A combination of competition from farm-saved seed, low multiplication rates, transportation and storage difficulties (especially root and tuber crops), and regionally-specific preferences mean it is difficult to profit from these categories (CIAT, 2003:1).

Farmers may prefer hybrids for their greater yields, extended growing season and overall improvement in quality (including a range of desirable traits such as increased vigour, pest or disease resistance, fast maturation), although these may be true only when the seed is accompanied with other Green Revolution technologies, such as synthetic agrochemicals and irrigation. A characteristic which makes hybrids so desired in commercial agriculture is the predictability and uniformity it produces in the seed. This uniformity is required for industrial harvesting and processing. In the fields, the plants mature at the same time and thus can be machine-harvested. In factories, silos and packhouses, sorting and processing machinery works most efficiently with uniform sizes. Mill technology calls for some degree of standardisation, depending on market requirements (e.g. specific standards or quality control procedures).

As discussed above, however, there are many reasons why resource poor smallholders in particular may not select hybrid seeds, including cost, the need for synthetic fertilisers, lack of adaptation, limited difference in yields with OPVs or local varieties, and poor storability and poor processing quality of hybrids. In some countries security of supply may be an issue, because it is not certain that commercial entities will deliver seed on time every season (Pixley and Banziger, 2001:22).

3.3 Genetically-modified seed

GM technology marks a break with previous forms of plant breeding by inserting foreign genetic material into the plant. Genetic modification is different from hybridisation in that the latter is a cross between two pre-existing varieties to create a new variety with specific characteristics, whereas GM is an intervention within the internal genetics of the plant to produce a new variety with specific characteristics. It moves from a technology between plants to one within plants, a technology which definitively cannot be achieved outside the context of a scientific laboratory. It therefore carries to the logical conclusion the separation of the seed production process from the agricultural producer and the centralisation of ownership and control over seed.

The background to GM seed in South Africa is well covered and there is no point in repeating that here. For background and recent information on GM in South Africa see the websites of African Centre for Biosafety, Biowatch South Africa and Safeage[i]. Currently, three GM crops are under commercial production in South Africa: maize, soya bean and cotton. Other crops that have been approved for trial release in the past five years in South Africa include sugar cane, cassava, grapes and potato.

There are two types of genetic modification. The first is pest resistance by inserting the Cry toxin from the soil-dwelling bacterium, *Bacillus thuringiensis* (Bt), into the plant to increase resistance to a range of insects, including moths. Bt is used in maize and cotton. The second type of GM seed is glyphosate resistance, used in maize, soya bean and cotton (Table 2). Glyphosate is a broad spectrum herbicide used to kill weeds. It was developed by Monsanto under the name of Roundup. Monsanto had a patent that gave it exclusive rights to market and sub-licence the product until 2000 in the US. Thereafter generics were permitted and China has taken over as a major producer of glyphosate. Glyphosate is the most widely used herbicide in commercial agriculture globally. The glyphosate genetic modification allows the plant to tolerate the application of the herbicide, which enables farmers to spray crops to kill weeds after seedlings have already appeared. Prior to this, farmers could only spray before the appearance of the seedlings, and then had to hand weed once the seedlings had appeared, which was labour intensive and disrupted the soil. In the drive to reduce input costs, the technology proved beneficial for commercial farmers.

TABLE 2: GM varieties in South Africa, 2010-11

	Bt	RR/glyphosate-tolerant	Stacked	Total
White maize	25	17	11	53
Yellow maize	43	25	23	91
Soya bean	0	31	0	31
Cotton	1	5	8	14
Total	69	78	42	189

(Source: Department of Agriculture Forestry and Fisheries, 2011b)

Stacked traits were developed more recently, and are a combination of Bt and glyphosate tolerant traits in a single seed. This category of seed is taking a growing market share, with an increasing number of modifications in each seed coming out as companies seek to stay ahead of competitors. In 2010 Monsanto and Dow AgroSciences announced the release in the US of SmartStax maize with 8 genetic traits artificially inserted into the seed, 6 Bt and 2 glyphosate tolerance.

The use of GM seed has grown rapidly in South Africa since 1997 when the first GM seed was allowed to be grown commercially. In 2010-11, 77% of maize (74.8% of area under white maize and 80.2% of area under yellow maize), 85% soya bean and 100% cotton were GM, both by seed volume and by area (Sansor, 2011a:11, SeedQuest, 2011). The figures in Table 3 show the percentage hybrid and OPV for the top 10 crops by value in South Africa in 2010-11. The GM percentage does not reflect the above figures because South African companies produce a large amount of non GM, mainly OPV seed for export, especially into Southern Africa. This market is very important, especially for maize seed. The table does show that OPVs are a very significant base for all the highest value crops in South Africa apart from sunflowers, which are entirely hybrid in the commercial market.

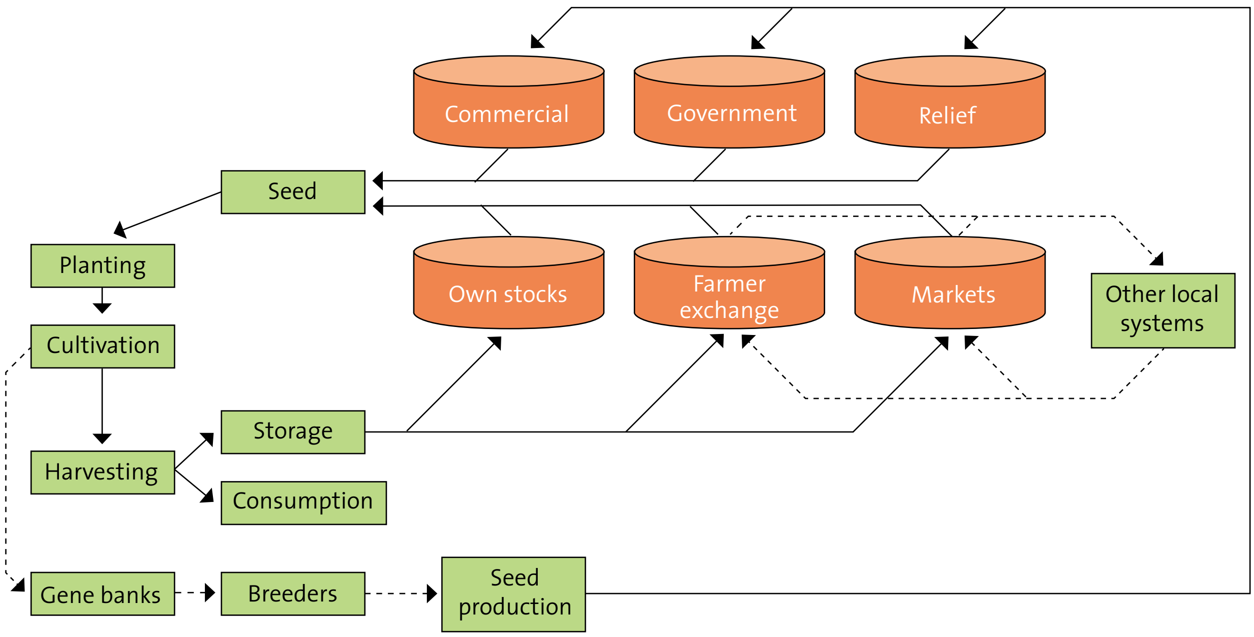
TABLE 3: Top 10 South African commercial seed crops by seed type, 2010-11

	% of total seed volume that is GM*	Seed type by volume (% of seed total) – domestic and export	
		Hybrid	OPV
Maize (white)	34.0	59.2	40.8
Maize (yellow)	59.9	49.3	50.7
Onion	-	22.9	77.1
Sunflower	-	100	-
Wheat	-	-	100
Tomato	-	9.5	90.5
Soya bean	96.1	-	100
Dry bean	-	-	100
Carrot	-	16	84
Groundnut	-	-	100

(Source: Sansor, 2011c, b, d)

**GM is a percentage of total hybrid and OPV seed with genetic modifications*

FIGURE 1: Seed system flow chart



(Source: International Centre for Tropical Agriculture, 2010:2)

4. Seed systems

4.1 Formal and informal seed systems

The overall seed system can be divided into two dominant types. On the one hand is the formal seed system which involves intensive R&D, regulated seed production and distribution through commercial seed companies. On the other hand are informal seed systems that are driven by on-farm seed saving and the production and distribution of seed is largely unregulated. Figure 1, taken from the CGIAR-aligned International Centre for Tropical Agriculture (CIAT) shows the interconnections between the two systems, in particular around farmer exchange and seed markets. Of the diagram, CIAT explains, "channels through which farmers source seed are depicted by the cylinders. Own seed stocks, exchange with other farmers and purchase through local grain markets constitute informal channels. Commercial seed stockists, government or research outlets and relief supplies constitute formal channels".

In the 'formal' seed system, bred seed is distinct from grain and the system includes formal breeding, gene banks, commercial companies and agro-dealers (Scoones and Thompson, 2011:7). It can be characterised as a chain, with an output of seed varieties developed outside the local context. The only connection with informal systems is the use of on-farm materials as raw material for gene banks. The 'informal' system includes household/farm seed selection and saving, farmer networks of gift and exchange and local markets (Scoones and Thompson, 2011:7). In the informal system, harvested grains can be used for consumption, seed for the next planting, or marketed as grain or used for seed by other farmers (Almekinders and Louwaars, 2002:22). The informal system can be characterised as a network with local production and dissemination connecting into broader systems. The formal and informal systems can be differentiated by the extent of enforcement of quality standards, and the distribution mechanisms.

Most seed (66-85%), regardless of the crop, comes from the informal seed system in sub-Saharan Africa (Setimela, 2006, MacRobert, 2009). However, the R&D focus on maize has meant a greater proportion of maize seed comes through the formal system. Hybrids represent an estimated 44% of maize area in East and Southern Africa (outside South Africa) and 60% of maize area in West and Central Africa, mostly being supplied through formal systems (Scoones and Thompson, 2011:8).

Challenges confront the private/formal seed sector to provide seeds to resource-poor smallholders, because these farmers commonly need small quantities, distribution needs to be arranged over wide and relatively inaccessible areas, and seed demand varies strongly between years, depending on average yield levels in the foregoing production season, and on the availability of cash (Almekinders and Louwaars, 2002:22).

Seed related activities in the informal system tend to be more integrated than in the formal system, in the ways farmers themselves produce, disseminate and procure seed - directly from their own harvest, by bartering, or through local grain markets and traders (International Centre for Tropical Agriculture, 2010:1). Informal seed networks provide both recent and earlier varieties of seed. It is not limited to old varieties. For smallholders in Africa 60%–70% of (maize) seed is saved on-farm, with 30%–40% acquired from relatives, neighbours and other community sources through barter, social obligation or other exchange mechanisms (Zerbe, 2001:660).

However, there are weaknesses in the farmer seed system. For example, it doesn't always respond well to the need for new varieties to refresh biodiversity or for varieties with higher productivity, and seed selection practices and storage conditions and practices are not always optimal (Almekinders and Louwaars, 2002:28). Expertise on these is available, but is mostly used to build the formal system targeting high input agriculture. There is an important role for individual farmer experts as key seed distributors and even as local seed producers.

Louwaars and others talk about integrated seed systems that combine the formal (especially improved varieties, not necessarily hybrid) with the informal (especially in distribution). There are many links between formal and informal systems e.g. new varieties of seed may be launched in the formal system but may move into informal systems quickly and be recycled by farmers or disseminated through farmer networks (Scoones and Thompson, 2011:8). Materials flow between the two systems, creating new hybrids that are often more useful to farmers than those produced in the formal or informal system alone. Farmers may draw seeds from both systems for different crops (e.g. maize through formal, beans or sorghum through informal). Farmers may also use different channels for the same crops (Sperling and Cooper, 2003:6).

TABLE 4: Characteristics of seed sources and their general suitability for planting material or new varieties

Seed source	Characteristics	Source for planting material	Source for new varieties
On farm	Known quality, cheap, readily available	+++	- - -
Neighbours, friends and relatives (in the community)	No cash involved, readily available	++	+
Others in the community	No cash involved, readily available, not necessarily easily accessible (social differentiation)	+	++
Local market	Unreliable quality, last seed resource	- -	- - -
Middlemen	Non-cash arrangements/loans, unreliable quality	+ -	- +
Neighbours, friends and relatives (outside the community)	Non-cash arrangement, resources needed for travelling	+	+++
Stores and commercial Enterprises	Cash for seed and travelling	+	++
Seed agencies, public seed sector	Unreliable availability and quality unknown	-	+++

Ranging from +++ (generally very suitable) to + - (reasonable suitability, depending the situation) and - - - (generally unsuitable)
(Source: Almekinders and Louwaars, 2002:25)

Seeing the seed system as integrated allows us to understand that farmers may have a variety of sources of seed, with different benefits depending on what the seed is needed for. On farm seed is good for known quality, availability and cheapness, but not useful if new varieties are sought. The public sector and others sources outside the community are good for new varieties, but quality is not always reliable. According to Almekinders and Louwaars (Table 4), local markets are the source of last resort, because new varieties are unlikely to be found there and quality is also unreliable. Key issues in determining source are quality, cash requirements and accessibility.

Four key issues need to be covered by the seed system: i) supplying seed to the final user at the right time; ii) supplying seed in the right place; iii) supplying seed of the right quantity, quality and condition (Pichop and Mndiga, 2007:5). Points i and ii refer to seed availability, while point iii refers to utilisation. In addition, iv) access is important, i.e. people are able to actually get the seed that is available (having financial assets or social networks) (Sperling and Cooper, 2003:8). A combination of formal and informal systems is likely to provide the most flexibility.

There is great variation in seed systems in Africa. Overall, we can learn that informal systems can actually be the basis for sustained food production. African countries have weak agricultural systems, to the extent that many countries rely on external food aid. Whether the poor productivity of African systems comes from the informality of the seed system and the lack of private sector involvement and the over-reliance on unimproved OPVs and traditional farming systems, are questions at the centre of debates about the future of agriculture in Africa. Green Revolution exponents argue that the spread of hybrid seed, the involvement of the private sector (which requires regulations that make it feasible to profit off the production and sale of seed), the private ownership of land and the modernisation of production techniques are the panacea to weak agricultural systems in Africa. On the other hand, others will argue that the historical imbalances in resource distribution which persist into the present, the lack of public resources that arise from colonial conquest and the development of resource extracting economic systems and overproduction in advanced capitalist economies that make domestic manufacturing and industrial efforts obsolete, and the continuing orientation of economies to the export of low value added products, all contribute to lack of investment in local systems of food production for local consumption, whether by the private sector or the state.

As indicated earlier, maize is one of the main crops to be drawn into the formal seed system in the rest of sub-Saharan Africa. Because maize is so widely grown in the region, and because African yields are so low when compared with other parts of the world, much attention has been paid to the improvement of maize varieties in Africa. Until the 1980s, states provided significant support to R&D and production of improved seed for maize and a variety of cash crops (e.g. cotton, rice) but the debt crisis and structural adjustment put an end to that. Other crops were left out of the formal system, and more than 80% of all seed was, and still is, produced and disseminated informally. Spending on R&D fell in about half the countries of sub-Saharan Africa in the 1990s (Smale *et al*., 2011:7). The emphasis has shifted from R&D of improved OPVs to hybrids. Even international research centres under the CGIAR umbrella (e.g. CIMMYT and IITA) lost resources, and regional breeding programmes began to be emphasised especially once the Gate Foundation reinvested in them in more recent years.

The role of the private foundations (Gates, Rockefeller) in resuscitating breeding programmes is indicative of a trend towards public-private partnerships in breeding and seed improvement. As Africa has become more in vogue as a 'new frontier' of investment, seed companies have started looking for other potential points of profit in the seed sector. Government policies sometimes make private sector entry difficult, but in other cases governments have paved the way for private companies to enter into seed sectors. Mozambique and Uganda have sought a market-led approach to food production. Kenya is considered the 'poster child' of the Green Revolution. The state has a partnership with the Alliance for a Green Revolution in Africa (AGRA)[ii] to build agro-dealer networks, which are envisaged to become channels for multinational seed. But the issue isn't so much weak seed distribution networks as high prices of inputs, especially fertiliser, diesel and labour; and unreliable or erratic rainfall (Odame and Muange, 2011). Of 250 maize varieties and hybrids and hybrids released in 13 sub-Saharan African countries (excluding South Africa) between 2002 and 2006, over 60% were released by the private sector (Smale *et al*., 2011:8), showing the expansion of private sector breeding programmes in maize in the past decade.

Other countries such as Zambia and Malawi have tended towards more direct state intervention. Here the government has tended to provide or subsidise the purchase of seed, which is not the same as enhancing and extending knowledge about production and distribution of high quality seed. In Ethiopia the state continues to play a big role in the seed sector e.g. state farms are deployed to produce breeder, pre-basic and basic seed and for seed multiplication. Parallel to this, decentralised, locally-run farmer-based seed production and marketing schemes exist and are also being promoted officially. These improve the possibility of production of locally demanded varieties, and continue to be the main source of seed for public seed enterprises. However, a public sector driven model requires significant external (state) support, intensive training of farmers, supervision, quality control and overall management. There are difficulties in contract enforcement, and price risks are borne by farmers (Alemu, 2011:72-73). The private sector in Ethiopia sources its basic seed from the public supply, and has to align with the public seed distribution system. The only current exception is Pioneer Hi-Bred Ethiopia, which has its own seed source and some distribution network. But the state sets prices and limits private distribution. This is seen as an obstacle to the expansion of the seed system, given the limits of state resources (Alemu, 2011).

Most studies tend to focus on the weaknesses of informal seed systems in Africa, with an emphasis on low productivity and limited access. We should not ignore these important issues, but it might also be possible to draw positive lessons from the way informal systems have managed to survive in very adverse conditions in Africa. Small holder farmers deriving seed from informal sources constitute an important base of food production in many African countries. Evidence shows that if provided with adequate support and linked to sources of improved varieties, the informal system can be a very reliable and efficient way to access improved varieties of crops mostly neglected in the formal system (Rubyogo *et al*., 2007).

4.2 An overview of South Africa's seed system

South Africa has the best-developed formal system on the continent. This is not to say it is the best system in providing smallholder and especially resource-poor farmers with appropriate and affordable seed. It is difficult to provide an overview of the seed system as a single entity, since each crop has its own dynamics.

South Africa's seed system is a product of the bifurcated agricultural system, with a dominant white-owned, large-scale commercial farming sector and a subordinated, primarily black small-scale resource-poor farming sector. The former was built on Green Revolution technology, with its key characteristics: hybrid and GM seed, separation of seed ownership from agricultural production, use of synthetic fertilisers and pesticides, irrigation, and associated extension services, concentrated ownership, commercial crops (necessary to afford the seeds and other inputs), commercial marketing institutions (including a strong role for state-controlled or state-mandated structures) and commercially-oriented infrastructure (silos, railway lines and services, roads, petrol stops, housing and associated services). South Africa's seed system was thus characterised by the development of specialised seed markets geared towards commercial farmers.
Table 5 sketches a history of the development of the formal seed system in South Africa. Seed was mainly imported until well into the 20th century when state-run research institutes began developing new varieties adapted to local requirements. During the period up to the 1960s, agricultural co-ops and private seed companies were nurtured. From the 1960s hybridisation began, especially after the introduction of private breeding programmes and the transfer of seed production to private companies. Plant breeder's rights and regulations governing seed quality were introduced.

TABLE 5: Brief history of growth of the formal seed industry in South Africa

Period	Stage	Major events
1500-1900	Farmer seed exchange	Introduction of maize into Africa by Portuguese; farmer seed exchange
1900-1960	Emergence	State-run experimental stations/research institutes; introduction and selection of new varieties; importation of seed; Fertilisers and Seeds Act
1960-1980	Growth	Release of hybrids; Seed Act; transfer of seed production and marketing to private sector; private breeding programmes; Plant Breeders' Rights Act; entry of multinationals
1980-	Maturity	Expansion of hybrids; agricultural restructuring; transfer of seed certification, lab testing and phytosanitary regulation to private sector; industry consolidation; establishment of Sansor in 1989; establishment of ARC in 1990 as umbrella for public agricultural research institutes; introduction of GM seed; entry of large multinationals

(Source: adapted from Rusike, 1995:13)

Multinationals entered the seed industry, especially from the 1960s and there was consolidation around six big companies (Pannar, Sensako, Asgrow, Ciba-Geigy, Saffola and Cargill Hybrid Seeds). Over time Cargill and Ciba-Geigy seed divisions merged and formed Carnia, which then bought the agronomy division of Asgrow. Consolidation of the seed industry started in the 1980s with the formation of the Association of National Seed Organisations (ANSO) in 1980. There was an increase in mergers, strategic alliances and acquisitions from the late 1980s to control distribution and sales costs in particular (Rusike, 1995:16-17). Pannar acquired Saffola (Rusike, 1995:15-16) and Monsanto acquired Carnia and Sensako in 1999 and 2000.

Following the processes of agricultural deregulation that began in the 1980s (Bayley, 2000) former co-ops were permitted to convert to companies. Such a shift permitted companies to provide a wider range of products and services than they were able to under the Co-operatives Act, including finance and retail services. This saw the conversion of the input distribution networks built under the co-ops into privately-owned systems. One of the earlier shifts to privatisation of agricultural institutions and infrastructure was the transfer of significant aspects of seed regulation to the private sector under the auspices of the industry body, the South African National Seed Organisation (Sansor) in 1989.

Deregulation also saw the formation of the Agricultural Research Council (ARC) as an umbrella for the various agricultural research institutes in 1992 and its corporatisation, i.e. it faced a shift to a profit-making entity that had to rely on private contracts to fund its breeding programmes and gene banks. While it has retained some 'public good' services thanks to grants from the state, these are very small compared with privately funded activities. For example, the Vegetable and Ornamental Plant Institute (ARC-VOPI) is now essentially the gene bank for the commercial potato industry.

The formal seed system was worth R3.6bn in 2010-11 (Table 6). Maize is by far the largest seed sector in South Africa, with nearly 59% of total seed market by value. White maize is mainly for human use, and yellow maize is mainly for animal feed, though some is also used for human consumption. Onion and sunflower, the next biggest seed sectors by value, were far behind maize with a combined total of just over 9% of total value between them. The top 10 commercial seed crops in

South Africa constituted 81% of total value of the seed market in 2010-11. Overall, OPVs are a very important part of the formal seed sector, constituting over 56% of total market by volume, although a large proportion of OPVs were for export, especially maize. In 7 of the top 10 seed crops in the formal sector, OPVs are still dominant. For some, like wheat, soya and dry beans this will always be the case, as discussed above.

TABLE 6: Top 10 South African commercial seed crops by value, 2010-11

	Value (R'm)	% of total market value
Maize (white)	1 127.45	31.30
Maize (yellow)	992.71	27.56
Onion	171.99	4.77
Sunflower	163.79	4.55
Wheat	91.74	2.55
Tomato	83.03	2.30
Soya bean	78.64	2.18
Dry bean	77.15	2.14
Carrot	71.98	2.00
Groundnut	59.66	1.66
Total - Top 10	***2 918.14***	***81.00***
Total market	**3 602.56**	**100.00**

(Source: Sansor, 2011c, b, d)

In the formal system there is pressure to produce new varieties on a regular basis to stay ahead of competition. Many of these varieties rely on a narrow germplasm base and there are small differences between one variety and another. In South Africa, just 25% of maize varieties had been listed for 7 years or longer, while 40% of varieties were on the list for 2 years or less (MacRobert, 2009:10). This shows a high turnover of varieties. The top 10 seed crops constitute 50% of total seed varieties (Department of Agriculture Forestry and Fisheries, 2011b), showing a fairly narrow germplasm base.

TABLE 7: Share of dominant companies in maize seed variety ownership, 2010-11

Company	Maize varieties owned	% of total maize varieties	% of total GM varieties			
	GM	**Hybrid**	**OPV**	**Total**		
Pioneer Hi-Bred SA	50	62		112	24.7	34.7
Pannar	37	46	3	86	18.9	14.6
Klein Karoo Seed	20	42	1	63	13.9	4.9
Monsanto SA	31	18		49	10.8	21.5
Top 4 share of maize varieties	***138***	***168***	***4***	***310***	***68.3***	***75.7***
Total all maize varieties	**144**	**277**	**33**	**454**	**100**	**100**

(Source: Derived from DAFF, 2011)

Market share is impossible to establish as this information is kept confidential by companies. However, we can get some measure of concentration of ownership in the seed sector by looking at ownership of varieties and plant breeders' rights. Four companies dominate ownership of maize seed varieties, with 68% between them (Table 7). These companies are Pioneer Hi-Bred, Pannar, Klein Karoo Seed and Monsanto SA. This is not the same as their market share, since some varieties have a greater share than others. Monsanto is taken to be the largest maize seed company in the country by sales (DAFF, 2011). Appendix 1 shows ownership patterns of seed varieties of the top 10 seed crops. The top 10 companies hold 76% of the top 10 seed varieties, with the same four dominant companies owning more than half of all varieties of the top 10 crops.

TABLE 8: Ownership of agricultural seed cultivars, 2011

Owner	Horticultural cultivars	Agronomic cultivars	Forage cultivars	TOTAL	% of all registered cultivars									
	hybrid	OPV	other*	Total	GM	hybrid	OPV	other*	Total	hybrid	OPV	Total		
Pannar total	155	20	6	181	46	132	51		229	5	30	35	445	20.3
-- Pannar	71	12		83						1	2	3	86	3.9
-- Pannar Seed					46	132	51		229	4	28	32	261	11.9
-- Starke Ayres	84	8	6	98									98	4.5
Monsanto total	75	22	1	98	37	23	51		111		12	12	221	10.1
-- Monsanto SA	67	22	1	90	37	20			57		2	2	149	6.8
- Seminis Vegetable Seeds SA	3			3									3	0.1
-- Sensako							44		44		10	10	54	2.5
-- Mahyco	5			5		3	7		10				15	0.7
ARC & other govt total		8		8		4	70	11	85	4	71	75	168	7.6
- ARC		8		8		4	67	11	82	4	70	74	164	7.5
- Cedara Research Station							1		1		1	1	2	0.1
- Lowveld Research Unit, DoA							2		2				2	0.1
Sakata Seed Southern Africa	118	7	5	130							2	2	132	6.0
Pioneer Hi-Bred RSA					57	64			121		8	8	129	5.9
Klein Karoo Seed	12	2		14	20	52	4		76	1	25	26	116	5.3
Hygrotech Seed	70	25	4	99							14	14	113	5.1
Syngenta SA	40	11	3	54	1	20	4		25				79	3.6
Agricol		1		1		22	1		23	2	50	52	76	3.5
M Burnett (Rijk Zwaan)	27	2	21	50									50	2.3
Other & unknown	188	146	14	348	28	99	100	6	233	3	84	87	668	30.4
TOTAL	***685***	***244***	***54***	***983***	***189***	***416***	***281***	***17***	***903***	***15***	***296***	***311***	***2,197***	***100.0***
Top 10 share of total	72.6	40.2	74.1	64.6	85.2	76.2	64.4	64.7	74.2	80.0	71.6	72.0	69.6	69.6

(Source: Derived from Department of Agriculture Forestry and Fisheries, 2011b)
**Other – unspecified, rootstock, tunnel varieties*

Table 8 shows the overall ownership of seed varieties in 2011 across horticultural, agronomic and forage crops. The 10 largest owners accounted for 70% of all registered seed varieties in 2011, up from 66% in 2008 (African Centre for Biosafety, 2009:45), indicating growing concentration of ownership. Concentration is highest in agronomic crops (which includes grains), with the ten biggest owners holding 74% of all varieties, compared with 72% for forage and 65% for horticultural varieties. The highest concentrations by seed type are found in GM agronomic crops (ten biggest owners hold 85% of varieties) and hybrid forage (80%). The most dispersed ownership is in horticultural OPVs, with the ten biggest owners accounting for 40% of varieties in this category.

TABLE 9: Plant Breeders' Rights, 2011

Company/institution	PBR granted/applied for	% of total varieties with PBR
Pannar total*	182	21.6
Pioneer Hi-Bred RSA	126	14.9
ARC	120	14.2
Monsanto total**	93	11.0
Klein Karoo Seed	53	6.3
Sakata Seed Southern Africa	53	6.3
Agricol	41	4.9
Hygrotech	20	2.4
Pro-Seed cc	16	1.9
Link Seed	15	1.8
Top 10	***719***	***85.3***
Total	**843**	**100.0**

(Source: Derived from Department of Agriculture Forestry and Fisheries, 2011b)

**Pannar and Pannar Seeds **Monsanto SA and Sensako*

The ten biggest owners of seed varieties in South Africa are the same as three years ago (African Centre for Biosafety, 2009) except that Afgri sold its seed division in 2009 to Klein Karoo Seed Marketing (KKSM). Afgri has decided to focus on value addition of grain via poultry. This increased KKSM's share, and Afgri was replaced in the top 10 by Rijk Zwaan, a company from the Netherlands and formerly owned by BP. Apart from KKSM, Pioneer Hi-Bred, Pannar and Agricol also increased their shares of variety ownership. Table 9 shows ownership of or applications for plant breeder's rights, with the same four companies holding 54% of all varieties with PBRs, and the top 10 companies holding 85% of such varieties.

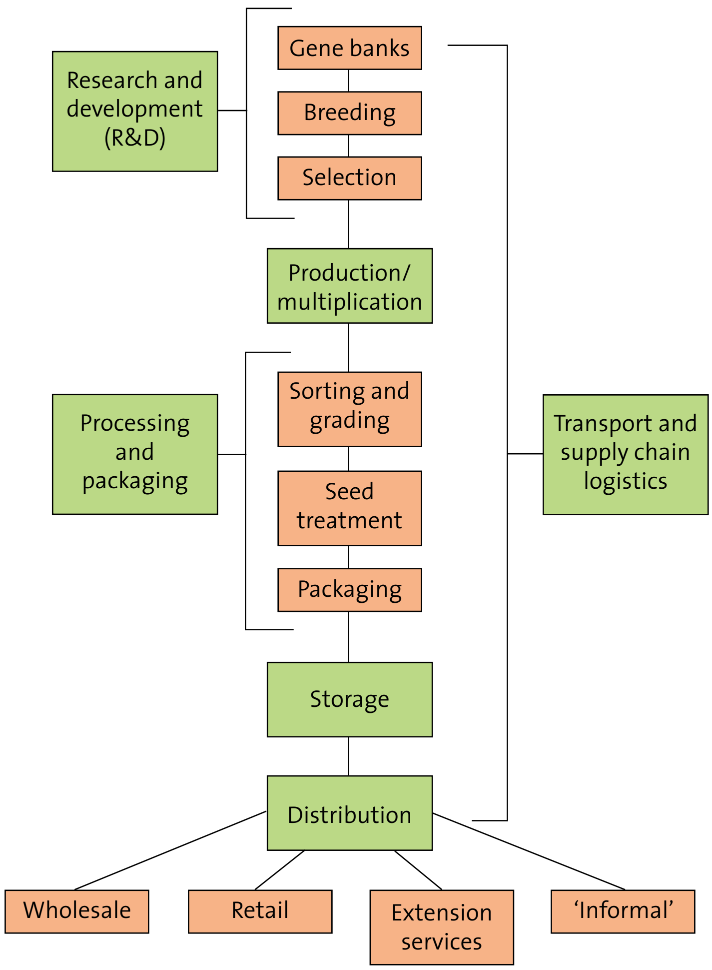
In contrast to the commercial farming sector, the 'subsistence' sector was historically characterised by the use of farm saved seed which meant farmers owned their seed, often poor quality seed, limited external inputs to increase productivity, weak and under-resourced extension services, dispersed ownership and producer base on small units of land, often insufficient to produce consistent surpluses (hence the tag of 'subsistence' production) and thus production mainly for household consumption, and weak or non-existent marketing support or agricultural infrastructure.

Late apartheid efforts to create a black 'master farmer' class were mainly top-down and did not give black farmers any real independence to make their own production decisions. After 1994, land reform and some state-driven group agricultural projects opened the door further to the integration of a small layer of black farmers in the formal system, but did nothing to break down the bifurcated agricultural structure. What did happen, however, was the expansion into former homeland areas of former co-operatives which had been converted into companies. These are the South African version of agro-dealers, but in a very concentrated and corporatised form. They provided a greater number of black farmers, who previously had been denied access to seed varieties from the formal system, with greater access to these seeds. But in the absence of other kinds of support or resources, many still relied on farm-saved seed and informal distribution networks.

5. The seed production process

5.1 Research and development

FIGURE 2: A simple seed supply chain



The first stage of the seed production cycle is the maintenance of the collection of germplasm that constitutes the agricultural biological base. In South Africa, seed was mainly imported in the early days, and farmers sustained the germplasm base until the development of government, parastatal and private collections. Until 1998 plant genetic material was kept in fragmented collections held under the control of a variety of government, parastatal and private collections. Of the 48,918 accessions nationally, a small proportion of wild, indigenous species were held by the Department of Agriculture. The majority of the national collection, which included both indigenous and foreign material, was held by the institutes of the ARC (National Department of Agriculture, 1995:17). Active working collections were maintained but without base backup collections.

The National Plant Genetic Resource Centre (NPGRC) – the national gene bank – was established in 1998 to consolidate a base collection, especially of plant genetic resources of food and agriculture (so-called mandate species). Before this there were no formal, in situ conservation programmes to protect landraces, traditional varieties or wild relatives. These genetic resources were not documented or systematically saved in any ex situ collections. The gene bank does not keep improved varieties, and hence does not collect from breeders. The bank focuses on indigenous crops for food and agriculture, and mainly stores material in a base collection (using cryo-preservation) and an active collection. In 2008, there were 5,800 landrace accessions to the NPGRC. It tests material regularly and only regenerates material where the germination rate has fallen below 85% (NPGRC, 2011). Duplicate samples of all materials are sent to the SADC Plant Genetic Resource Centre in Zambia. Some of the landraces conserved in the national gene bank are shown in Appendix 2.

The bank aims to increase the availability of indigenous and adapted plant genetic resources to farmers, breeders and researchers for further improvement. Accessions in the active collection are stored in small bags, ready for distribution to breeders and researchers. Seeds are only distributed on completion of a standard germplasm acquisition agreement (NPGRC, 2011). The agreement makes biological materials held by the NPGRC freely available for non-commercial use. If recipients want to commercialise any material deriving from the original material, they must sign a separate agreement with the NPGRC which will specify fair and equitable benefit sharing. The material can

not be shared with anyone else except by written agreement. It is primarily designed for those who want to improve the material. The collections are aimed for public use, and there are no real requirements for access except that the bank has on record the purpose for accessing seed, and in recent times tries to follow up on what the outcomes of using the seed were.[iii]

So there are three main germplasm stores in South Africa at present: within the ARC system, in the national gene bank, and in privately-owned collections. A fourth might be in-situ seed and genetic resource collections on farms and in local-level seed banks, although the extent of this has not been investigated to date. The NPGRC has a programme to develop on-farm collections at Sterkspruit in the Eastern Cape and Vhembe in Limpopo. The Centre also seeks to restore landrace accessions to small scale farmers, and to promote broader use of landraces.

These gene collections provide the material for plant breeding. There are three main stages in plant breeding: i) the introduction of limited genetic material of a crop and observation to see how it performs in existing conditions; ii) selection – evaluation of a wide range of material for yield, pest and disease resistance, and stress tolerance to identify most productive cultivars; iii) creation of new material by controlled cross-pollination to produce new selections or hybrids (Rusike, 1995:2). Key factors for which seed is bred or selected include yield, stress tolerance (drought, poor soil fertility), maturation period, nutrient use efficiency, pest and disease resistance, storability, processing quality and adaptation to local environments.

In the early days of plant breeding, the public sector (government agencies and parastatals) was historically dominant in Southern Africa. Profitability was not a primary objective, although cost recovery became more important with liberalisation (Zerbe, 2001:659). The first maize breeders' programme in South Africa was established in 1917, followed by the first government maize hybrid breeding programme in 1925. The Maize Control Board, formed in 1944, carried out hybrid seed production and marketing while nurturing the formation of private seed companies and co-ops (Rusike, 1995:15). Over time there was acceptance of private maize breeding, and in 1959 Sensako established the first private hybrid breeding programme, followed by others. Strategic alliances were developed between DeKalb Genetics and Sensako in the early 1960s (both subsequently absorbed by Monsanto) and Pioneer Hi-Bred and Pannar in 1968 (which laid the historical basis for the current attempted merger) (Rusike, 1995:15).

The R&D process may take up to 10 years if successful, and much research leads into dead ends. The full-scale entry of the private sector into plant breeding was therefore delayed until rights to exclusive use of new cultivars were assured. In the early 1960s legislation protecting plant breeders' rights was developed, culminating in the Plant Breeders' Rights Act in 1976, discussed in more detail below. Protection of plant breeders' rights opened the door for private sector involvement in breeding, and the formal seed sector consolidated around a few core companies. The Act allowed for the licensing of traits to other companies which would then incorporate them into their own germplasm.

In the 1990s, biotechnology introduced new consolidations in the seed sector as companies with ownership of biotech traits and applications bought up seed companies that owned the germplasm. Hence Monsanto purchased two of South Africa's major seed companies – Sensako and Carnia – in the late 1990s and Pioneer Hi-Bred is seeking a merger with Pannar at present. In both cases, biotechnology companies sought direct control over the germplasm base, rather than merely getting royalties from licensing traits. This indicated that ownership of germplasm had become a profit centre.

Historically, private germplasm collections focused on imported breeding material, with little attention paid to indigenous plant material. This remains true, with most private sector R&D being adaptations of imported technologies which are then distributed under licence from multinational companies (Kirsten, 2011). Old cultivars of indigenous crops such as millets, cassava, plantain, sorghum, cowpea, okra, yams, and sweet lupins have been maintained on-farm mainly by subsistence farmers (National Department of Agriculture, 1995:14). The proprietary breeding programmes saw private companies doing breeding on a profit-making basis. With enhanced IPR protection, anyone who registers a variety becomes the *de facto* owner of that variety. For-profit research is largely confined to hybrids and genetic modification for maize, cotton and soya bean. Generally speaking, both public sector seed networks and private companies have failed to provide seed to farmers outside high-potential commercial areas (Zerbe, 2001:659).

As proprietary breeding programmes expanded, the public sector shrunk, especially after the fiscal crisis faced by the state in the late 1980s and early 1990s, which saw the slashing of agricultural budgets amongst others. The parastatal research institutes, who previously were fully funded by government, were corporatised and had to secure part of their funding from contracts with private companies. Between 2000 and 2010, ARC received approximately 64% of its income from government, mainly from DAFF and a smaller amount from the Department of Science and Technology (DST). ARC institutes were forced to cover operational costs from privately paid contract work (Agricultural Research Council, 2010:9). Today most public sector breeders have retired or been retrenched and the institutes have limited resources to maintain breeding programmes. New students are mostly channelled into biotechnology and genetic modification research, and there are few courses on seed science left at the technical colleges or universities.[iv] They were thus increasingly drawn into maintaining private germplasm collections on behalf of companies, with only a limited amount of R&D being carried out in the public interest. In the 1990s the Vegetable and Ornamental Plant Institute (ARC-VOPI) made a decision to abandon R&D into seed vegetable crops, and focus attention on vegetatively propagated crops (primarily potato, sweet potato, garlic and cassava). The Grain Crops Institute (ARC-GCI) has entered into public-private partnerships (PPPs) such as Water Efficient Maize for Africa (WEMA), which includes the International Maize and Wheat Improvement Centre (CIMMYT), Monsanto and national research institutes from a number of African countries, with funding from the Gates and Buffett Foundations; and the Improved Maize for African Soils (IMAS) with CIMMYT, Pioneer Hi-Bred and Kenya's agricultural research institute (KARI), funded by Gates and USAID (Agricultural Research Council, 2010:28-29).

The ARC institutes generally have three strands to their work: a small 'public good' strand where they do their own R&D and the collection is open for public use; a sub-licence strand where the institute gets a licence to work on privately owned germplasm and pays royalties to the owner if they develop a product that is sold; and a private client collection, which is the core of their work.[v] If we focus on vegetables and grains – the primary crops grown by resource-poor smallholders – it is apparent that the public good strand is very small compared with privately funded activities. ARC-VOPI have six potato varieties available to the public, and also a few varieties of sweet potato and cassava. They have a small programme on indigenous crops, and ARC is the only source of seed for some of these crops, e.g. amaranth, spider flower, jute, local species of nightshades, local landraces of cowpea and pumpkin, bitter watermelon and amadumbe.[vi] Mainstream vegetables are all in the hands of the private sector. ARC-GCI, which deals with maize, sunflowers and soya amongst others, does almost no public good R&D anymore,[vii] and at best works in PPPs which might also be seen as the use of public institutions to expand the reach of GM seed. ARC-SGI (Small Grains Institute) is active in breeding wheat, oats and triticale, and is doing its own marketing of the varieties it develops. The Range and Forage Institute at Cedara does breeding on local ryegrass varieties.

Participatory plant breeding has never been big in South Africa. This is closely related to the 'transfer-of-technology' extension model, where farmers are passive recipients of knowledge generated by outside technical experts, and are offered technologies on a 'take it or leave it' basis. Where there is some form of farmer involvement in breeding processes, this often becomes an outsourced approach to testing varieties in experiments of accredited breeders, with farmer-based seed multiplication a route for farmer co-option into private sector projects. Such 'participatory' programmes do not necessarily offer a farmer-led source of innovation and seed supply rooted in the local seed system (Scoones and Thompson, 2011:16). Ways of connecting local expertise and innovation with external sources of technology and skills are still required.

Since 1989, Sansor has been responsible for the licensing of plant breeders' rights. Sansor currently has 32 registered breeders as members.[viii] The majority of the biggest seed companies are registered with Sansor as breeders (only Agricol and Hygrotech in the Top 10 are not).

5.2 Farmers' Rights

Farmers' Rights are those rights arising from the past, present and future contributions of farmers in conserving, improving and making available genetic resources, particularly those in the centres of origin/diversity. The concept of Farmers' Rights is recognised in the United Nation's Food and Agriculture (FAO) International Treaty on Plant Genetic Resources, ("The Seed Treaty"), which entered into force in 2004. The Seed Treaty's objectives include the conservation and sustainable use of plant genetic resources for food and agriculture. Its preamble affirms farmers' rights to save, use, exchange and sell farm-saved seed and other propagating material, and to participate in decision-making.

Further, Article 9 of the Treaty recognizes the enormous contribution that local and indigenous communities and farmers of all regions of the world, particularly those in the centres of origin and crop diversity, have made and will continue to make for the conservation and development of plant genetic resources which constitute the basis of food and agriculture production throughout the world.

Plant Breeders Rights in South Africa

Currently, South Africa's Plant Breeders Rights Act, 1976 (Act No.15 of 1976) grants plant breeders certain intellectual property and other rights over plant varieties. These allow the rights holder to claim royalties as remuneration for the use of a protected variety and prevent unlawful uses. The plant breeder/right holder has a sole right to the variety for the first 5 to 8 years to produce and market propagating material of the variety. During the next 15 to 17 years the holder is compelled to issue licenses to other persons who may also wish to use and market the material. When the holder issues a licence to another person, the holder may continue to claim royalties for any propagating material produced and sold. Use of a protection variety without the consent of the right holder is thus not allowed and is regarded as unlawful.

Section 23 of the Act provides for certain exceptions, which allows a farmer to use farm saved seeds and propagating material on land occupied by him or her without paying royalties. The law does not, however, allow the exchange of protected seeds between farmers.

SA, UPOV and farmers rights

South Africa's plant breeder's rights legislation is strongly influenced by the International Union for the Protection of New Varieties (UPOV). UPOV was established in 1961 and is an international regime designed principally to protect the interests of plant breeders. UPOV has been amended several times-in 1972, 1978 and 1991. South Africa is a Party to the 1978 UPOV agreement and its provisions are binding on the Republic. In terms of the 1978 UPOV agreement, the holder of a plant variety had a monopoly on the commercial propagation and marketing of the variety but little control over other uses. The scope of the intellectual property right protection is only in respect of production for the purposes of **commercial marketing, offering for sale and marketing of propagating material of a protected variety**.

Farmers were thus free to multiply seed **for their own use** for as long as they wished. Breeders were also free to use a protected variety to develop a new variety as long as it did not require repeated use of that variety. Farmers were also allowed to freely use their harvested material from a protected variety for any purposes.

However all of this changed dramatically when UPOV was revised in 1991, the rights of breeders strengthened and those of farmers severely curtailed.

UPOV 1991 extended the scope of a plant breeder rights' to also include other activities such as exporting, importing and stocking of protected varieties. Breeders' rights were also restricted in that they were no longer allowed to produce varieties that were essentially derived from a protected variety. Crucially, it allowed national governments to decide whether farmers could be allowed to reuse the harvest of protected varieties on their own landholdings without the authorisation of the rights holder. UPOV 1991 binds its members to disallow the exchange or selling of such harvested material. There is no flexibility in UPOV with regard to this restriction.

While South Africa has signed this UPOV 1991 version, it has not yet ratified it. In other words, the UPOV 1991 is not binding on South Africa and it is thus under no obligation to either implement or ratify UPOV 1991. No developing country that is a member of the 1978 UPOV agreement, including major grain exporting countries such as Brazil and Argentina, has ratified UPOV 1991.

Nevertheless, South Africa, already as far back as 1996, and in terms of amendments to the Plant Breeders Rights Act at that time, began a process of implementing some of the UPOV 1991 provisions. These relate inter alia to the restriction on farmers' rights, particularly in regard to harvested material. The current provisions of the Plant Breeders Rights Act, namely those contained in the current section 23(6)(f) thus prohibits the exchange of harvested material and ties such harvested material to a farmer who is in occupation of land. However, farmers are allowed to use all propagating material including vegetative material for the purposes of propagation.

Three critical differences between the 1978 and 1991 versions on UPOV are shown in Table 10.

TABLE 10: Key differences in UPOV 1978 and 1991

	UPOV 1978	UPOV 1991
Rights	Others are prevented from commercialising the propagating materials	Others are prevented from commercialising the propagating materials and, under certain conditions, others are prevented from using harvested material
Seed saving	Allowed on farmers' own holdings	Only allowed for listed crops
Seed exchange	Allowed if it is non-commercial	Outlaws seed exchange of protected varieties

(Source: Mulle and Ruppanner, 2010:25)

Proposed new law severely restricts farmers' rights
South Africa wants change to its Plant Breeders Rights Act and further restrict farmers' rights. It has during 2011, published the Plant Breeders' Rights Bill for comment. Stakeholder consultations are still underway and government is still open to receiving inputs and comments. Government appears to be particularly keen to engage with small farmers.

The Plant Breeders' Rights Bill contains a new section 9, dealing with farmers rights. It continues to prohibit the exchange of protected seeds between farmers, however there are still no limits on farm saved seeds for further propagation.

The proposed provisions contained in sections 9(1)(d) and 9(2) are of crucial importance. A farmer is now prohibited from propagating vegetatively propagated crops. The propagation of other crops is still allowed but only – as it has been the case under the current law – on their own holdings. Small farmers must carefully consider that the implications are of these restrictions for them. Furthermore, the exchange of such harvested material derived from protected varieties between farmers is prohibited.

Seed that is later produced post harvest from such protected variety appears to be excluded from the provisions and may not be used for further saving, propagation and exchange.

The proposed section 9(1)(2) expressly prohibits farmers from saving, exchanging, propagating or using protected varieties of **vegetatively propagated crops** (which will be prescribed). Vegetatively propagated material are produced asexually and in agronomic terms, includes, apples, avocados, cannabis, citrus, date, fig, grapes, manioc, potato, strawberry, sugarcane, tea, vanilla and willow. This prohibition will have extremely far reaching implications for farmers.

Small- holder farmers need protection

The South African government argues in its 2011 Plant Breeders' Rights Policy that as a result of the lack of a clear definitions of 'farmer' and scale of production and the scope of the plant varieties, the farmers privilege has been abused by commercial farmers, to such an extent that there has been a significant decrease in the investment in planting breeding and the virtual collapse of plant breeding programmes. It appears that breeders have singled our vegetatively propagated crops as a major problem.

While it is beyond the scope of this article to delve into these arguments, we do believe as a general principle, that Farmers Rights, particularly those of small- holder and subsistence farmers should be fully protected for all kind of crops and not restricted.

The rights of small famers to save and exchange all seed and use and exchange propagating material (including seeds) between communities is in fact non-negotiable. Farmers' Rights are crucial for ensuring present and future food security in general, and in the fight against rural poverty in particular. Farmers' Rights are necessary prerequisites for the maintenance of crop genetic diversity, which is the basis of all food and agriculture production in the world. The protection and recognition of Farmers' Rights will allow farmers to maintain and develop crop genetic resources as they have done since the dawn of agriculture some ten thousand years ago.
The government needs to pay special attention to the needs and interests of small-holder black farmers, particularly with regard to land tenure, land holding, communal ownership of land and generally how communities organise themselves when it comes to farming the land and the use of harvested material.

Plant Improvement Act
Varieties of any major crop cannot be sold unless it is listed. Once the breeder has identified the variety, they must list it. The Plant Improvement Act (No 53 of 1976 as amended) (PIA) specifies conditions under which new varieties can be registered. This may not have immediate relevance to smallholder farmers, but relates to the possibility that they have their own seed varieties they have been using that have not been registered. To qualify as a new variety that can be registered, a seed must be:

i) new, i.e. it must not have been sold by the breeder for a year prior to the application for registration;
ii) distinct, i.e. it must be clearly different from another variety of the same plant whose existence is 'common knowledge' on the date of application;
iii) uniform with regard to the characteristics of that variety; and
iv) stable, i.e. characteristics must remain the same after repeated propagation.

DAFF's Genetic Resources Division is responsible for testing seed against all existing varieties. Registration takes 1-2 years. Regional variety control offices are located at Roodeplaat, Nelspruit and Stellenbosch. It is clear that this framework is designed within a system where a high level of scientific accuracy can be recorded, and where there is broad knowledge about the availability of varieties on the market and their specific characteristics. This will make it difficult for smallholder farmers to enter new varieties onto the list, and thus to be able to trade in the seed, without specialist technical support.

Varieties of certain plants, especially commercially important crops, cannot be sold in South Africa unless they are placed on the variety list maintained by DAFF. This is to control the sale and distribution of plants and to prevent genetically inferior plants from entering the system.[ix] DAFF checks plants on the variety list to make sure they comply with requirements. The cost of listing a plant on the variety list is R1,100 per variety for application, and another R1,800 for agronomic crops, vegetables, sweet corn and pasture crops; R2,200 for white and yellow maize; and R2,500 for fruits and vines (Table 1 s.3(a) of the regulations). It can take between 1 and 5 years for DAFF to complete the evaluation of the variety, depending on the type of plant.

Imports for cultivation in South Africa are not allowed unless the varieties are on the variety list, and requested information about the imported material is provided to DAFF. DAFF has the right to examine and sample the material to ensure it conforms to phytosanitary and other requirements before releasing it for use. This means that cross-boundary seed sharing (e.g. with Zimbabwean or Mozambiquean farmers) must go through the formal system. The SADC harmonisation process is relevant to the extent that farmers want to share seed across national borders. The process aims to establish a uniform seed certification and quality assurance system based on "genetic purity" of seed (SADC Seed Security Network, 2004). The protocols became legal in November 2010 after all SADC Ministers ratified the MoU, but there is still no implementing mechanism. Countries are expected to comply by the end of 2014. The Regional Seed Variety Release System creates a regional variety catalogue where varieties released in two countries are eligible for regional listing without further trials. Seeds listed in the catalogue can then be sold throughout the region (Sansor, 2011a:42).

5.3 Production

Once a variety has been selected for commercialisation, the formal seed system enters into the production stage. There are three stages of seed multiplication in the formal seed system (Setimela *et al*., 2006:6): i) breeders' and pre-basic seed; ii) foundation or basic seed; iii) certified seed under contract.

Limited amounts (about 7 kg) of breeders' seed are produced with high varietal purity. This is then multiplied to produce pre-basic seed with a ratio of 1:10.[x] In some cases, a second pre-basic batch is produced, again multiplied by 10. Breeders produce this seed on small plots (0.3 ha) to monitor that there is no cross-pollination and to make sure the plants are 'true to type'. The breeder or variety developer is responsible for maintaining genetically pure breeders' seed.

Foundation or basic seed is produced by breeders or seed companies using the pre-basic seed, and then sold or given to farmers to produce certified seed under contract. This is mainly a process of getting enough bulk to advance the seed to the next stage. For most grains, the ratio of breeder seed to foundation seed is 1:50 (Tinsley, 2009:13). Basic seed is also produced on small areas, starting at 1 ha although it can go up to 50 ha depending on how much seed is needed and how quickly. This is used to produce certified seed, and this stage usually remains within the company that does the breeding.[xi] Pre-basic and basic seed are checked by government to make sure it's the same as the breeders' seed. In the third stage, contract farmers produce certified seed under controlled conditions to ensure purity and identity.

The key issue in the production stage is to maintain the purity of the variety. Varieties have to be isolated from one another to prevent natural cross-pollination. This means having enough land to prevent cross-pollination - which mostly occurs through insects (e.g. bees) and wind - or otherwise enclosing the plants in greenhouses or tunnels. Maize, onions, cucumbers, pumpkins, squash, broccoli, beets, carrots, cabbage, cauliflower, melons, radishes, spinach, Swiss chard and turnips are all insect-or wind-pollinated. The seeds of self-pollinating crops will produce plants like the parent plant that produced the seeds. [xii] The distance required varies between crops. The normal dispersal range of maize pollen is less than 400m, so this is the distance that must be maintained for the production of maize hybrids or improved varieties (Setimela *et al*., 2006:3). For other crops, 3 metres between varieties will be enough. For OPVs, harvesting can take place from the middle of the field to minimise contamination. The minimum field size for maize is 1 ha (Setimela *et al*., 2006:7).

If farmers only have access to a small piece of land, it is better to only grow one variety at a time to prevent unwanted cross-pollination between varieties. One way of minimising contamination is to offer neighbouring farmers seed of the same variety that is being produced at reduced cost or free (Setimela, 2006). Cross-pollination is not necessarily always a problem, especially outside the formal system. It allows for 'plasticity' and adaptation of seed to the local environment.[xiii]

The Official Seed Testing Station was established at Roodeplaat in the late 1940s. Certification began in 1961 after boycotts of apartheid made importing of seeds difficult. Until 1989, all certification and testing was done by the government. The Department of Agriculture had offices around the country with 8-10 inspectors, but they couldn't afford this structure in the late 1980s and thus rationalised it and transferred certification to Sansor in 1989. The government of the day pressurised industry to work under one umbrella and speak as one. The OECD initially would not accept companies doing their own inspections but after the system was tested out, it eventually accepted industry self-regulation in South Africa. Private and company seed testing laboratories were able to register and conduct tests for their own purposes, test seed for certification and sell their services. In 2005 there were 24 registered private seed testing facilities. But there are specific requirements and company inspectors are liable. They are trained and authorised by Sansor.[xiv] Regulations of the PIA stipulate strict requirements for the quality and condition of facilities, the storing of seed and separation of cleaned and uncleaned seed, and records to be kept.

The PIA governs the production and distribution of seed in South Africa, including registration of seed establishments and seed varieties, and prescription of the conditions of sale of seed or plant material for planting. It replaced the Seed Act and the Foundation Seed Act, both of 1961. The purpose of the Act essentially is to ensure quality control of plant materials being used in South Africa. Seed can be certified but this is not a requirement in all cases. For some seed varieties, compulsory participation in a certification scheme is required. These 'Table 8' varieties (named after their listing in Table 8 of the PIA regulations) currently include 123 varieties of 27 plant types, including wheat (41 varieties), dry beans (12), maize (11), onions (7) and groundnuts (6). Seventy five (61%) of the listed varieties are protected by plant breeders' rights. Most of the listed plant types are OPVs, including forage crops, wheat, dry beans and soya beans. Control over reproduction is difficult for OPVs because farmers can save seed. The aim of compulsory certification is to control the planting and seed production of these crops.

The PIA regulates the establishment of seed schemes. The Minister can establish a scheme, indicating who should run the scheme, and the Act regulates registration of land units used for propagation under a scheme, application procedures for registration as a seed unit and the requirements for registration, which plants the scheme applies to, seed production and treatment processes, inspection procedures, establishment of quality standards, and details of packing, marking, labelling, storage and distribution of plant material/seeds. At present, Sansor runs all certification schemes. Sansor sits on the Certification Standing Committee and National Seed Certification Secretariat, which oversee seed certification.

In other cases, voluntary certification schemes can be established to ensure high quality seed. These may be any variety not included in Table 8, and producers do not have to be part of the scheme to produce the seed for sale. Section 13 of PIA stipulates conditions under which uncertified seed may be sold. Plants or seed can only be sold for cultivation if they are on the variety list and if:

i) the percentage of other matter, other seed and weed seed is below a certain level (these levels vary by crop and the maximum allowable percentage of 'trash' is specified in Table 4 of the regulations[xv]);
ii) the germination or viability of the seed meets or exceeds a certain percentage (also specified for each crop in Table 4);
iii) the seed is true to variety;
iv) no prohibited weed seed is present (prohibited weed seed is specified in Table 5 of the regulations); and
v) the seed is homogenous.

If they do not meet these criteria, but there is good cause for this failure, an application can be made to the Registrar for exemption. Samples are taken regularly by inspectors and sent to the official seed testing lab for germination and purity tests. If the seed does not comply with the requirements, the seller is prohibited to sell seed of those seed lots.[xvi]

Regardless of whether seed is produced under a scheme or not, anyone who wants to produce, clean or pack seed for sale must be registered. The Act defines 'sale' as including "agree to sell, or to offer, advertise, prepare, keep, expose, transmit, send, convey or deliver for sale, or to exchange or to dispose of in any manner for a consideration". The key question here is the meaning of 'consideration'. It is not clear that if a farmer shares seed with other farmers without being paid, but in turn gets other seeds from other farmers at the same or a different time, whether that constitutes 'exchange for a consideration'. According to the Registrar of the PIA, if actions are done with seed that is not covered by the definition of 'sell', or the kinds of plants are not listed in Table 2 of the PIA, then the PIA is not applicable on that seed.[xvii] If seeds are not sold or exchanged 'for a consideration' there is no infringement of the Act. All Table 2 varieties must be entered onto the variety list and comply with the requirements for doing so. Table 2 includes 120 plant types including all the major vegetable, agronomic and forage crops. This generally limits us to indigenous crops. The PBRA also prohibits the distribution of any seed or plant material for which someone else hold the rights. Legally this therefore only refers to seeds not covered by any plant breeders' rights. In a nutshell, if seed is not listed on the variety list and is not being sold, it can be distributed freely. However, systems will be required to maintain quality and cleanness of the seed.

Anyone who wants to sell seed must have a registered seed establishment in terms of the PIA (s6). The Act and its regulations (Chapter II) provide detailed specifications for the successful registration of an establishment. The regulations are essentially about quality control and record keeping. Different types of seed business are recognised: nurseries, cleaning, pre-packing and selling establishments and test laboratories. Registration is for two years and is renewable. A fee of R220 for the first type of business and R110 for each additional one must be paid. The renewal fee is the same. The Minister and the registrar (on application) may exempt any premises from these requirements. Smallholder farmers or organisations who might wish to sell or exchange seed could therefore apply to be exempted from these requirements, but there would have to be a good reason and the purpose of the regulations (quality control, e.g. ensuring seed is stored correctly, is labelled properly and does not get mixed up) would need to be secured in some other way.

For all registered establishments, DAFF or Sansor monitor seed production. Seed units must be registered within 28 days of planting (which obviously means the process of registration must be started before planting commences). Authorised inspectors conduct a series of quality checks at various stages of the production process. Field inspections of the seed unit are undertaken at different physiological stages to ensure quality standards are met, isolation distances are correct, the fields are free of weeds, and 'off type' plants are removed from field (Setimela *et al.*, 2006:7). An early season visit is made to check for isolation to avoid cross-contamination. In the middle of the season inspectors visit to check uniformity, tillering (the number of shoots per seed – if there are too many, yields may be lower) and other physiological traits that can easily be observed in a field inspection. At the end of the season, a sample is taken to check for germination, and for other laboratory tests (Tinsley, 2009:13). Half of seed must be saved as reserve stock.

Currently, 48 companies are registered as growers/producers with Sansor.[xviii] 60% of the top 10 seed companies were registered as grower/producers. Those that were not included ARC, Pioneer, Syngenta and Rijk Zwaan. This may indicate the extent to which production is outsourced to smaller producers or companies.

Government, ARC and Sansor have made sporadic efforts to support community-based OPV seed production. Small initiatives have been established in Limpopo with seed processing at Madzivhandila Agricultural College in Vhembe district, Limpopo in a partnership with EcoLink Seeds and farmers. The Limpopo Department of Agriculture had a participatory extension programme called Broadening Agricultural Services and Extension Delivery (BASED) (which is no longer functioning) that worked with smallholders to produce seeds, sponsored by German Technical Co-operation (GTZ). These were CIMMYT improved, stress tolerant OPVs (ZM421, ZM521, and ZM621) responding to drought and low soil fertility. ARC-SGI maintained the breeders' seed and did basic seed production, and then the seed was contracted to the farmer groups to produce certified seed. The seed was provided free of charge to the farmers, paid for by DAFF. Extension officers acted as 'intermediaries' between the research institutes and the farmers. Sansor provided training on certification and trained extension officers on certification and inspections. More recently, Sansor signed a contract with the Department ot train extension officers. In KZN there is a ZM1423 OPV maize seed production unit, planted by Mdwebu Farmers Club at Ntabamhlope near Estcourt. These initiatives are designed to bring farmers into the formal seed system, including involving them in the production of certified seed. There are bound to be other such initiatives, but uncovering them will require further, more detailed investigation.

5.4 Processing, packaging and storage

After harvesting, seed is conditioned or processed and then packaged for sale to farmers. The first stage is assembly, where the seeds produced in different places are gathered at a central point for cleaning, sorting, grading and packaging. This can be at homestead or an industrial level. Seed is pre-tested for purity and pre-cleaned (removal of other material that got mixed in with the seed when it was harvested).

As noted above, PIA specifies minimum standards for germination, presence of trash etc. Formal standards are linked to certification requirements. Uniformity and specific qualities (depending on markets) have to be guaranteed if seed is to be exported or used for commercial processing. Companies buying the seed from farmers first check it to see if they can take it in based on their own standards and requirements. Initial cleaning, sizing and quality control (e.g. removing damaged seed) is done by hand. In some cases, there is some mechanisation in sorting and checking using an 'electronic eye' to do a final check, including checking for certain diseases.[xix]

Outside the formal system, quality is usually assured through existing trust between buyers and sellers, using germination tests as an indicator of quality (Setimela, 2006). Local technical knowledge and standards guide informal seed system performance (International Centre for

Tropical Agriculture, 2010:1). In informal systems, OPV maize is harvested and then husked, selected for uniformity and quality (pest- and disease-free, not discoloured) and sun-dried to 14% moisture content before shelling. A simple way of checking moisture content is to mix about 100 kernels with one gram of salt. If the salt is moist after 5 minutes, then it should be dried further. Shelled seed is then winnowed (including removal of weed seeds), and chipped or diseased seeds are removed by hand (Setimela *et al*., 2006:8). A simple informal method of checking germination rates is to select 100 seeds, place them on a cloth in a 10x10 matrix, roll the cloth up, tie the ends, soak it in water, allow it to drain, and then keep it moist for three days. After that, the cloth is opened and the seeds that have started germinating are counted for a percentage germination rate (Tinsley, 2009:12).

After grading and sorting seed is usually then treated with herbicides or fungicides for storage and germination. Processors aim to delay treatment for as long as possible because this can negatively affect germination. They will only treat enough seed to meet expected demand. Beans and groundnuts are not treated as seed, but are treated on the farm by farmers a day before planting.

Following treatment, seed is packaged. Packaging is important to protect the seed from insect damage or fungi (air-proof); to preserve the moisture level of the seed; to facilitate handling and transportation from one place to another; to hold the quantities of seed desired; to provide basic information about the seed (e.g. what seed is it, when was it produced); and in some cases to provide instructions on how to handle, store and use the seed (Pichop and Mndiga, 2007:6). In informal systems, some of the latter might be carried out in ways other than through the packaging (e.g. instructions for use can be passed verbally). The seed's moisture content is very critical, and determines its viability. Aluminium foil is the best packaging material, since it is resistant to water vapour, gas transmission, water, oil and grease (Pichop and Mndiga, 2007:7), but there are obviously environmental issues with that (reliance on mining and high level processing).

In the formal sector, seed establishments must be registered with DAFF to clean and package seed for sale. A two year registration costs R250 and seed can only be sold if it is packaged in compliance with specifications laid out in the PIA. This includes the need for sealing and labelling. Samples are taken to check purity, germination and other standards. This is done by a registered laboratory, usually a private company. DAFF checks imports and exports. DAFF does checks for small-scale seed producers free of charge, although it is not certain this service will be continued in future. If seed complies with the minimum standards, a sample is planted out to check for varietal purity (for certification schemes). Uncertified seed is only checked on request or if a complaint is lodged. DAFF Variety Control does this.[xx]

In South Africa, 52 companies were registered with Sansor as seed cleaners/conditioners.[xxi] 70% of the top 10 were registered a cleaners/conditioners (ARC, Syngenta and Rijk Zwaan were not). Other agribusinesses also do some processing, for example VKB processes wheat seed at Reitz in the Free State. Madzivhandila College in Vhembe in Limpopo, and Spitskop, east of Polokwane at the University of Limpopo, offer seed cleaning services for small holder producers.

Storage of seed requires consideration of temperature and humidity. It depends on how the seed is packaged, and whether storage will be long term or short term. Without proper storage, germination qualities will be lost (Pichop and Mndiga, 2007:8). Seed should be stored in a cool, dry place: low seed moisture increases seed viability and storability (Setimela *et al*., 2006:8). Every 1% increase in seed moisture content reduces the storage period by half (Wambugu *et al*., 2009:1121). A study in Kenya found that a combination of airtight containers and the use of cow dung ash as a seed protectant (to control insect damage) increased seed longevity - recommendation of 30% ash by weight in relation to seed and 35-50% by volume (Wambugu *et al*., 2009). Agents who buy the seed for distribution usually incur the costs of storage, grading, transport, packaging etc.

In South Africa, seed availability is less of an issue than access to seed, although some OPVs and indigenous varieties are not always available everywhere. Farmers who are distant from towns or service centres will find it more difficult to access seeds as distribution channels do not always reach them. La Via Campesina (2011:5) proposes small, local *ex situ* seed collections under farmer control. Such systems do not really exist in South Africa, and efforts to generate local seed collections are sporadic.

5.5 Distribution

The final stage of the seed production process is distribution to the end user, the farmer. Seed must be available "within the zone of mobility of the farmer" (Pichop and Mndiga, 2007:12). Where seed is locally produced and stored, it is much easier for farmers to access seed, but they will not necessarily have access to a wide range of seeds. Distribution can take the form of direct sales, wholesale, retail, agents, extension services, between individuals, groups and networks.

There are three main channels for distribution in formal seed system. In direct distribution, the seed producer sells directly to the farmer. This works when farmers are geographically concentrated and can generate high returns for seed producers. In dealer-distribution systems, producers sell the seed through dealers. The latter are usually more in touch with the needs of local farmers, but the retailer (the agro-dealer) captures a share of the value added. In a distributor system, producers sell to distributors, who then sell to merchants and agents, who then sell to retailers/dealers, who then sell to the farmer. Here the producer outsources the distribution network, but loses value added (Pichop and Mndiga, 2007:26).

In South Africa, before 1994 most maize seed was distributed directly to farmers through sales reps with a small amount going via the co-ops (Rusike, 1995:16). In Zimbabwe, because maize was mostly produced by smallholders, the bulk of seed was distributed through private storekeepers since the cost of having sales reps would be too high (Rusike, 1995:20).

Private agro-dealer networks, based on independent, small-scale private entrepreneurs are at the centre of the Green Revolution for Africa as espoused by AGRA and others (Scoones and Thompson, 2011). AGRA has a five year Agro-dealer Development Programme to train at least 10,000 agro-dealers throughout Africa. The purpose is to sell products but also provide information and support, including marketing, processing and value-adding services (storage, transport, milling, packaging) (Scoones and Thompson, 2011:12). The Common Market for East and Southern Africa (Comesa) has a similar programme called the Regional Agricultural Inputs Programme. In these programmes, the emphasis is on individual entrepreneurship.

South Africa has a well-developed private agro-dealer system, built on the back of the former co-ops. The model here is less individual entrepreneurship and more concentrated corporate control. Some of the main companies that exert regional dominance in input distribution are Afgri (Mpumalanga, Gauteng, North West, Free State), NTK (Limpopo), VKB (Free State), Senwes (Free State, North West, N Cape and Gauteng), Kaap Agri (W Cape, N Cape and Namibia), Tuinroete Agri (S Cape), NWK (North West), GWK (N Cape, Free State, NW), Oos Vrystaat Kaap (Free State and E Cape) and Sentraal-Suid (S and W Cape). These dominate retail input supply in a combination of own stores and agents, and outsourced distributors. Afgri is planning to dispose of its retail units on the Lowveld and in Natal. These former co-ops have established outlets in the former homeland areas too to capture the growing market of small holder black farmers in these areas.

Twenty seven companies are registered with Sansor as seed brokers or agents. Just three of the top ten seed companies were registered as agents or brokers (Starke Ayres, belonging to Pannar; Sakata and Klein Karoo). A broker or agent buys seeds from producers and sells on their behalf. This signifies a separation, at present, of input production (whether seed or agrochemicals) and the distribution of these inputs. Fifty-five companies were registered with Sansor as seed retailers, including the top seed companies (excluding Sakata). The large seed companies don't need to invest in their own seed traders or brokers because they can capture agro-dealer networks with relatively small inducements (Scoones and Thompson, 2011:13). As indicated above, PIA regulates the establishment of seed enterprises that seek to sell seed.

For the bigger companies, both suppliers and retailers carry a lot of weight. In food retailing, retailers dominate the supply chain. But they employ differential strategies with suppliers. For the bigger food manufacturers like Unilever or Coca Cola, they seek to maintain a friendly relationship. But smaller suppliers are often squeezed through a range of tactics such as forcing them to offer trade credit, making them pay for in-store promotions and merchandising, buying goods on 'spec' or imposing a returns policy (where if the product doesn't sell the supplier must take it back without being paid for it), and transferring storage costs onto suppliers (UK Competition Commission, 2000, Fearne *et al*., 2004). Identifying the relationships between the seed and agrochemical companies and the input retailers to see if some of these patterns are replicated would involve further research. Where extension services distribute seed, the extension model is relevant, because a transfer of technology model brings seed to the farmer whereas in a farmer-to-farmer model farmers are directly involved in developing the seed they will use. Cuba offers a model of participatory extension which relies mainly on sharing of farmers' innovations, with a supporting infrastructure controlled by farmer-peasant movements. In contrast, South Africa still retains a commodity approach to extension, which focuses on a single crop with the aim of improving quality and yield. The extension organisation provides resources, trains technicians and provides support services. Success is based on total production of the crop, and extension officers do not offer advice to farmers on other crops (Pichop and Mndiga, 2007:45).

Small packaging quantities, local languages on labels, distribution through multiple channels (e.g. clinics, community-based groups), pricing that recognises farmers that are able or willing to pay only a small premium for clean seed, and initial subsidisation of seed can support distribution into resource-poor areas (CIAT, 2003:2).

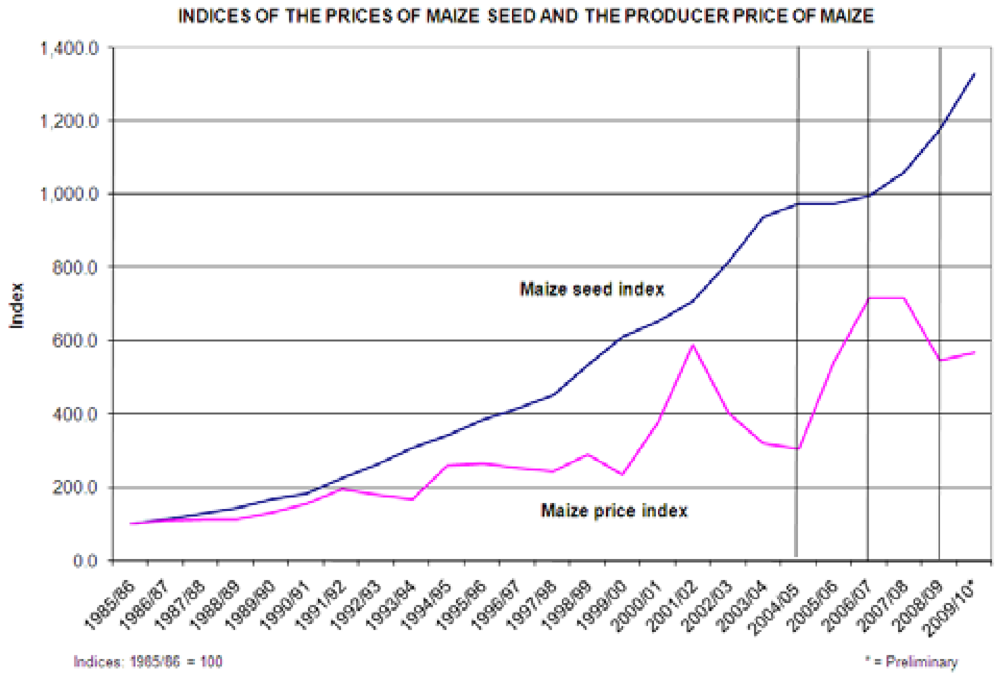
5.6 Seed prices

The base line for seed prices is the combined cost of R&D, production, storage and distribution. Each node in the chain will have its base costs which are the operational costs. In a capitalist system, a margin of profit or surplus is added to this. This is cost plus margin pricing, incorporating the cost of the product and overheads plus a profit margin (MacRobert, 2009:51) A key question is how the profit margin is determined. The possible surplus is determined by the perceived value of the seed, i.e. how much farmers are willing to pay for it (Pichop and Mndiga, 2007:22). The distribution of profit between the different nodes is shaped by the relationships of power between the agents in the chain. Another way of setting prices, which is not necessarily profit-driven (although it can be), is to include operating expenses and the expected volume of sales (MacRobert, 2009:51). If a co-op or other farmer-owned entity is selling the seeds, overall operating costs can be divided across all products and services, including staff costs.

For maize in South Africa, seed constituted just over 10% of all input costs for commercial producers in 2008/09. This rose from about 7.5% in 2001/02, although it was slightly lower than the 11.5% reached between 2006 and 2008, at the height of the economic bubble (National Agricultural Marketing Council, 2010:2). There were regional variations, for example 6-7% in the Free State compared with 14-15% around Ermelo in Mpumalanga and in northern KZN. For wheat, seed costs as a proportion of total input costs were also regionally variable, rising from 10% in 2001/02 to 17% in 2008/09 in the southern Cape, with similar rises in the Swartland of the Western Cape although the peak was reached earlier and the share subsequently dropped back to just above 10% by 2008/09. In the Free State, wheat seed as a share of input costs either remained stable at around 5% (east), or dropped from 10% to around 7% (west) (National Agricultural Marketing Council, 2010). This does not necessarily mean seed prices were dropping, but could mean that other input prices (especially fertiliser and fuel, which spiked sharply in 2007 and 2008) were rising even faster. Apart from wheat seed in the Free State, even despite the sharp price spikes of other inputs, seed prices still rose as a proportion of overall input costs, suggesting a significant rise in prices for these two major grain categories in the past decade. Grain SA shows that maize seed prices have risen far more sharply than maize prices since 1985 (Figure 3). Grain SA statistics also show that wheat seed prices rose by up to 75% between 2007 and 2008, and Monsanto irrigated wheat seed prices rose by an average of 25% in 2008 after a 23% increase the year before.[xxii]

Basic capitalist economics indicates that price is strongly shaped by supply and demand. If there is an oversupply, the price of seed will drop. If there is not enough supply to meet demand, then prices will rise. Although in the formal system, seed and grain are treated as two separate markets, the price of grain can also shape the price of seed because grain destined for consumption can also be used as seed. If grain prices are low, this will push seed prices down. This is related to the basic supply and demand equation.

FIGURE 3: Indices of maize seed prices and maize producer prices, 1985/86-2009/10



(Source: Grain SA, 2010)

This basic relationship is mediated in a number of ways. First, if there are alternatives to the seed type, buyers can shift to alternatives if the prices get too high. This applies specifically to varieties of the same crop, but may occasionally apply to different crops altogether (for example, sorghum as an alternative to maize). In this regard, an alternative to purchased seed may be farm-saved seed, with the prices incorporating the cost of production and storage of farm-saved seed (of similar desired qualities, e.g. yield, storability, drought tolerance). This is the base cost on which seed prices should be measured, especially self-pollinating crops which are likely to be similar to commercial seed.[xxiii] Farmer-saved seed on self-pollinated crops can force the price of hybrid competitors down, but hybrids will have the advantage on cross-pollinated crops (Pichop and Mndiga, 2007:24). Other factors such as difficulty of storage or extent of seed-transmitted diseases can also determine prices, but these are part of the 'perceived value' of the seed.

The second factor that mediates the basic supply and demand relationship is the power of seed producers to determine the price of seed. Where the ownership and production of seed is concentrated, oligopolies may form where prices are artificially raised to accrue more profit for seed owners. Cartels are one form of this, where companies collaborate with one another to set prices. This is outlawed in competition law, although it does take place in the agro-food value chain, as cases before the Competition Commission have revealed (e.g. bread manufacturers, silo owners, fertiliser producers). But where the market is concentrated, major companies can decide not to wage a price war and rather to compete on other grounds, thus keeping prices high. The recent hearings in the Competition Tribunal on the proposed merger of Pioneer Hi-Bred and Pannar centred on the extent to which the merger would result in an inordinate increase in seed prices because of the narrowing of competition in maize seed markets in particular. South Africa has never had price regulation on seed.

6. Conclusion

The formal seed system dominates the informal seed system in a way that is not the case for most of the rest of Africa. In other African countries, the formal system is gaining ground mainly in maize seed and perhaps in one or two other seed types where opportunities for sustained profit present themselves. Two features of the formal seed system in South Africa stand out. The first is the dominance of the production process by a few multinational companies, in particular Monsanto, Pannar and Pioneer Hi-Bred. The second is that substantial public sector capacity has been allowed to decay over the past 20 years as the private sector has taken over key aspects of governance of the seed system. Nevertheless, South Africa has a very well-regulated formal seed sector. This is positive from the point of view of maintaining quality and integrity of seed being used in agriculture. However, the tightly regulated system also makes it very difficult for small-scale seed producers to enter into the system, or for the development of points of intersection between the formal and informal systems.

We know very little about the practices of small holder farmers, referring specifically to black farmers and to resource poor farmers, in relation to seed. Although we can speculate that the main source of seed is bought from input suppliers, we know next to nothing about the extent to which farmers save seed and their reasons for doing so. There are a couple of areas in law and policy where alternatives should be developed, especially with resource-poor smallholders in mind. This includes farmers' privilege to allow resource poor farmers not only to save seed for use on their own farms, but also for distribution to others in their networks. This is currently against the law. The exclusion of vegetatively-propagated crops such as potatoes from farmers' privilege in the new Bill is a concern. It is evident that the legal framework narrows the possibilities for local production and distribution of seed. The reasons for this are not always incorrect. Seed quality, germination rates, absence of diseases etc are all very relevant to small holder farmers as much as to large-scale commercial farmers. However, within this context, farmers' privilege should extend, in principle, to all farmers.

The public sector has a key role to play in the development of improved varieties for small holder use, but farmers and their associations (or even small scale commercial ventures) are better placed than government to produce, package, store and disseminate seed. The approach is not that government should do this, but that government should provide or otherwise mobilise resources to build the capacity of farmers and their associations to do this themselves. The extension service can play a critical facilitating and co-ordinating role here.

The dominant view that use of OPVs implies backward agriculture and the use of hybrids signifies the future must be challenged. Agroecology and OPV seeds go hand in hand, since OPVs can be saved on farms, have the potential for local adaptability and can be produced more cheaply than hybrids. Further down the line, on-farm plant breeding capacity will become important. But the experience of Cuba and elsewhere is that this will work best in a context of good farmer-peasant organisation, and will work poorly out of that context. Therefore, before an on-farm plant breeding system can be produced, seed saving networks need to be established. These can form the institutional basis for on-farm saved seed distribution and a plant breeding system.

APPENDIX 1: Top owners of varieties of top 10 seed crops by value, 2011

Owner	Variety					Plant breeders' rights		
	GM	hybrid	OPV	other*	Totals	% of total Top 10 seed crops	granted	applied for
Pannar total	46	130	55		231	21.2	114	20
-- Pannar Seed	46	72	49		167	15.3	86	20
-- Pannar		35	2		37	3.4	23	
-- Starke Ayres		23	4		27	2.5	5	
Monsanto total	33	51	46		130	11.9	72	
-- Monsanto SA	33	47	4		84	7.7	44	
-- Mahyco		4			4	0.4	28	
-- Sensako			42		42	3.9		
Pioneer Hi-Bred SA	57	64			121	11.1	112	6
Klein Karoo Seed	20	52	5		77	7.1	32	8
ARC and other govt total		4	70		74	6.8	45	2
-- ARC		4	67		71	6.5	44	2
-- Lowveld Research Unit, DoA			2		2	0.2	1	
-- Cedara Agric Research Station			1		1	0.1		
Sakata Seed Southern Africa		61	2	2	65	6.0	24	3
Hygrotech Seed		31	11		42	3.9	7	
Syngenta SA	1	31	1		33	3.0		
Link Seed	17	10	1		28	2.6	8	7
Quality Seed		23	3		26	2.4		
Top 10 variety owners	***174***	***457***	***194***	***2***	***827***	***76.0***	***414***	***46***
Other	1	141	59		201	18.5	41	4
Unknown		23	37		60	5.5		
Top 10 owners share of top 10 seed crop varieties (%)	***99.4***	***73.6***	***66.9***	***100.0***	***76.0***	***76.0***	***91.0***	***92.0***
Total top 10 seed crops	**175**	**621**	**290**	**2**	**1,088**	**100**	**455**	**50**

(Source: Department of Agriculture Forestry and Fisheries, 2011b)

**other – unspecified, rootstock, tunnel varieties*

APPENDIX 2: Some landraces conserved in the national gene bank

Species	No of accessions
Abelmoschus (Okra)	29
Amaranthus (Pigweed)	14
Arachis (groundnut)	76
Capiscum (chilli)	8
Chenopodium (Lambsquarter)	4
Citrullus (Watermelon)	76
Cleome (Cats whiskers)	14
Cucurbita (Pumpkin)	104
Eleusine (Finger millet)	18
Lagenaria (Calabash)	49
Pennisetum (Pearl millet)	15
Sesamum (Sesame)	28
Sorghum	86
Vigna radiata (Mung bean)	14
Vigna ungiculata (cowpea)	114
Vigna subterranea (Bambara groundnuts)	71

(Source: http://www.doa.agric.za/ - Division: Genetic Resources, Plant Genetic Resources Centre, National Genetic Bank)

APPENDIX 3: List of contacts

Name	Designation/description	Email	Phone
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Goldschagg, Eddie Mr	Sansor Technical Manager – can offer training on certified seed production for a fee	seedcert@sansor.co.za	012 349 1438
Hart, Sue Dr	EcoLink in Mpumalanga, does training on seed production, including OPVs	info@ecolink.za.org	013 751 2120
Kruger, Erna Ms	Mahlathini Organics – company specialising in indigenous and OPV seed in KZN, also can provide training on seed production	erna@mahlathiniorganics.co.za	082 873 2289
Laing, Mark Prof.	Director: African Centre for Crop Improvement (ACCI), UKZN – training on plant breeding on African crops	laing@ukzn.ac.za	033 260 5524
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Sadie, Joan Ms	DAFF, Registrar of Plant Improvement	JoanS@nda.agric.za	012 319 6034
Saruchera, Munyaradzi Mr	Facilitates work on community seed banks	munya@labyrinthconsult.org	084 654 5584 082 644 3066
Thabo ??	Curator: National gene bank	ThaboTj@daff.gov.za	012 808 5387/9
van Rensburg, Willem Dr	ARC-VOPI Plant Breeding Division – specialises in indigenous vegetatively propagated crops		012 841-9790

References

African Centre for Biosafety (2009) Biotechnology, seed and agrochemcials: global and South African industry structure and trends. Johannesburg, African Centre for Biosafety.

Agricultural Research Council (2010) Annual report, 2009-2010. Pretoria, ARC.

Alemu, D. (2011) The Political Economy of Ethiopian Cereal Seed Systems: State Control, Market Liberalisation and Decentralisation. *IDS Bulletin*, 42:4, 69-77.

Almekinders, C. & Louwaars, N. (2002) The Importance of the Farmers' Seed Systems in a Functional National Seed Sector. *Journal of New Seeds*, 4:1-2, 15-33.

Bayley, B. (2000) A Revolution in the Market: The Deregulation of South African Agriculture. Oxford, Oxford Policy Management.

CIAT (2003) Developing sustainable seed supply systems. *Highlights: CIAT in Africa*. http://www.sabrn.org/pdfs/highlight5.pdf - accessed 24 June 2011

Conway, G. (1997) *The Doubly Green Revolution: Food for all in the 21st century*, London, Penguin Books.

DAFF (2011) Maize market value chain profile. http://www.nda.agric.za/docs/AMCP/MaizeMVCP2010-2011.pdf - accessed 22 June 2011

Department of Agriculture Forestry and Fisheries (2011a) Abstract of Agricultural Statistics. Pretoria, DAFF.

Department of Agriculture Forestry and Fisheries (2011b) South African Variety List as maintained by the Registrar of Plant Improvement: Seed Crops. April 2011. http://www.sansor.org/pdf/varietylist.pdf - accessed 8 June 2011

Fearne, A., Duffy, R. & Hornibrook, S. (2004) Measuring distributive and procedural justice in buyer/supplier relationships: an empirical study of UK supermarket supply chains. Presentation to 88th Seminar of the European Association of Agricultural Economics: Retailing and Producer-Retailer Relationships in Food Chains. Paris. May 5-6.

Grain SA (2010) Price indices of inputs. www.grainsa.co.za/documents/Prysindekse price indices_2.ppt - accessed 13 October 2011

IAASTD (2009) Agriculture at a Crossroads: International Assessment of Agricultural Knowledge, Science and Technology for Development Global Report. Washington DC, Centre for Resource Economics.

International Centre for Tropical Agriculture (2010) Understanding Seed Systems Used by Small Farmers in Africa: Focus on Markets. *CIAT Practice Brief No. 6*. http://www.ciat.cgiar.org/work/Africa/Documents/seed%20brief%206-10.pdf - accessed 3 June 2011

Kirsten, J. (2011) More research! *Farmers' Weekly*. 26 August, 48

La Via Campesina (2011) Bali Seed Declaration. La Via Campesina.

Langyintuo, A. S., Mwangi, W., Diallo, A. O., MacRobert, J., Dixon, J. & Bänziger, M. (2008) An analysis of the bottlenecks affecting the production and deployment of maize seed in eastern and southern Africa. Harare, CIMMYT.

MacRobert, J. F. (2009) *Seed business management in Africa*, Harare, CIMMYT.

Mulle, E. D. & Ruppanner, V. (2010) Exploring the Global Food Supply Chain: Markets,Companies, Systems. *THREAD Backgrounder No. 2*. Geneva, 3D.

National Agricultural Marketing Council (2010) Input cost monitor: The story of maize and wheat - an update. Pretoria, NAMC.

National Department of Agriculture (1995) South Africa Country Report. Presentation to International Conference and Programme on Plant Genetic Resources. Leipzig.

NPGRC (2011) Diversity in suspended animation. http://www.nda.agric.za/doaDev/sideMenu/geneticResources/plant_genetic.htm, accessed 21 Sept 2011

Odame, H. & Muange, E. (2011) Can Agro-dealers Deliver the Green Revolution in Kenya? *IDS Bulletin*, 42:4, 78-89.

Pichop, G. N. & Mndiga, H. S. (2007) Essentials of Modern Marketing Management and Supply Chain Systems for Vegetable Seed Companies. *Technical Bulletin No. 39*. Shanhua, Taiwan, AVRDC - The World Vegetable Center.

Pixley, K. & Banziger, M. (2001) Open-Pollinated Maize Varieties: A backward step or valuable option for farmers? Presentation to Seventh Eastern and Southern Africa Regional Maize Conference. Nairobi. 11-15 February.

Rubyogo, J.-C., Sperling, L., Nasirumbi, L. & Kasambala, S. (2007) Developing seed systems with and for the marginalized: case of common beans (Phaseolus vulgaris L.) in East, Central and Southern Africa. http://www.future-agricultures.org/farmerfirst/files/T1a_Rubyogo.pdf - accessed 3 June 2011

Rusike, J. (1995) The Development of Maize Seed Markets in Sub-Saharan Africa. *Markets and Structural Studies Division Discussion Paper No. 5*. Washington, DC, International Food Policy Research Institute.

SADC Seed Security Network (2004) SADC puts seed certification on its agenda. *SADC Seed Update*. 12. http://www.sadc.int/fanr/crops/seed_security/docs/SADCSEEDUpdateN22004.pdf - accessed 3 June 2011

Sansor (2011a) Annual report 2010/11. Pretoria, Sansor.

Sansor (2011b) South African horticulture seed market, 2010-11. http://www.sansor.org/pdf/seedmarketforhorticulturalcrops.pdf - accessed 8 June 2011

Sansor (2011c) South African agronomic seed market, 2010-11. http://www.sansor.org/pdf/seedmarketforagronomiccrops.pdf - accessed 8 June 2011

Sansor (2011d) South African forage seed market, 2010-11. http://www.sansor.org/pdf/seedmarketforforagecrops.pdf - accessed 8 June 2011

Schenkelaars, P., de Vriend, H. & Kalaitzandonakes, N. (2011) Drivers of Consolidation in the Seed Industry and its Consequences for Innovation. http://www.sbcbiotech.nl/page/downloads/CGM_2011-01_drivers_of_consolidation_in_the_seed_industry_and_its_consequences_for_innovation1.pdf

Scoones, I. & Thompson, J. (2011) The Politics of Seed in Africa's Green Revolution: Alternative Narratives and Competing Pathways. *IDS Bulletin*, 42:4, 1-23.

SeedQuest (2011) South Africa's Minister of Agriculture reports on the status of commercialized GM crops. http://www.seedquest.com/market.php?type=market&id_article=15137&id_region=&id_category=1&id_crop>= - accessed 29 June 2011

Setimela, P. S. (2006) Analysis of Community-Based Maize Seed Production and Supply Schemes in sub-Saharan Africa. In Setimela, P. S. & Kosina, P. (eds.) *Strategies for Strengthening and Scaling up Community-based Seed Production*. Mexico, D.F., CIMMYT.

Setimela, P. S., Mhike, X., MacRobert, J. F. & Muungani, D. (2006) Maize Hybrids and Open-Pollinated Varieties: Seed Production Strategies. In Setimela, P. S. & Kosina, P. (eds.) *Strategies for Strengthening and Scaling up Community-based Seed Production*. Mexico, D.F., CIMMYT.

Smale, M., Byerlee, D. & Jayne, T. (2011) Maize revolutions in sub-Saharan Africa. *Policy Research Working Paper 5659*. Washington DC, World Bank, Development Research Group.

Sperling, L. & Cooper, H. D. (2003) Understanding seed systems and seed security. In Improving the effectiveness and sustainability of seed relief. Proceedings of a stakeholders' workshop. Rome, Food and Agriculture Organisation, 26-28 May.

Tinsley, R. L. (2009) Post Harvest Handling & Seed Quality Evaluation for Selected Value Chain Commodities in Nigeria. http://lamar.colostate.edu/~rtinsley/WASANigeria.pdf - accessed 3 June 2011

UK Competition Commission (2000) Supermarkets: A report on the supply of groceries from multiple stores in the United Kingdom. http://www.competition-commission.org.uk/rep_pub/reports/2000/446super.htm#full - accessed 13 Oct 2011

Wambugu, P. W., Mathenge, P. W., Auma, E. O. & van Rheenen, H. A. (2009) Efficacy of traditional maize (Zea mays L.) seed storage methods in western Kenya. *African Journal of Food, Agriculture, Nutrition and Development*, 9:4, pp.1110-1128.

Zerbe, N. (2001) Seeds of hope, seeds of despair: towards a political economy of the seed industry in southern Africa. *Third World Quarterly*, 22:4, 657-673.

Endnotes

1 http://en.wikipedia.org/wiki/Plant_breeding - accessed 20 June 2011
2 Interview, Eddie Goldschagg, 12 Sept 2011
3 International Assessment of Agricultural Knowledge, Science and Technology for Development, a World Bank and FAO-led initiative drawing on more than 400 experts in the field.
4 Ethiopia, Kenya, Tanzania, Uganda, Angola, Malawi, Mozambique, Zambia, Zimbabwe
5 http://www.i-sis.org.uk/hybridSeed.php - accessed 19 September 2011
6 http://en.wikipedia.org/wiki/F1_hybrid - accessed 20 June 2011

Footnotes

i. http://www.biosafetyafrica.org.za/; http://www.biowatch.org.za/; http://www.safeage.org/
ii. A public-private partnership sponsored by the Rockefeller and Bill and Melinda Gates Foundations and the UK Department for International Development (DFID)
iii. Personal communications, Natalie Feltman, DAFF Deputy Director: Plant Genetic Resources, 12 Oct 2011
iv. Interview, Eddie Goldschagg, Sansor, 12 Sept 2011
v. Interview, Nokuthula Myeza, 7 Sept 2011
vi. Interview, Dr Willem van Rensburg, senior researcher, ARC-VOPI Plant Breeding Division, 7 Sept 2011
vii. Interview, Dr Willem van Rensburg, 7 Sept 2011
viii. http://www.sansor.org/byactivity/breeder.htm - accessed 30 August 2011
ix. http://www.spoor.com/home/index.php?ipkContentID=620
x. Interview, Eddie Goldschagg, Sansor, 12 Sept 2011
xi. Interview, Eddie Goldschagg, Sansor, 12 Sept 2011
xii. McDowell County Center, "Cross-Pollinating Crops", http://mcdowell.ces.ncsu.edu/content/Cross+Pollinating+Crops – accessed 6 June 2011
xiii. Interview, Dr Willem van Rensburg, ARC-VOPI, 7 Sept 2011
xiv. Interview, Eddie Goldschagg and Pine Pienaar, Sansor, 12 Sept 2011
xv. Table 4 is 14 pages long so it was not included as an annex to this report
xvi. Personal communications, Joan Sadie, Registrar, Plant Improvement Act, 10 October 2011
xvii. Personal communications, Joan Sadie, Registrar, Plant Improvement Act (DAFF: Directorate Plant Production), 10 October 2011
xviii. http://www.sansor.org/byactivity/grower.htm - accessed 30 August 2011
xix. Interview, Eddie Goldschagg and Pine Pienaar, Sansor, 12 Sept 2011
xx. Interview, Eddie Goldschagg, Sansor, 12 Sept 2011

xxi. http://www.sansor.org/byactivity/conditioner.htm - accessed 30 August 2011
xxii. www.grainsa.co.za/Documents/12Mar Koring - Saadpryse.xls – accessed 13 Oct 2011
xxiii. McDowell County Center, "Cross-Pollinating Crops", http://mcdowell.ces.ncsu.edu/content/Cross+Pollinating+Crops – accessed 6 June 2011