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Zimbabwe Seed Industry Entrepreneurship Evolution

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Abstract: This paper covers the entrepreneurship evolution of the Zimbabwe seed industry covering private-public engagements, changes in research technologies, commercialisation strategies and the graduation from serving Zimbabwe to serving the whole of Africa. Various survival strategies are shared for wider critique and possible adoption. Guiding entrepreneurship theories included: innovations, economic and opportunity based inspirations.

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I. Introduction

In the 1940s some farmers' associations initiated seed production in Zimbabwe. Thereafterthe seed industry has been supported by research and plant breeding by Government and Statutory Boards. By the end of the 1980s and in the early 1990s, the Zimbabwe agro-industry contributed to the research effort and complemented the excellent Government programmes. For most of the field crops grown in Zimbabwe, there are locally-bred, well-adapted varieties for particular ecological and farming conditions. Seed producers can obtain advice based on research to enable them to grow their seed crops efficiently. Various seed distribution systems have been used to ensure that seed of the right varieties was available when required, especially for the former large scale farming sector but considerable strides have been made to enable smallholder farmers to obtain the seed they require too. Price controls and realistic pricing policies meant that good quality seed produced in Zimbabwe could be purchased at prices lower than in most countries in the World. The fast track resettlement programme that began in 2000 has resulted in a number of challenges within the seed industry. The increased demand for seed by newly resettled farmers and reduced seed production by white commercial farmers and seed houses has left the industry in disarray. The challenge after 2000 is how best to increase seed production by the newly resettled farmers in order to ensure that all types of farmers can access seed requirements on time. This article discusses the development of the seed industry in Zimbabwe from the pre-colonial era until recent times. It will examine the organizational structure and the legislation issues of seed production and related issues such as plant breeding.

1. Guiding Entrepreneurship Theory:

*Innovation-based theory:*this relates to research and development (R&D) outputs, in this case improved crop varieties released for farmers' uptake, being commercialised through existing or new seed companies

Opportunity-based theory: this relates to the supply of hybrid seed into the market, substituting or complementing open-pollinated varieties (OPV) within varying farming systems. Hybrid seeds are often priced higher than OPV and must be bought every season but produce better yields. The returns emanating from higher yields offset higher seed procurement costs.

Economic-based theory: this relates the deliberate pursuit of market opportunities for improved seed (hybrid), based existing or created demand within farming systems. Seed houses launch and/or promote new varieties for wider uptake through advertisements, demonstration fields and branded attire for farmers' use.

2. History of the Seed Industry

Historically, Government Seed Breeding Programmes were legally required under the tripartite and bipartite agreements to release breeders' seed only to the Seed Company (Seed Co) for further multiplication to foundation and certified seed. The Seed Company produced foundation and certified seed by contract with about 150 large-scale commercial farmers who were members of the Zimbabwe Seed Maize Association (ZSMA) and the Zimbabwe Crop Seeds Association (ZCSA). The Government supplied seed varieties, established official seed certification and legislated for plant breeders' rights but also passed legislation to control and organize the seed industry. It entered into written agreements with some of the associations to formalize and strengthen

relationships. These developments led to the establishment of a sound, locally-controlled seed-production industry capable of meeting the country's requirements and eventually able to export seed as well (Rusike and Eicher, 1997).

The first move to organize seed production was in 1940 when the Southern Rhodesia Seed Maize Association was founded by a small group of commercial farmers (Weinmann, 1975). Its objectives were to produce certified maize seed (open pollinated at that time) under the supervision of the Department of Agriculture and provide members with advice on the best methods of seed production. The formation of the association was a big step forward in the history of maize production. When hybrid maize was first developed in Zimbabwe and seed production was required, the association took up the task in close liaison with the Government (Rattray, 1988).

The first commercial double-hybrid seed was marketed in 1949. Less than 100 tonnes were grown then compared with almost 60,000 tonnes in the 1990s, a 600-fold increase in only 50 years. Following the success of the maize seed association, other associations and seed schemes were established with encouragement from Government and the Rhodesian Farmers' Union because improved varieties could be made available to the farmers quickly and seed certification schemes could be organized. Commodity Board and Producer Association Schemes also participated in seed production. The Cotton Marketing Board's cotton seed scheme was initiated by the Board in 1970 for the production of seed varieties released by Government under the Cotton Marketing and Control Act of 1969. Good cotton growers were selected to produce seed and were offered incentive prices above the normal seed cotton prices. The Coffee Producers'Association's coffee seed scheme was established in 1980 with six producers of seed varieties required by the industry. The seed scheme produced most of the seed required in the country plus a substantial amount for export.

3. The Tripartite and Bipartite Agreements

All the Seed Associations since their inception have established formal agreements with Government with regard to the use of varieties by Government and Research Boards. The tripartite agreement for maize was drawn up in 1970 between the Ministry of Agriculture, the Seed Maize Association and the Rhodesian National Farmers' Union. The bipartite agreement for certain crop seeds (sorghum, wheat, barley, soybeans and groundnuts) was drawn up in 1981 between the Ministry of Agriculture and the Crop Seeds Association. Representatives of the users - the farmers' unions - had to be consulted on production levels and prices. These two agreements were responsible for the stability of the seed industry in Zimbabwe at and prior to national independence. Important features of the agreements include:

- The associations have exclusive access to Government-bred inbred lines and varieties of the designated crops for the production of seed
- The benefits and results of any plant breeding carried out by the associations must be available to Government
- The annual seed production programme must be agreed to with Government and the farmers' unions
- A strategic reserve of seed of at least 20 per cent of hybrids must be held by the associations and surplus production of 30 per cent of non-hybrids must be planned for
- Seed must be adequately distributed to all parts of the country
- Seed must be grown under inspection and be certified, as far as possible
- Government retains ownership of the varieties under the Plant Breeders' Rights Act of 1973 and the associations are the sole licensees
- The associations may export seed provided it is surplus to local requirements, including the strategic reserve
- Seed prices are to be controlled by government after consultations with the associations and the farmers' unions
- Donations by the associations towards Government research would be used exclusively for the crops specified in the agreements

These agreements, though monopolistic, managed to ensure a sound production base and supply of seed of adapted varieties at reasonable prices. They ensured the strategic seed reserves.

4. The Seed Industry during the Liberalized Period

The trade liberalization policy of the economic structural adjustment programme in the early 1990s contributed to the emergence of several private seed companies. Government had partially liberalized seed certification in the 1980s and Pannar, Pioneer and Cargill companies started seed certification alongside the Seed Company. Before 1991. The new entrants were required to register their varieties for certification and to become designated as seed certification agencies in order to produce seed. In 1996 the largest seed house, the Seed Coop Company of Zimbabwe Limited, floated its shares on the stock market and became the present Seed Co Limited. The major change in the organization was intended to encourage local and foreign investment in order to facilitate plant breeding research, seed production capacity and seed distribution. Despite competition from new seed companies, Seed Co Limited maintained 80 to 85 per cent market share of seed maize; 90 to 95 per cent of wheat and 100 per cent of soybean seed. The company reorganized its structure into two mandates to

ensure efficiency of service in the specific areas of responsibility: Seed Co Zimbabwe (Private) Limited became solely responsible for the business in Zimbabwe, while the Seed Co Group Limited became responsible for the international seed business in the rest of Africa.

The adoption of the trade liberalization policy by the Government and the emergence of competing seed houses broke down the monopolies in the marketing of seed varieties and thus nullified the advantages of the tripartite and the bipartite agreements to all the parties involved.

Some of the factors contributing to the final termination of agreements in the late 1990s were:

• Government had no control over private germplasm;

• Conditions of agreements were no longer suitable to the recipients of Government-bred varieties in the trade liberalization atmosphere;

• It was no longer within the interests of the recipient organizations to support government research since the varietal release throughput from government research was low;

• The agreements would now prejudice the price structure of seed in the recipient organizations relative to the seed prices set by free companies;

• The Government was no longer getting full benefit from the use of its seed varieties. At the termination of the agreements, the government promulgated royalties on the use of government-bred varieties in order to source funds for its research and development.

Government also undertook to increase the seed production activities of its agriculturally-based parastatal, the Agricultural and Rural Development Authority (ARDA). This would serve as a seed security measure and also a seed price stabilizer for the country.

5. Status of Seed Production from Year 2000

The fast track resettlement programme period has seen a significant decline in seed production because of the acquisition of land from large-scale farms producing seed. The country has also experienced a low level of crop production since 2000. The increase in seed sales, however, is attributed to high demand for the drought recovery programmes by both government and the non-governmental organization sector and the increase in the numbers of farmers due to the resettlement programme. Whilst maize seed requirements for the 2003/04 season were estimated at 87,599 tonnes, the seed available for the season was only 31,495 tonnes, leaving a shortfall of 56,005 tonnes (Utete, 2003). Reduced production of seed due to acquisition of seed producing farms meant most of this demand had to be satisfied by export bans. For example, hybrid maize seed production was 35,000 tonnes in 1991, increasing to 60,000 tonnes in 2001 and was expected to decline to about 33,000 tonnes in 2004 (Zimbabwe Seed Traders' Association, 2004). The drop in seed production represented an estimated reduction in acreage of close to 4,000 hectares due to farm acquisition. For example, National Tested Seeds, which had based its seed production on its three farms had lost two of them by end of 2002. Exacerbating the production situation were on-farm production constraints including poor fertilizer availability and erratic supplies of diesel and electricity due to load shedding (especially for the winter seed crops). Seed production and distribution is currently associated with a reduced production base, poor seed quality, increased marketing outlets and increased marketing costs.

6. Seed Legislation and Implementation

6.1 The Seed Act of 1965

This Act legalized all the various instruments required to monitor production and marketing of seed. These were gazetted in the Seed Regulations, 1979 and Seeds (Certification Scheme) Notice. 1971. The Seeds (Certification Scheme) Notice laid down the rules for seed certification stipulating the procedures, the standards and by whom certification could be carried out. The scheme defined three categories of seed as breeders, foundation and certified. Seed not falling into these categories would be standard seed. The Seed (Certification Scheme) Notice was reviewed in 2000 to prevent the marketing of inferior seed varieties in the country. Government then brought in regulations that all the seed sold in the country had to be registered and certified by the certifying authority - the Government - before release for commercial use by farmers.

6.2 The Plant Breeders' Rights Act of 1973

This Act enables persons or organizations to protect the ownership of varieties bred either within or outside Zimbabwe.

6.3 Other Regulations

The Department of Research and Extension has a Crop Variety Release Committee comprising members of the department plus other invited representatives from organizations such as farmers' unions, food processing industries and extension. It is now imperative that all seed varieties be officially released for use by this committee. In the implementation of seed legislation, the Zimbabwe Seed Services Unit, a branch of the Department of Research and Extension is the enforcement agency of the seed legislation mentioned above.

It is responsible for:
• Policing the Seed Act;
• Implementing the seed certification scheme;
• Conducting distinctiveness, uniformity and suitability (DUS) tests for end use inspection;
• Registering plant breeders' rights;
• Analysing seed for purity, germination, diseases and so on;
• Issuing seed analysis certificates for both local and international seed trade.
The institute is an affiliate of the International Seed Testing Association and subscribes to the Organization of Economic Cooperation and Development on behalf of the country.

6.4 Seed Testing

Sampling and seed testing for purity and germination is conducted for the issuance of local and Orange International Certificates (OICs) to facilitate trade in quality seed. Internal audits are also done in order to check compliance of seed samplers and seed company laboratories to policies and operational procedures. The Official Seed Testing laboratory undergoes a three-round proficiency testing annually and an International Seed Testing Association Accreditation Audit after every three years, whose purposes are to check reliability of seed testing results and monitor uniformity in seed testing world-wide, and compliance to policies and operational standards. Local certificates are issued for domestic seed trade while OICs are issued for international seed trade. All seed lots traded internationally are sampled and sealed by the Certifying Authority.

7. The Zimbabwe Seed Traders' Association

This association is meant to address matters of concern in the seed business on behalf of its members. Over the years the association has been a loose body with a narrow constitution. It is currently changing its status into an executive organization to be called the Zimbabwe Seed Organization/Association. A proposal has been made to Government on this development and the government has shown willingness to accommodate such an additional organization in the agricultural industry. The functions of the new organization are:
• To provide the seed industry with a spokesbody to represent and further the interests of the trade;
• To represent the trade at all relevant regional international forums, for example, in relation to the Organization of Economic Cooperation and Development, and the International Seed Testing Association;
• To assist the trade in addressing legislative issues with seed services, plant protection, crop breeding institutes and government in general
• To assist the Ministry of Agriculture in the provision of confidential seed trade statistics to promote the use of quality seed
• To assist members with the training of special seeds people and authorization of inspectors and analysts
• To monitor the seed certification scheme under the umbrella of seed services
• To assist the seed services unit in monitoring plant breeders rights
• To regulate the registration of new cultivars to be produced or marketed in Zimbabwe
• To facilitate the registration of private laboratories under the seed services unit and/or the International Seed Testing Association
• To encourage the continued use of Zimbabwe as a preferred source of seed for export markets
• To encourage the development of regional procedures related to seed imports and exports
• To ensure that members adhere to ethical business conduct policies
• To discipline members or individuals found guilty of malpractices
The membership of the association was around 20 by 1990 and it was envisaged to increase as non-members realized the benefits derived from the services of the association.

8. Plant breeding

Plant breeding has played a major role in the development of the seed industry in Zimbabwe. Most of the varietal improvement was undertaken by the government prior to and at independence in 1980. The introduction of competition as more players joined the seed industry spurred a vigorous research and extension input within the various organizations in the seed industry. The decline in government funding of research forced an exodus of several experienced research personnel, most of whom joined the leading private seed organizations within the country. Thus the technical expertise was fortuitously maintained within the country for continuity. The significant contributions made by the government, statutory bodies and other private organizations will be outlined below.

8.1 Plant Breeding conducted by Government

Government agricultural research commenced in 1897 with the establishment of the Southern Rhodesia Department of Agriculture. Agricultural research was organized in 1948 with the establishment of the Department of Research and Specialist Services (Weinmann, 1972). Plant breeding was consolidated in 1975

into the Crop Breeding Institute based at the Harare Research Station. The Crop Breeding Institute could make use of about 18 research stations and educational centres for multi-locational testing in different agro-ecological regions. The government also used to make extensive use of the Rattray Arnold Research Station, which is privately owned by Seed Co Limited, when the tripartite and bipartite agreements still held the two organizations together. The government is assisted in its extensive testing by the Agricultural Research Trust farm which was established by the commodity association of the Commercial Farmers' Union for independent evaluation of varieties for use by its members.

On-farm testing of varieties in communal lands was initiated shortly after independence but it has been curtailed due to financial constraints. Maize breeding commenced in 1933 and concentrated on hybrids. The first double hybrid was released in 1949 and the first single hybrid for commercial production, the SR52, was released in 1960, making Zimbabwe the first country in the world to use a single hybrid commercially. Since then, a number of single and three way hybrids of different maturities have been released of both white and yellow dent grain which are well adapted to local conditions. A small sorghum breeding programme which commenced in 1960 made its first releases of brown grained types used for brewing opaque beer. More recently, however, greater emphasis has been placed on white-grained sorghum for human consumption.

The programme has received germplasm and assistance from the International Crop Research Institute for the Semi-Arid Tropics (ICRISAT). The releases made by ICRISAT by the end of 2004 had been open-pollinated varieties but there was continued work on developing hybrids. In addition to sorghum, work has commenced with pearl millet for marginal rainfall areas. Attempts to breed wheat for production in hot summer months have not been successful. A successful programme to breed spring wheat varieties for production in winter under irrigation has been carried out since the mid-1950s with the first varieties released about 1960 (Agricultural Experiment Station. 1961). The varieties are high-yielding, short-strawed, and lodging-resistant and have good milling and baking qualities. In recent years, much of the germplasm has come from the International Maize and Wheat Improvement Centre (CIMMYT) in Mexico.

A small barley breeding programme for winter production has also been developed for the local malting and brewing industry. This programme has since been adopted by National Breweries Limited and new locally-bred varieties have already been released. Government has also bred three oilseed crops, namely soybeans, groundnuts and sunflowers. Soybean breeding commenced in 1963 to develop varieties for local conditions of day length and temperature with high yields, resistance to lodging and pod shattering, high pod clearance and resistance to diseases. Many varieties have since been released which suit the local environment.

Groundnut breeding started about the same time and varieties belonging to two distinct groups have been developed - early maturing for dry land production and late maturing for production with supplementary irrigation. Sunflower breeding is more recent, aiming to produce high oil content varieties to be grown as cash crops in marginal rainfall areas. Open-pollinated and hybrid sunflower varieties have already been released in the programme. Cotton breeding was initiated in 1925 and the programme is based at the Cotton Research Institute, Kadoka. Since lint quality is very important, there is a well-equipped fibre laboratory to support the breeding work. Different varieties for the mid-altitude (1200 metres above sea level) and low altitude (450 metres above sea level) are bred in addition to special long-staple types and the main groups of medium-staple varieties. The Cotton Research Institute is the only source of improvement for hybrid cotton. Only the Cotton Company of Zimbabwe multiplies and distributes cotton seed and has sole access to the Cotton Research Institute's germplasm. Government conducts a small potato breeding programme in the cool Eastern Highlands where it also maintains virus-free stocks of varieties and releases virus-tested breeders' seed for seed multiplication.

Other small programmes have recently been initiated with field beans and cowpeas. A rapid growth of the horticultural industry to meet the export incentive drive by the government in the post-independence era necessitated the establishment of the Horticultural Research Institute by the government. The institute became responsible for research with horticultural crop production through selection for adaptability and yield performance. The institute possessed a fine collection of sweet potatoes and other vegetable germplasm which could be accessed by any member of the horticultural industry. The institute is based in Mariner. The Department of Research and Specialist Services has now been reorganized into the Department of Agricultural Research and Extension to service the agrarian reform more appropriately. Private companies have largely complemented government efforts on seed research and improvement.

8.2 The Role of Seed Co Limited in Plant Breeding

Major contributions to the success of plant breeding have been made by Seed Co Limited during the past decades. Contributing factors to this success were:

• The establishment of the privately-owned Rattray Arnold Research Station by the Seed Coop in 1973. This research station is useful in screening and breeding for disease resistance because it is situated in the intensive commercial farming area in Enterprise which experiences very high incidences of diseases

• The establishment of the Kadoma Research Station for heat and drought tolerance breeding by Seed Co Limited in 1997
• The engagement of the most experienced first generation and second generation government plant breeders such as the famous Allan Rattray (maize) and his successor Mike Caufield, Rex Tattersfield (soybeans). Geoff Hildebrand (groundnuts), the late Rob Oliver (maize), Barry McCarter (maize), Jacob Tichagwa (soybeans), Paul Rupende (maize) and Ephraim Havazvidi (wheat)
• Collaborative research programmes with local and international companies and institutions
• Extensive variety testing and extension programmes including in the communal sector
• Increased injection of funding into internal and international research activities arising from share capital
• The mission policy to maintain the leading position in the delivery of high quality seeds to the nation and to Africa as a whole.

Seed Co Limited has in the past decade released maize hybrids covering the full range of maturities from the very early maturing group to the late maturing group. The intention has been to provide maize hybrids suited to the different agro-ecological regions of Zimbabwe and Africa. Of particular note about Seed Co Limited plant breeding programmes has been the ability to identify the sources of resistance to a host of diseases and pathotype races which bedevilled the major crops in Zimbabwe during the past decade. Seed Co Limited has already released maize hybrids that are resistant to the two devastating diseases, the maize streak virus disease and the grey leaf spot fungal disease (Cercospora z.eae maydis).

8.3 Regional programmes

The International Crop Research Institute for the Semi-Arid Tropics established regional breeding and research programmes on sorghum, pearl millet and finger millet in cooperation with the Southern African Development Community. The programmes are based at Matopos Research Station outside Bulawayo. The government and private research programmes have benefited from the release of sorghum and pearl millet varieties in Zimbabwe. The International Maize and Wheat Improvement Centre is conducting breeding and research on maize streak virus, grey leaf spot resistance, nutrient use efficiency, abiotic stress tolerance, nutritional maize and improvement of open-pollinated varieties of maize. The centre's substation near Harare has not only significantly contributed to maize and wheat germplasm for the local breeding programmes but has also coordinated and funded networking and training in both maize and wheat research fields in the past 20 years. Much of the wheat improvement in the sub region, including Zimbabwe, is attributed to the centre.

8.4 Research programmes by Private Seed Companies

Pioneer International, a United States of America based company, established a research unit at the Agricultural Research Trust farm near Harare. A number of adapted maize hybrids have been released in Zimbabwe from this breeding effort over the last ten years. Pannar conducts plant breeding research at a unit situated along Mistook Road about 50kms northeast of Harare. Pannar has also released a considerable number of maize hybrids on the Zimbabwean market. Cargill/Monsanto is another international seed company which not only deals in cotton marketing but is also involved in maize improvement work in Zimbabwe. Cargill has marketed a few maize hybrids in the country. The African Centre for Fertilizer Development branch has recently established a research centre in Emerald Hill near Harare. A spin-off programme on dwarf maize breeding towards nutrient use efficiency and resistance to abiotic stresses is being carried out. A few adapted dwarf maize hybrids have already been released to Zimbabwean farmers from this programme.

8.5 Other plant breeding programmes

The Zimbabwe Sugar Association Experiment Station nearChiredzi is funded by the industry to carry out sugar variety selection work. Some plant breeding work is conducted by the crop science department of the University of Zimbabwe on crops such as summer rain fed wheat and cassava. The Scientific Industrial Research and Development Centre was set up by government to conduct, among other activities, research on field and horticultural crops. Of interest is their collaborative 'novel' or genetic engineering approach towards incorporation of disease and drought stress tolerance in maize germplasm, an activity in which the International Maize and Wheat Improvement Centre is the other participant.

9. Challenges faced in Seed Industry (Evolutionary angle)

9.1 Short Shelf Life of the Seeds:

Normally, certified seeds are valid for one season only and they have to be revalidated for use in the next season. The retailers are not equipped to store the seeds for one whole year.

9.2 Unpredictability of the Demand:

It is very difficult for the dealers (private or co-operative) to exactly predict the demand of certified seeds owing to the unpredictability of Nature, changes in the commodity prices and other reasons.

9.3 Lack of Effective Monitoring Mechanism:
There is no effective monitoring mechanism for controlling the quality of seeds at the selling points. The dealers even sell those seeds whose samples have failed in the laboratory tests by SSCs. The producing and marketing agencies of seed do not have any control on their production once the product is sold. This is mainly because the monitoring of selling of seeds is neither possible nor economical.

9.4 Lack of Infrastructure:
Availability of seeds in time still remains a problem for the farmers. The problem is compounded by poor infrastructure in distant villages, the lack of purchasing power at the time of sowing and the uncertainty of rainfall, on which the sowing is largely dependent.

9.5 Poor Extension Services:
The various extension services offered by the Agriculture department leave much to be desired in terms of effectiveness of the programmes offered by them, for popularising the modern agricultural practices, which includes improved seeds practices.
Agricultural supervisors generally are seen active only for showing their targets that are fulfilled, by distributing the mini kits and conducting field demonstrations rather than emphasising on the result oriented approach. The popularisation of a variety in a prolonged period has reasons other than the slow activity of the extension network like the performance of the crop and availability of the seed variety.

10. Strategy for a Seed Enterprise:
10.1 Product Differentiation and Brand Image:
A firm, which has to establish itself in the seed market in India, needs to differentiate its product either in terms of better yield or in terms of providing accessory benefits like pest resistance. Though product differentiation is very difficult in seed industry, some private companies have been innovative and proactive like Mahyco.

They developed a variety of pearl millet which is not only high yielding, but it is also resistant to the disease which no other company has been able to offer. Since seeds are prone to fast deterioration, it becomes essential to ensure seeds in the first season itself.
The firm should try to minimise the carryover stocks and maximise the sales. Seed is a product where there is hardly any product differentiation possible. Therefore, promoting company's brand name becomes important rather than promoting the product. So, brand image of the company should be the focus in sales management.

10.2 Monitoring:
To adjust the imbalances in the demand and supply during the season, the firm should continuously monitor variables like weather till the sowing season is over, so as to avoid additional cost and efforts in cross transportation. In short, an efficient information system should be developed which helps to organise production better and market it efficiently. Perhaps, the Seed Association of India or any such organisation can take up this responsibility.

10.3 Seed Replacement Rate:
Increase in SRR will surely increase the demand for certified seeds and it will also lead to increase in the productivity of different crops. Thus, alleviating the problems faced by the farmers in using certified seeds may help to improve the consumption of certified seeds.
To enhance the seed replacement rate, both the public sector and private companies should develop and produce seeds which are not only high yielding varieties, but also require replacement every year. This would encourage the farmers to replace seeds every year and thus increase SRR.

To increase the SRR, a firm has to concentrate on evolving newer hybrids which could increase the yield and require 100 per cent replacement or should come up with newer varieties of self-pollinated and cross-pollinated crops, that would make the farmer to go for newer seed varieties the next year, to utilise the newer benefit it offers, rather than using the same variety for next sowing season which they can do without any significant change in the yield.

10.4. Promotional Activities:
Normally, the SSCs and private firms opt for a blending of both pull and push promotion strategy. They intend to generate the demand from the farmers, for their seed only through pull strategy. By the push effort, each company channelizes its product through the dealers to the farmers.A mixture of this two-prong strategy will yield the best result. Demonstration is one of the cost-effective tools of reaching the farmers. Demonstration has the electrifying effect on the farmers not only for the new varieties, but also for the existing varieties. Moreover

it brings out the true picture of the attributes of the seed and thus increases the credibility of the particular variety and of the company.

11. Seed Technology Research

11.1 The development of improved seed technology

Efficiency in hybrid seed maize production entails strict control of contamination of seed crops by foreign pollen from neighbouring different genotypes of maize plants and also from female parent tassels which are inadvertently missed during the DE tasseling exercise. One method of preventing foreign pollen contamination is by distance isolation. Kok (1985) showed that, for certified seed, the field. The other method of isolation is by time, so that no foreign pollen is being shed when the seed field is silking. This research required studies of flowering dates of maize genotypes under different environmental conditions. From this data, formulae were derived to calculate safe planting dates for various combinations and circumstances (Havazvidi, 1989). Computer models were developed for determining time isolations and synchronization of flowering of maize seed parents and the effect of seed crop contamination on subsequent commercial crop yields. The studies showed that contamination of up to 10 per cent did not reduce yields while contamination from incomplete detasseling within seed fields was more detrimental than outcrossing.

Studies of how widespread contamination is from a single rogue in a seed field indicated that most contamination occurs within a radius of five metres. It was established that within a seed field, synchronization of tassels and silks of the male and female parents must be good to achieve good pollination and seed set. The rate of silking and how long maize silks remain viable have been determined and flowering times of seed parents are precisely measured to determine their correct planting dates. It has also been found that extra phosphate can hasten flowering if necessary. Required distance of 350 metres can be reduced to 150 metres provided 20 barrier rows of a well-synchronized male parent are planted around the seed.

11.2 Studies to increase the yield of Maize Seed Crops

The effects of female to male planting patterns and plant populations have been studied at Rattray Arnold Research Station and on growers' fields. Narrow gang patterns (3 females: 1 male or 4 females: 1 male) over plant populations ranging between 48,000 to 60,000 plants per hectare have been found to be more efficacious than wide gang patterns (6 females: 2 males) and low plant populations, provided that the male parents are vigorous pollinators which stand well. Early removal of the male rows soon after pollination also increased seed yields. Early harvesting and drying of seed crops has reduced field losses appreciably while field drying by sloughing cob sheaths in sunny weather has hastened the process. It was shown that seed should not be reaped above 25 per cent moisture nor dried above 35 degrees centigrade. Maize may be deficient in molybdenum, especially on certain acid soils (Tanner and Grant, 1977).

A minimum level of 0.083 parts per millimetre is stipulated in the certification scheme. Applying 100 grams per hectare of sodium molybdate as a spray between 9 and 14 weeks after planting corrected the deficiency. Inbreds have been found to require less nitrogenous fertilizer than hybrid maize and smaller applications can be recommended for them. Inbreds are more prone to disease and pest attack than hybrids. Of various pesticides tested, Carbofuran (Furadan or Curaterr), a wide spectrum pesticide, has increased yields considerably when applied at 15 to 20 kgs per hectare. Another pesticide, Gaucho, has been very effective as a seed dressing in controlling maize streak and mottle viruses.

11.3 Other seed production research

The Seed Co Limited has conducted parent synchronization research with sunflowers and sorghums in a manner similar to that used for maize to determine planting dates for male and female parents used in hybrid seed production. Work has also been carried out to improve the mechanical handling of seed. An integrated unit for cleaning, grading and treating maize seed has been designed and improvements to planting and shelling machines have been made.

11. Production levels, Distribution and Pricing

11.1 Production of Commercial Seed

Seed production more than doubled within the past decade as a result of the emergence of new seed houses, the government trade liberalization policy and the introduction of the export incentive scheme. However, the ongoing resettlement programme has reversed the increase in seed production.

11.2 Home-grown seed

A large quantity of seed of the small grain crops such as beans, cowpeas, millets, open-pollinated varieties of sorghums and sunflowers, is not purchased but retained from the previous season's field crops. Retention of seed from maize hybrid crops has almost ceased because research has illustrated the poor performance of second-generation seed compared to hybrid seed. Rattray (1970) reported a yield reduction of 46 per cent with second-generation seed of single hybrid SR52 and 19 per cent with second-generation seed of double hybrid SR

12 seed. This result was corroborated by a study conducted by the International Maize and Wheat Improvement Centre in Zimbabwe that compared the grain yield performance of elite maize hybrids with improved open-pollinated varieties of maize. In this study, the centre observed that maize hybrids out yielded improved open-pollinated varieties of maize by 20 per cent and that maize hybrids were more profitable than open-pollinated varieties at and above commercial maize grain yields of 1.5 tonnes per hectare.

The retention of tobacco and cotton seed is also negligible because farmers do not have the equipment to clean and process the seed and there is very strict variety control throughout the country. Moreover hybrid seed technology has just been introduced in the propagation of these two crops, thereby discouraging the use of second-generation seed. The use of farmer-retained seed in wheat and soybean cropping has been drastically reduced during the past decade due to the aggressive breeding programmes by the Seed Co Limited. Seed of new and better performing varieties that are also resistant to new diseases have also been released.

In practice, farmer retained seed is usually inferior for a number of reasons:

• Varietal purity is reduced by ad-mixture and cross pollination; 249

• Biotic stress in terms of new diseases and new pathotype races have dramatically increased, necessitating a rapid turnover of varieties;

• Seed will often be attacked by storage pests;

• Physical quality of seed tends to be reduced since grading and testing is usually not done;

• Viability and germination vigour is not ensured because farm storage is usually not equipped to maintain the ideal humidity and temperature regimes;

• Seed-borne diseases will be prevalent in farmer-retained seed.

11.3 Seed distribution

Seed distribution varies from a simple outlet to serve the whole country, such as for tobacco seed, to a nationwide system which is used by Seed Co Limited and the other new seed companies. Seed Co Limited and its new competitors ensured that seed was available even to the most remote communal land farmers by establishing agencies and depots throughout the country. Seed Co Limited used a three-stage system which involved the distributor, wholesaler and retailer. Most seed moved through all stages prior to sale but farmers could buy directly from any stage of the system, including direct purchase from Seed Co Limited's main warehouse. Consignment stock was built up by the distributors who received discounts from Seed Co Limited, some of which they passed on to the other stage in the system.

The use of small packs was an important development in marketing maize seed. The standard 50kg pack was reduced to a 25kg pack for ease of handling while small packs in sizes of 10kg, 2kg and 500g have been developed to cater for smallholders mostly concentrated in urban areas. Strong marketing and extension service teams in the form of marketing officers and agronomists are employed by Seed Co Limited and also other seed houses to advise the public on the use of the seed varieties released for commercial production. Seed exports to the sub-Saharan region had increased significantly during the past decade. Some of the international seed companies produced seed in Zimbabwe for markets overseas and in Africa.

11.4 Seed pricing

In the days of the tripartite and bipartite agreements between government and Seed Co Limited, prices of seed were set in consultation with the government and the commodity associations of the farmers' unions. Trade liberalization then allowed seed prices to be set in-house by the management of the companies and after 2000 the government had stepped in with price controls on seed in an attempt to make it affordable to the poor sector of the farming community. The price of maize seed in Zimbabwe was the lowest in the world in the 1980s and 1990s. In 2004 the price was approximately Z$8 million per tonne and in the ratio 10 maize seed: 1 commercial maize grain ratio.

12. The National and Regional effects of the Seed Industry

Agriculture in Zimbabwe has made great strides. The general improvement in crop yields was reviewed by Tattersfield (1982) and related to the impact of research and plant breeding. In the case of maize, the main food staple, yields had increased by 325 per cent during the period in both large-scale and smallholder farming sectors. A significant portion of this increase can be attributed to the use of improved hybrids: Tattersfield (1982) reports that they contributed 40 per cent to the yield increase on commercial farms between 1950 and 1980. This yield increase is probably the same for communal land farmers, especially over the last ten years. The benefits of improved varieties only reach the farmer when seed is available through the seed industry. Thus the seed industry has played a vital role in Zimbabwe through the transfer of better genetic material from research to the farmer.

The major strides in breeding for disease resistance in maize, soybeans and wheat sustained and even increased yields of these crops. Soybean average yields improved from about two tonnes to almost three tonnes per hectare with some farmers achieving five tonnes per hectare. Wheat yields above ten tonnes per hectare

were consistently obtained by some Zimbabwean farmers and the national average yield has been raised, mainly by breeding, to about seven tonnes per hectare. Breeding of high quality wheat had alleviated importation of this commodity in the past decade. An important feature of Zimbabwe's seed industry is that it uses mainly locally-bred varieties. Local plant breeders developed these to suit local conditions and these outperformed imported varieties. The industry was therefore independent from outside parties and it did not have to pay out large sums of foreign exchange in royalties.

The use of external commercial germplasm and technology, especially biotechnology, has been under discussion in a context in which there is a need for a very strong base of local germ-plasm for future progress. The introduction of a competitive environment in the seed industry in the past decade had dramatically improved service to the farming community in terms of variety choice, seed price and extension of both technology and knowledge. Zimbabwe exported seed, especially maize hybrids and open-pollinated varieties. These exports boosted trade, earned the country foreign exchange and were very beneficial to the agricultural industry. Seed was also imported, mainly for horticultural crops but a significant portion was used to grow seed crops for export on contract.

13. The Zimbabwe Seed Industry in relation to the Southern African Region

Zimbabwe's well-developed seed industry has important regional implications. Seed production in the region is unstable. There are large fluctuations in output from year to year and in some years certain countries have severe shortages of seed for their main staple crops, particularly maize. Under such circumstances, these countries could obtain ample supplies of suitable varieties from Zimbabwe. Zimbabwe was responsible for food security under the Southern African Development Community and, in practice, it fulfilled an important seed security role. No country chooses to import seed in preference to growing their own but present circumstances necessitate importations from time to time. Zimbabwe was a willing supplier and the industry was geared to meet future demands for seed from neighbouring countries when they had seed shortages.

Zimbabwe's seed industry had a high standard of performance and it has developed and adapted technology to suit conditions in central African countries. A number of neighbouring countries are trying to improve and extend their industries but they require information and training. Some organizations in the industry, such as Seed Co Limited, are willing to pass on their knowledge and experience and provide training facilities for people from other countries. Likewise, government departments involved with the seed industry, especially the seed services unit and the Crop Breeding Institute in Harare, will willingly assist other countries with their problems and provide material for research purposes. Further developments and growth in Zimbabwe's seed industry is envisaged in the future as the agrarian reform and improvement on land tenure introduces more productive farmers on the land.

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