NSIMA ANNUAL COLLABORATORS' MEETING

Summaries of Key Papers Presented at the Meeting held at Benoni, South Africa, 10-11 August, 2006.

The Seed Incubator Concept

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The Sustainable Commercialization of Seeds in Africa (SCOSA) Project coordinated by ICRISAT has three main objectives:

i) Improve access to and adoption of the best new varieties developed by public plant breeding programs,
ii) Strengthen private sector capacity for seed marketing, and
iii) Promote the development of regionalized seed markets in order to achieve scale economies in variety development and distribution.

Tripp (2003) noted four major types of seed demand, *viz.,* acute seed insecurity resulting from civil and/or natural disasters; chronic seed insecurity usually as a result of poverty; demand for quality seed by commercially-minded farmers, and demand for new varieties. The development of commercial seed systems requires regular demand for seed. Larger seed companies, including multinationals, operate with significant private capital and are vertically coordinated managing all aspects of seed production from breeding through to marketing. On the other hand, smaller seed companies operate with a mix of public and private investment, and tend to concentrate on the marketing end of the seed production chain. Consequently, they often rely on the public sector or license agreements to acquire new varieties. Public sector investments in seed systems could well increase availability of improved varieties to farmers, particularly where this stimulates entrepreneurship in the seed industry. Key components of this include the development of seed catalogues of public and commercial varieties to improve the availability of information, and ensuring access to foundation seed of listed public varieties as the non-availability or irregular supply of quality Foundation or basic seed (FS) of public varieties is a constraint.

Constraints to the development of the seed sector in Africa include:

- Uncoordinated efforts amongst the various stakeholders
- Many released varieties are never multiplied
- High market transaction costs, especially related to market dispersion
- Markets are often distorted by relief seed distribution
- Limited investment in retail networks by seed companies
- National seed markets in a number of African countries are too small to sustain a diverse seed sector
- Private investments in breeding is limited, while access to public varieties is not always transparent or simple
- Public investments in plant breeding tends to be inconsistent and inefficient
- Limited output market development, which gives little incentive to farmers to increase production through the use of improved varieties.
- Non-availability or irregular supply of quality Foundation seed of Public Varieties.

A potential solution to this is the establishment of Foundation See Enterprises (FSEs) that will play an essential role in the transition between public plant breeding and private seed production. These FSEs need to be recognized as sole source of FS and operate with a clearly defined strategy for managing Intellectual Property Rights (IPRs).

The FSE structure would depend on the national seed sector dynamics. The FSEs may also be involved in the provision of other services in support of seed entrepreneurs, such as providing seed certifying services, seed processing facilities, business management advice and technical information. A model of an FSE is operational in Mozambique, and is multiplying basic seed of many public varieties in a range of crops. Currently, activities are underway to explore the possibility of establishing FSEs in 22 countries in Africa through the development of business plans that will attract a mix of public and private investors. It is expected that FSEs will support the development of a more diverse seed sector that serves the farmers of Africa.

Community Based Seed Production

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Introduction

In the past in South Africa, the formal seed systems did not meet the needs of smallholder farmers, while research for the selection of crop varieties mainly focused on the needs of commercial farmers. Furthermore, the past seed system activities did not allow small holder farmers to produce seeds. With the new dispensation, greater attention is being given to the smallholder sector. In the Limpopo Province, the Department of Agriculture has been exposing smallholder farmers to demonstration trials aimed at promoting suppliers of inputs rather than addressing specific environmental and socio-economic constraints that characterize smallholder agriculture in the communal farming system. This was necessary because centralized seed distribution by private sector was costly because small-scale dryland farmers are dispersed across vast areas, requiring lots of tiny sales transactions. Faced with these drawbacks, many multinational seed companies have simply stayed away from these areas. Furthermore, commercial hybrid-varieties were not affordable to smallholder farmers. Consequently, the farmers were recycling "Local Varieties" (LVs) of seeds. Smallholder farmers in Limpopo Province clearly articulated their problem in respect to local varieties as follows:

- LVs are appreciated for their characteristics suitable for low-external input, taste, etc.
- LVs have become increasingly non-adapted to environmental and socio-economic changes.
- Farmers expressed needs to have a variety of maize with the following traits.
  - Disease resistance
  - Storage characteristics and taste similar to local variety
  - Grains uniformly white in colour
  - Early maturing
  - Cobs that cover the tip

TABLE 1: Farmer preferred maize varieties from MBT and VEVO trials in Limpopo Province in 2000/1.

Entry Pedigree	Type	Rank
SNK 2147	Hybrid	1
GRACE	OPV	2
ZM 521	OPV	3
SC 513	Hybrid	4
ZM 421	OPV	5
PAN 67	Hybrid	6
MATUBA	OPV	7
KEP	OPV	8
PAN 6671	Hybrid	9
ZM 303	OPV	10

How were the Challenges Addressed?

The Department of Agriculture drew together a platform of stakeholders, including CIMMYT, ARC-GCI, SANSOR, NDA- Genetic resources, LDA colleges, Progress Milling and Private seed companies. Together a Seed provision strategy was formulated:

- ✓ To expose farmers to different seed varieties and enable them to identify preferred varieties according to their own criteria, using MBTs and VEVO trials.
- ✓ Capacitate farmers to become seed multipliers of preferred varieties to guarantee local seed security and to make seed production an income opportunity

Following the conduct of MBTs and VEVO trials in 2000/1 (Table 1), a number of OPVs were registered in South Africa. In 2002, ZM521 and Grace were registered. In 2005, ZM421, SAM1037 and Obatanpa were registered. The Madzivhandila College was registered as a seed establishment. Since 2003, more than 300 ha of ZM521 certified seed fields have been produced. In 2005 alone, 42 t of ZM521 certified seed was produced by community-based seed growers. In 2006, 8 ha of registered seed units of ZM1421 were established. Construction of seed collection and processing point is under way in Vhembe district. A tender for the construction of a seed collection and processing point in Mashushu has been awarded. The office of the MEC purchased a seed processing machine for the scheme.

Economic Analysis (2004):

The seed production scheme was able to provide an adequate net profit to the farmers (Table 2). In order to reduce production costs, farmers were organized to form seed cooperatives.

Fifteen seed growers' associations were formed in 2004 in Capricorn and Vhembe districts, with a total of 676 members. The model to order seed process and marketing was developed.

A model to organize seed production, processing and marketing was also developed.

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TABLE 2: Economic analysis of community seed production in Limpopo Province in 2004.

Price for which farmers are selling seed	R17.50/kg
Visible cost (land preparation, basic seeds, registration of units, seed treatment, plastic bags and seed inspection requirements, etc.)	R 10.37/kg
Nett profit	R 7.13/kg

Conclusion:

For sustainability of community based seed it is necessary to have the following:

- Involvement of different partners throughout the value chain
- Commodity association
- Provision of basic seed
- Seed certification authority
- Value adding and market linkages
- Continuous seed development and evaluation

SESSION 1: DEVELOPMENT OF STRESS TOLERANT, NUTRITIOUS MAIZE CULTIVARS

Maize Breeding Progress in Angola

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Maize breeding has taken place in Angola since the early 1960's. These activities may be divided into three phases (Table 1). The first phase occurred under colonialism and focussed on commercial farmers who exported maize. The second phase was concurrent with the civil war, and was associated with low farm yields and difficulties in conducting off-station experimentation. Following the introduction of peace in 1993, a third phase began in which progress is being made in maize variety improvement and on-farm research. During each of the three phases, some breeding progress was made (Table 2), but it has only been in the third phase when significant progress has been made, and particularly with white dent maize.

The current phase of maize breeding (III) is based near Luanda. The major objectives of this programme are:

- Yellow, flint grain type
- High and Stable Yield Potential
- Earliness
- Tolerance to Drought, Low N, Low pH
- Resistance to Major Diseases & Pests (MSV, Rust, E. turc., GLS, Ear rots, Stem borers)
- High Nutrition Value (Vitamin A, QPM)

A number of varieties have been released since 1993 (Table 3). The majority of these are OPVs, but some seed houses have registered a few hybrids. The amount of seed produced and sold annually remains low and constraints relate to the recovery of the economy and infrastructure following the liberation and civil war.

TABLE 1: The three main periods of maize breeding activities in Angola

Phase	Period	Area (/1000 ha)	Yield (t/ha)	Grain Type	Major Constraints	Farmers	Use
I	1963 – 1975	150 – 300	1.50 – 2.50	Yellow Flint, White Flint, White Dent	Low yield, grain quality	Commercial	Export
II	1976 – 1992	350 – 450	0.35 – 0.85	Yellow Flint	Low yield, storability, grain type	Small-scale	Subsistence
III	1993 to date	900 – 1000	0.65 – 1.20	Yellow Flint	Low yield, diseases and pests, abiotic, grain type, maturity	Small-scale and commercial	Domestic consumption

TABLE 2: Yield improvements in Angola in the three phases of breeding activity

Germplasm	Breeding stage			Yield improvement (%)
	Phase I	Phase II	Phase III	
White Dent	1.00	0.45	4.00	
White flint	0.50	0.25	1.50	
Yellow flint	0.65	0.35	2.50	
Average	0.75	0.35	2.67	8.9

TABLE 3: Varieties released in Angola since 1993

Variety name	Origin	Year of release
ZM 423	CIMMYT	2006
ZM 623	CIMMYT	2006
SAM-4	Angola IIA	2004
ZM 621	CIMMYT	2004
ZM 421	CIMMYT	2003
ZM 521	CIMMYT	2003
PAN 6443	Pannar	2003
SC 513, 625, 709	Seed Co Ltd	2002
BR-205	EMBRAPA	2002
MATUBA	Moçambique	2000
Mazozo-1	Angola	1998
CM-1	Angola	1997

Maize Breeding Progress in Malawi

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The Maize Breeding programme in Malawi started in early 1950s with the production of flint hybrid and synthetic varieties derived from locally bred germplasm. LH11 hybrid and SV37 and SV27 varieties were released in 1961. Thereafter, the emphasis shifted to production of composite varieties (OPV) and CCA and UCA were released in 1973. From 1978 onwards, the program worked on both composite and hybrid varieties, and since then many varieties have been released (Table 1). The CIMMYT OPVs ZM421, ZM621, ZM721 and ZM623 have also been released in Malawi.

The National Maize Breeding Programme has the goal of improving smallholder farmers' yields and food security at the household level. The breeding concentrates on high yield potential, disease tolerance (GLS, Leaf Blight and Rust), drought, low pH, Low N, yield stability, flint grain, earliness to maturity and high nutritive value (QPM). Since the inception of the National Maize Breeding Program, several high yielding flint textured varieties (MH18) , CZR8, CZR4, CZR3) have been developed and are grown in the country. MH18 which was released in 1991 is extensively grown in the country because of the flintiness of the grain.

In addition to variety development, several improved agronomic technologies have been developed. The major focus of the agronomic programme is to evaluate the best management practices to sustain optimum maize yields of economic input levels such as:

(a) Application of green legumes manures to improve soil fertility and maize yields. Mucuna (Velvet beans), *Crotalaria juncea*, and Lablab are recommended for use.
(b) Strategies for witch weed (*Striga asiatica*) suppression and field hygiene.
    i. Preventive measures
    ii. Suppressive measures
    iii. Good husbandry practices.
(c) Application of Herbicides and fertilizers for weed and witch weed control.
(d) Strategies for winter maize production in dambos (wetlands) and along river valleys.
(e) Liming of acidic soils for improving yields of maize.

TABLE 1: Maize hybrid and open pollinated varieties released in Malawi by the National Maize Breeding Programme since 1978

Hybrid	Open pollinated
MH12	CCC
MH16	CCD
MH17	Tuxpeno 1
MH18	Sundiwe
MH19	Matindiri
MH20	Kafumba
MH21	Mchotsanjala
MH22	Kadzuwa(Yellow)
Thanzi (QPM)	Chitibu
	Kakhomera
	Masika

Currently, research is focusing on development and providing varieties that will withstand different biotic and abiotic stresses. Consequently, Low N, Low pH and drought locations have been established. For the future, a key strategy in maize research will be to increase the participation of different stakeholders. The involvement of farmers, NGOs, extension workers, private seed companies and other stakeholders at the developmental stages of different technologies is pertinent to the adoption process. The Mother and Baby trial (MBT) approach is one such strategy.

For increasing the adoption process of different maize varieties grown in Malawi, nine Mother and Baby trials were conducted in different areas throughout Malawi. The sites chosen represented the two main maize ecological growing areas (Mid–Altitude and Low–Altitude). There was full involvement of farmers, extension workers and private seed companies. More recently, NGOs have taken an active role together with other stakeholders in running these trials. Sites included: Mpingu, Mchinji, Chitala, Mponela, Zombwe, Chivadzulu, Chingale, Bunda and Bembeke.

Maize Breeding Progress in Mozambique

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Maize farmers in Mozambique face a number of constraints, notably, low soil fertility, drought, pests and diseases, while the grain of common maize has poor protein quality and the yields are low (~1.2 t/ha). The national breeding programme in Mozambique is tackling these constraints using both population improvement and pedigree breeding methods. Two main locations for breeding are used, *viz.*, Umbeluzi for downey mildew and earliness, and Sussundenga for leaf and ear disease screening. The programme has released a number of open pollinated varieties: Matuba, Changalane, Sussuma (QPM, similar to Obatanpa), Djanza (ZM421), Obregon and Chinaca (ZM521). Breeders' seed of these varieties are produced by the maize programme. This is passed on to USEBA for basic seed production, and further distribution to seed companies.

Maize Breeding Progress in South Africa

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The South African maize industry is highly specialised with a diverse and advanced seed industry. The national maize programme under the Agricultural Research Council's Grain Crops Institute (ARC-GCI) and most of the large seed companies have long-standing maize breeding programmes. In the past the ARC-GCI produced only inbred lines as end products. The inbred lines were released to the private seed industry through SANSOR (the national seed certifying agency) on a royalty basis. With the advent of democracy in 1994, the ARC-GCI was tasked to cater for the needs of both commercial and smallholder farmers. The ARC-GCI cannot compete with the private seed industry in developing hybrids and, therefore, continues to cater for the needs of commercial farmers by developing and releasing elite inbred lines. Recently nine elite inbred lines with good combining ability and resistance to grey leaf spot (GLS) were released to the private seed industry.

Maize is by far the most important crop grown by smallholder farmers. This is because it is the staple food crop and mainstay of rural diets as well as a cash crop. Most of the smallholder farmers are resource-poor and struggle to buy hybrid seed, fertilizer and other inputs. As a result, they are growing mostly landraces and recycled seed of unknown origin under very low levels of management, and their yields are very low (about 1.5 tonnes per hectare). To address this challenge, the ARC-GCI, in collaboration with CIMMYT-Zimbabwe, is developing open-pollinated varieties (OPVs) as an alternative to hybrids. To date, nine OPVs (viz, SAM 1037, SAM 1059, ZM 521, ZM 1421, ZM 1611, ZM 1423, ZM 1523, ZM 1623 and Obatanpa-SR) have been registered with SANSOR. These varieties are performing well (Table 1) and are reasonably accepted by farmers, and some of them (viz, SAM 1037, ZM 1421, ZM 521 and Obatanpa) have already been adopted by farmers in Limpopo and Mpumalanga provinces. Some smallholder farmers in communities in Limpopo province are growing certified seed of ZM 1421, ZM 521, SAM 1037 and Obatanpa-SR. The ARC-GCI has the mandate to maintain and produce Pre-basic seed of the OPVs.

The breeding programme is making concerted efforts to develop open-pollinated and hybrid cultivars with high quality protein (with high levels of the essential amino acids lysine and tryptophan).

Despite its popularity with farmers in Limpopo and Mpumalanga provinces, the original Obatanpa (introduced from CIMMYT-Zimbabwe) was not registered because of low yield potential, late maturity and root lodging.

An improved and streak tolerant version of Obatanpa, called Obatanpa-SR, and a locally developed QPM OPV named SAM 1059 have been registered. Seven experimental QPM OPVs and 83 experimental QPM hybrids are in yield trials in 2006/07. An additional 20 experimental QPM OPVs will be in yield trials in 2007/08. The ARC-GCI has initiated the conversion of ten farmer-preferred stress-tolerant OPVs (namely, ZM 1421, ZM 1423, ZM 521, ZM 1523, ZM 1623, ZM 1611, SAM 1065, SAM 1066, SAM 1070 and German yellow) to QPM, using marker-assisted backcrossing. Furthermore, a number of elite maize inbred lines are being converted to QPM.

Comparative performance of elite maize OPVs and commercial hybrids in Limpopo and Eastern Cape provinces

Variety	Mean yield (t/ha)	Rank	Relative yield (%)	Standard deviation
CRN 3505 (Hybrid)	4.79	1	132	1.7
PAN 6479 (Hybrid)	4.79	2	132	1.8
QS 7707 (QPM Hybrid)	4.09	3	113	1.8
ZM 623	3.85	4	106	1.7
ZM 1423	3.75	5	103	1.4
ZM 1523	3.72	6	102	1.4
ZM 521	3.59	7	99	1.3
SAM 1037	3.52	8	97	1.3
SAM 1110	3.47	9	96	1.4
ZM 1421	3.43	10	94	1.4
SAM 1101	3.31	11	91	1.2
German Yellow	3.31	12	91	1.0
SAM 1065	3.13	13	86	1.1
SAM 1066	3.13	14	86	1.4
CRN 3505 **F2**	3.12	15	86	2.5
Obatanpa-SR	3.09	16	85	1.3
Grand mean	3.63	-	100	1.5

Maize Breeding Progress in Tanzania

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The history of maize improvement in Tanzania goes back to the 1940s. Selection for appropriate varieties, fertilizer application rates and materials, plant densities, and time of planting have been carried out over the years. Since 1961, a total of 56 maize varieties have been released in Tanzania, of which 26 varieties are from the public sector and 30 varieties from private seed companies. At present there are more than seven OPVs and five hybrids (including one QPM hybrid) in the final stages of evaluation before release.

A selection of released public varieties since 1966 and their associated potential and farmer yield potentials is given (Figure 1). Today 24 varieties of maize from the public sector and 28 from the private sector are currently on the market. An adoption study done recently indicated that only 26% of farmers are adopting improved varieties with their recommended practice.

National maize production figures and areas of production were used to calculate average farm yields since 1960 (Figure 2). The overall trend has been an increase in total yield, acreage and grain yield. Over the 44 years since 1960, the lowest production of 488 000 t was obtained in 1970, while the highest production of 3 230 000 T was obtained in 2004 and 2005. The lowest average yield of 0.48 t/ha was obtained in 1970, which did not coincide with a droughty year. The highest yield of 1.71 t/ha was obtained in 2001, a slightly below average rainfall year. The increase in yield could probably be due to adoption of improved maize varieties and management practices. Mean yields of 44, 30, 20 and 10 years prior to 2005 were 1.17, 1.38, 1.44 and 1.52 t/ha respectively, indicating that national average yields have been progressively improving. The average yield was raised from a low of 0.41 to 1.71 t/ha, which is an increase of 1.30 t/ha and translates into an average annual increase of 29.5 kg/year.

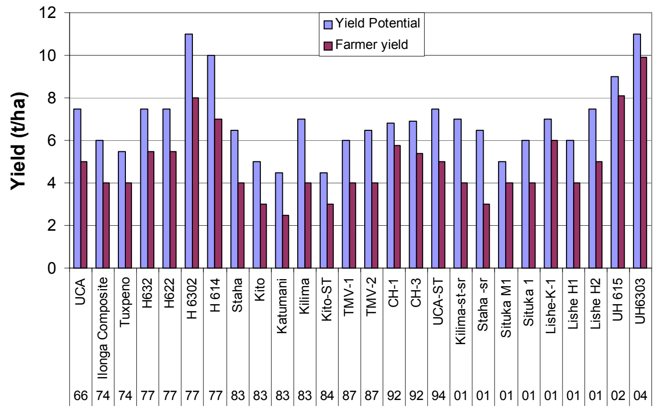

FIGURE 1: Public varieties released in Tanzania since 1966, together with the potential and farmer yields.

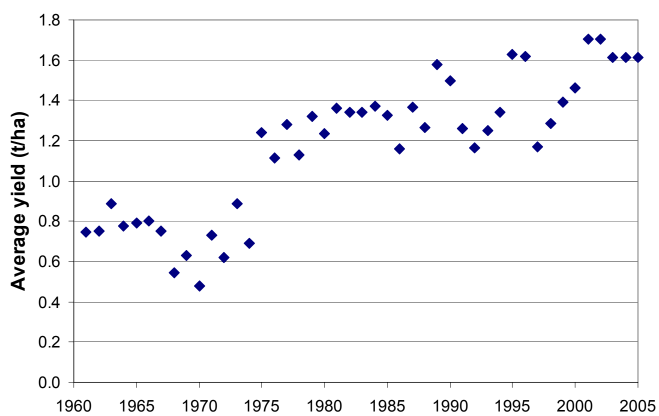

FIGURE 2: National average yields of maize in Tanzania since 1960

Looking at the average area of maize in Tanzania for the last 44 years (1.4 million ha) and the farmers' average yields for the variety improvement programme (4.5 t/ha), it is evident that the country's grain production has the potential to reach as high as 6.3 million tones. This is almost twice the highest production obtained in 2004 and 2005. The challenge here is that the breeding progress obtained for the last 39 years has not been fully exploited by the farmers. From the last ten years (1996-2005), the average production was 2,657,971 t. Theoretically if the adoption rate of improved varieties is increased to about 50%, then maize production will be over 5.3 million metric tons. This therefore indicates the importance of promoting variety adoption amongst Tanzanian farmers.

Maize Breeding Progress in Zambia

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The history of the Zambian economy may be basically divided into three periods: a free market economy up to independence in 1964; a state controlled economy immediately after independence, during which time there was a single national seed company; followed by market liberalization in 1991, which enabled a number of new seed companies to become established in the country. Prior to independence, no maize varieties were bred in the country, although a number of long season hybrids, such as SR52, were inherited from the colonial era. Following independence, the country was faced with the challenge of developing white-grained varieties of various maturity groups, with adapted characteristics, such as disease and insect tolerance, for the small scale farmer, and yellow-grained varieties for livestock feed.

The national maize breeding programme began in 1964 and two OPVs (ZCA, ZUCA) and one hybrid (ZH1) were released by 1977. Breeding intensified in 1978. Germplasm was sourced from inside and outside the country, including CIMMYT and IITA. The first variety to be released post 1978, was MM752 in 1983, this being a local improvement of SR52. From 1983 onwards, 31 varieties, both OPVs and hybrids were developed and released by the national maize breeding programme that were suitable for all regions and farming practices (Table 1). Of these varieties, 28 are white-grained, and three yellow-grained; 23 are hybrids, and eight are OPVs. Of the hybrids, 12 are single crosses, eight are three-ways, two are double crosses and one is a top cross hybrid. In terms of maturity, seven varieties are early, four are medium early, 14 medium late and five are late maturing.

TABLE 1: Maize varieties released by the national breeding programme in Zambia

Year	Variety	Type
1983	MM752	SC
1984	MMV 400	OPV
	MM 501	SC
	MM 502	SC
	MM 504	3W
	MM 601	SC
	MM 603	3W
	MM 604	3W
	MMV 600	OPV
1988	MM612	DC
1992	MM 441	DC
	MM 62	SC
1995	Pool 16	OPV
	GV 61	SC
1998	GV 702	SC
	GV 703	3W
	GV 704	SC
	GV 412	TP
	GV 408	3W
	GV 470	3W
	GV 512	SC
	GV 607	3W
	GV 722	SC
	GV 67	3W
2002	Pop 10	OPV
	Pop 25	OPV
2004	ZM 421	OPV
	ZM 521	OPV
	ZM 621	OPV
	GV 640	SC
	GV 659	SC

Following market liberalization, private seed companies introduced a number of new hybrids into Zambia from the SADC region and within the country, with a total of 107 private varieties released between 1991 and 2006. Currently, the national formal seed sales amounts to ~12 000 t per annum.

The national average yield rose from 800 kg/ha in 1982 to 2700 kg/ha in the late 1980s. Almost 100% of the maize varieties being marketed were from the national programme.

Maize Breeding Progress in Zimbabwe (Recent Developments)

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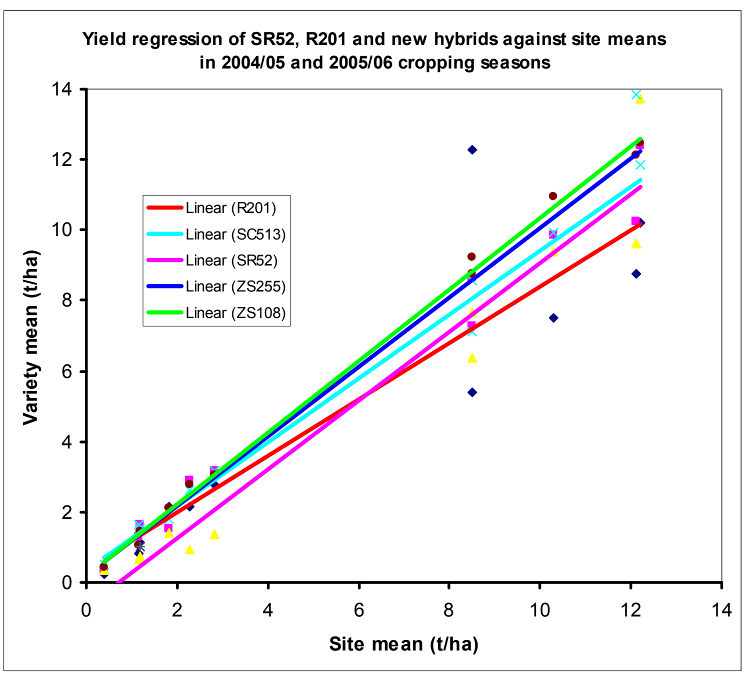
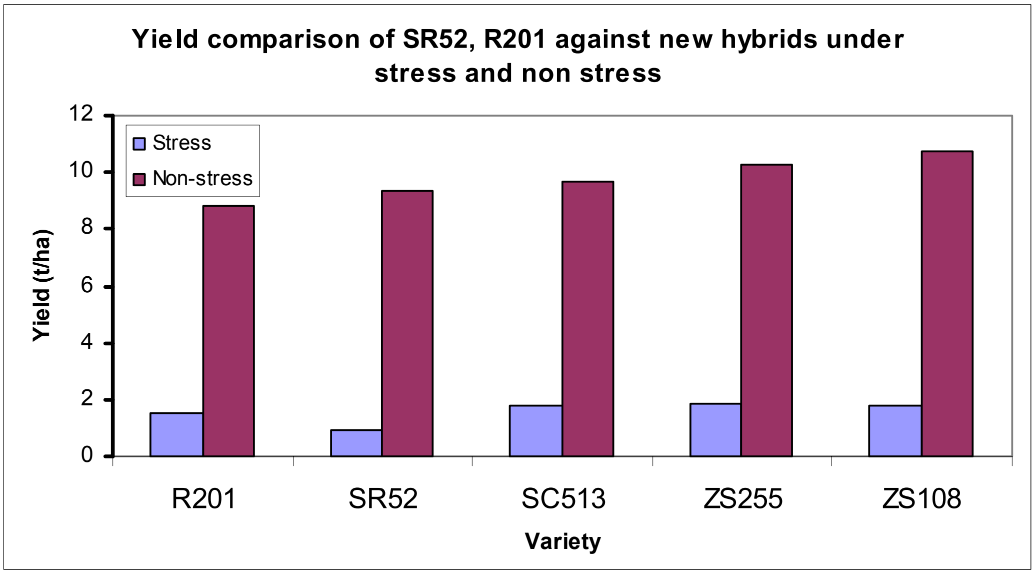
Maize (*Zea mays* L.) is the most important cereal in Zimbabwe. Production of maize is divided into two major sectors: large scale sector (commercial) and smallholder sector (communal). Research in maize improvement started in 1909 with the improvement of introduced open pollinated varieties (OPVs). Maize breeding evolved through five distinct but inseparable stages defined by products: OPV (1909-1932), top and double cross hybrids (1932-1975), three way hybrids (1969 to date), single cross hybrids (1960 to date) and modified single cross hybrids (1977 to date). Initially research focused on developing cultivars suited to high potential areas of Zimbabwe, and in the 1950's a number of single cross hybrids were released, notably SR52. In view of the contribution of farmers in more marginal areas to total area under maize and the unsuitability of cultivars developed by the initial breeding programme, researchers increasingly concentrated on breeding short season (early maturing) hybrids. This led to the release of stress tolerant varieties R200, R201, R215, R86 and R214. The subsequent delivery of the hybrid seed of these stress tolerant hybrids to the communal sector shifted yields from as low as 0.2 t/ha to 1.2 t/ha. Significant yields gains from genetic improvement were acknowledged in both the large scale and smallholder sector. These yield increases were also attributed to developments in agronomy and support services (extension, credit and inputs). The susceptibility of these hybrids to diseases such as GLS and MSV, led to the decline in yields in both sectors. Yield further declined due to reduced fertiliser usages (due to cost and availability) in the late 1990s and the prevalence of devastating droughts. A product oriented breeding approach was then initiated by CIMMYT and AREX in 1996 in order to increase yields under low input environments. This led to the development of stress tolerant hybrids such as ZS255, ZS257, ZS259, and the OPVs, ZM421 and ZM521. These cultivars combined disease and abiotic (low N and drought) stress tolerance. Although there were no clear yield gains in farmers' fields principally due to lack of fertilisers and drought, an analysis of SR52 and R201 with new hybrids across the 2004/05 and 2005/06 cropping seasons indicated that clear yield gains have been recorded in the breeding programme. Although the performance of R201 against new hybrids is still comparable under low potential zones, an analysis of disease response indicates that there have been clear gains in breeding for resistance to diseases. Translation of these gains in the breeding programme to the farmers through extension is expected to increase national yield gains in the more marginal and disease prone areas.





Maize Breeding progress in Zimbabwe since 1900

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Large scale and planned introduction of maize (*Zea mays*) in southern Africa was done during the last 100 years. Average maize grain yield per area on commercial farms in Zimbabwe has increased dramatically since commercial maize breeding started during the early 1900s, starting mainly with open-pollinated varieties. With the advent of the first maize hybrids in Zimbabwe in the 1950s, the original open-pollinated landraces were substituted by a limited number of hybrids. Hybrids progressively dominated maize plantings, such that by the 1980s almost 80 % of maize plantings were to three-way and single-cross hybrids. A study was conducted to determine genetic gain in yield and diversity trends in a time series of key maize varieties released and grown widely in Zimbabwe from 1990 to present. The following varieties were used:

- Ancestral OPVs (Leaming, HK, GK, ISM, BCW, Eureka)
- Early OPVs developed in Zimbabwe (SW, SC, HK)
- Pre-independence hybrids (SR52, R200-series)
- Post-independence hybrids (ZS-series, SC-series)
- CIMMYT OPVs (ZM-series)

Results obtained showed that the more recently-bred maize varieties showed consistent improvement over older cultivars for grain yield. The apparent yearly rate of yield increase due to genetic improvement was positive under optimum growing conditions (Figure 1), low soil N levels and drought stress, although the rate of increase was less under stress environments. Under optimum growing conditions, the apparent rate of yield increase was 55 kg ha^{-1} yr^{-1}, whereas under low N and drought stress, the apparent rates of yield increase were 14 and 7 kg ha^{-1} yr^{-1}, respectively. Genetic diversity in Zimbabwean maize has neither significantly decreased nor increased over time, and temporal changes observed were more qualitative than quantitative. The genetic diversity of the varieties tested indicated five distinct groups, with CIMMYT germplasm exhibiting numerous unique alleles that are absent in the elite maize breeding pools of other organizations.

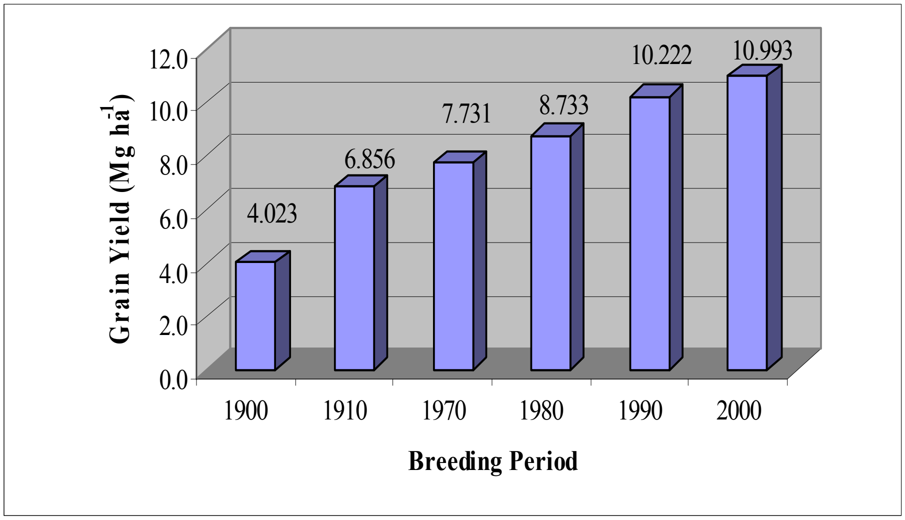


FIGURE 1: Average yield of maize varieties representing decade of breeding.

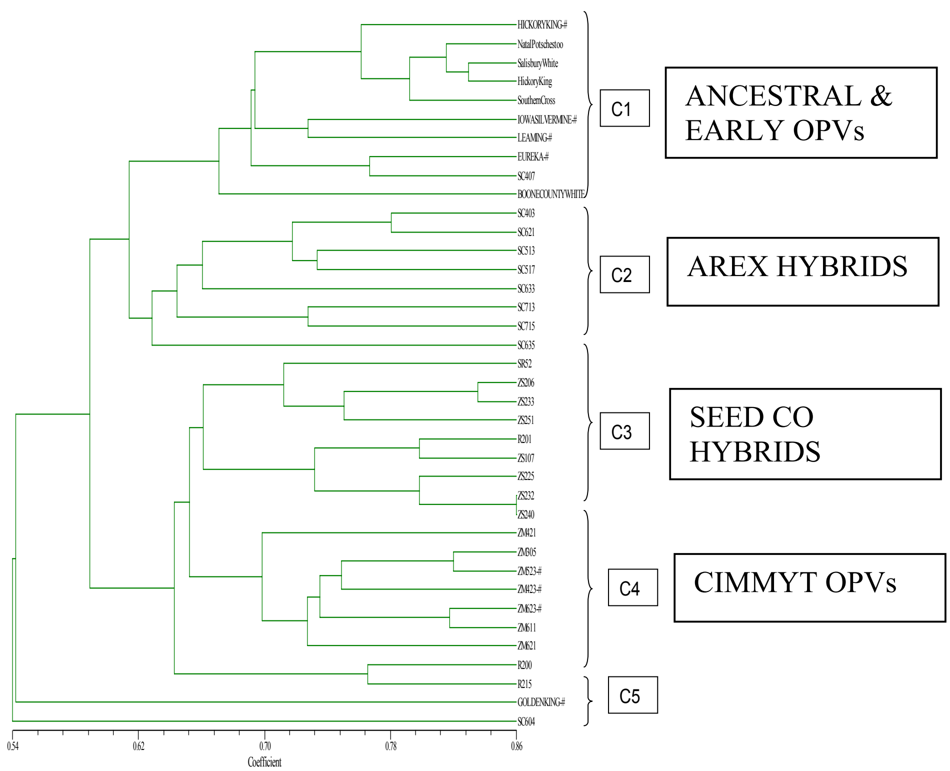


FIGURE 2: Dendogram used for cluster analysis based on genetic distance data of maize varieties representing stages of maize breeding in Zimbabwe.

SESSION 2: VARIETY RELEASE AND ADOPTION

Options in On-farm Maize Variety Verification

Mick S. Mwala, Seconded Breeder, CIMMYT, Harare

CIMMYT coordinated on-farm maize variety verification started in 1999 as Mother-Baby Trials piloting from Zimbabwe (De Meyer and Banziger, 2000). Over the years, partners of the SADLF project (predecessor to NSIMA project) adopted the scheme. To date the scheme is used in ten countries in the maize variety development and testing. The scheme has been acclaimed to be useful in:

- Verifying maize variety performance in target environments, especially incorporating farmers' feedback in the selection of appropriate varieties.
- Demonstrating improved varieties to farmers.
- Generating data and information useful for variety release purposes.
- Others, such as teaching and exchange of information, facilitating learning and exposing farmers to other technologies, such as soil fertility management, weed control and conservation agriculture.

Challenges and Possible Solutions:

MBTs have presented many challenges, particularly with respect to variations in the trial layout, concerns about the integrity of qualitative data and cost effectiveness.

1. Variations in the trial layout:

Traditionally, MBTs follow a particular design linking the baby trials (BT) with the mother trial (MT), with a set number of BTs per MT. The BT is a subset of MT. Thus, if there are problems in any BT, the analysis of the MBT becomes problematic. In South Africa, a modification of on-farm testing has been introduced, called the VEVO (Variety Evaluation, Verification and Observation) trial, which places all varieties in BTs, which are usually managed by groups of farmers.

2. Qualitative data concerns:

A large number of variables (as many as 13) is usually requested and collected in MBTs. This raises the questions whether all these are necessary, what level of data integrity is achieved in data collection, and to what use is all the data put? Researchers using MBTs should critically examine the demands on data collection, and only gather that which are really of use to farmers and researchers. Furthermore, it is important to ensure that all data collectors are using the same scales and methods of data collection.

3. Trial design aspects:

In view of the limited land availability on smallholder farms and issues of labour limitations, both plot size and the number of varieties per trial needs to be critically examined. Ideally, the MBT is the last stage in variety testing. Thus, the trial should comprise those varieties that are "pre-release" and have been identified in CIMMYT regional trials and National researcher-managed trials. Seed of these varieties should be in preliminary stages of multiplication so that rapid scale-up of farmer-selected varieties might occur.

4. Cost effectiveness:

MBTs should become self-sustaining through increased partner input. Often, there is a limited commitment from partners, possibly because they are not recognizing or receiving the potential benefits from the trials. Key to gaining partner confidence is integrity of results and timely dissemination of information so that seed companies and farmers obtain the right information on variety performance in time to make appropriate variety dissemination and purchase decisions.

The VEVO Model:

The South African VEVO model may offer a good alternative to MBTs, especially where there are concerns about the success of MBTs. The VEVO trials use bigger plots and comprise the complete set of varieties being tested. Although this limits the number of varieties to between six and 12, there is less likelihood of missing data. As with MBTs, the farmers manage the trials and there is adequate opportunity for exchange of information and experiences with researchers and other partners. A minimum set of variables (up to 5) is collected for the BTs, so as not to over-burden farmers and to ensure accurate data collection. The trial design and plot size is variable, but in general the varieties are randomized in each location. Plot sizes may be variable as in the MBTs. The design of VEVO trials would remain the jurisdiction of the NCU.

Conclusions:

For MBTs to be useful in the development and testing of maize varieties their unique strengths must be applied through improvements in the management. Where these strengths are compromised due to any of either the above factors or others, serious consideration must be given to other modifications such as the VEVO trials. Trials are an investment and the issue of cost effectiveness or value for money must guide decisions in this regard. It is time to adjust the trials to fit into the current state of knowledge and situations based on our past experiences. NCUs have the liberty to use what works best and that is most cost effective. As we operate in a network, collaborators are always encouraged to consult each other and the Project Coordination staff when in doubt.

Mother and Baby Trials: Challenges and Strategies to make them Sustainable and More Widely Appreciated

Karsto Kwazira, Department of Research and Extension Services (AREX), Zimbabwe

Mother-Baby Trials (MBT) are a way of evaluating new varieties in the fields of small-scale farmers, thereby exposing the new varieties to farmers and providing a means for farmers to participate in variety selection and release. The trial design consists of two types of experiments, *viz.,* a researcher-managed 'mother trial', usually conducted under both optimum and farmer-managed scenarios, and farmer-managed 'baby trials'. The baby trials consist of subsets of the varieties in the mother trial and are located on many farmers' fields. The maize varieties are therefore evaluated under 'real' farmer conditions and they create opportunities for communication and interaction between all stakeholders, represented by the farmers, breeders, extension staff and seed companies. The MBTs have been utilized in southern Africa for over five years (Table 1), and are now widely recognized as an essential component of variety evaluation and promotion.

The MBTs are usually planned and organized by a coordination unit (CU) in each country. The CU puts together the trials, provides inputs, conducts off- and on-site training, visits and monitors trials, analyses results, provides technical back-up to partners and collaborators, writes reports and organizes workshops (including feedback workshops). The role of the partners in the MBTs is to select sites (more conveniently where the partner operates), identify capable and interested farmers in his/her area, provide farmer training, distribute inputs, ensure planting, monitor, harvests and complete the field books of the mother trials; and organize demonstrations and field days. Stakeholders enjoy some benefits of the MBTs. These are:

- Farmers have a chance to evaluate different varieties under his/her management conditions and compare their performance with other varieties in the mother trial, and so they gather information on what seed to purchase in subsequent years.
- Partners, such as extension services and NGOs receive inputs for trial planting, technical back-stopping, and access to results for use in his/her operational areas.
- Breeders and seed houses obtain rapid and reliable information on performance and acceptance of new varieties under farmers' conditions. This has sometimes enabled rapid release of new varieties.

TABLE 1: The number of Mother-Baby Trials conducted in selected countries in SADC.

Country	2001	2002	2003	2004	2005
Angola	10	12	21	14	18
Botswana	0	5	7	7	8
Lesotho	0	6	6	10	10
Malawi	7	10	18	8	12
Mozambique	8	8	13	34	30
RSA	6	18	20	23	35
Swaziland[$]	0	0	0	7	10
Tanzania	5	9	15	22	22
Zambia	0	17	17	15	17
Zimbabwe	18	26	34	27	27

MBTs – Challenges:

- Droughts: Persistent droughts in the region do not spare MBTs. An average of 30% of MBTs are not harvested due to the mid-season droughts.
- Pest and Disease Outbreaks: These are mostly experienced on baby trials due to financial constraints preventing appropriate control measures. Common problems include GLS, MSV, and Stalk borer. Sometimes termites, domestic and wild animals and thieves unfairly share MBTs produce with the farmers mainly because of late harvesting.
- Capacity Building: The field of play in capacity building for the MBTs personnel is far from being level. Almost 100% of scholarships which come along are granted to researchers, whilst extension staff are by-passed. More than 95% of MBTs are implemented by non-researchers.
- Inputs Delivery: Usually late delivery of inputs leads to late plantings and consequently lower and a-typical yields.
- Trial Monitoring and Crop Husbandry: Often MBTs are not taken seriously by farmers, and so trial management is inadequate.
- High Staff Turnover: Highly competent and experienced staff leave departments for greener pastures, and so there is lack of continuity in management.
- Inconsistency of Some Partners: Some partners are very sensitive and susceptible to economic and political factors in their operational areas that they sooner than later abandon the MBTs. Frequent changing of operational staff is very common with most of our partners.

MBTs – Strategies

- Establishment of CUs: Should be made up of effective and interested stakeholders in the MBTs (researchers, agronomists, extensionists, private companies, NGOs etc). The CU must coordinate the day to day activities of the MBTs (crop management, data collection and analysis, report writing and feedback workshops).
- Integration of MBTs into departmental programmes so that they can also get some funds from the national programme.
- Variety Release: Although not advocating compulsory use of MBTs, it is recommended that new varieties should first pass through the MBTs before release.
- Policy Makers: The involvement of the directorate in MBTs is very important since they have influence on policy makers (field days, official opening/closing of feedback workshops etc). The same should happen in the operational areas (local leaderships). Appreciation by authorities (nationally and locally) is essential for success.
- Farmer custodians: Let farmers be the custodians of the MBTs (Farmer Centered)

Evaluation of Early to Medium Maturing Open-pollinated Maize Varieties in SADC Region using Biplot

P.S. Setimela, B. Vivek, M. Bänziger, J. Crossa and F. Maideni

Analysis of multi-environment trials (METs) of genotypes (G) and genotype x environment (GE) interactions for yield performance across environments, and selection of the best genotypes is an important routine in maize breeding programs. Analysis and interpretation of METs data have been limited to analysis of variance and mean comparison among genotypes. This type of analysis has not been effective in exploiting GE interactions encountered in METs data sets. The objectives of this study were to exploit METs data sets from maize regional trails using G plus GE interaction (GGE) biplots from site regression (SREG) model analysis. The GGE biplots displays graphically the relationship among test environments, genotypes and GE interactions. Grain yield data of 35 early to medium maturing open pollinated maize varieties (OPVs) from five seasons (1999 - 2003) across 59 locations in Southern African Development Community (SADC) were analyzed. The GGE biplots of SREG indicated that yield performance of maize OPVs were under major environmental effects of GE interactions. Through the construction symmetrical scale principal components (PC1 and PC2) from singular value decomposition (SVD) GGE biplots, showed the ideal test environments and the stability of OPVs across environments (Figure 1) and which OPVs is best for what (Figure 2). The Average Environment Coordination from the biplot points towards maize OPVs with high and stable grain mean performance across the environments. The OPVs G1 (ZM 623), G35 (ZM 621) and G8 (ECAVL2-DLN) were high yielding and stable relative stable for grain yield while G17 (Matindiri) and G21 (Pool 16 BNSEQ) were low yielding. Figure 2 shows which maize OPVs won where or what is best for what.

In each sector the best and worst yielding maize OPVs. The GGE biplot of SREG model showed that there were large variations from year to year relative genotypic performances. In spite the large variation from year to year some maize OPVs responded positively to better environmental conditions relative to grain yield performance. Most of the OPVs were grouped according to maturity. The analysis provided a framework for identifying the target testing locations that discriminates genotypes and this suggests that fewer but better locations should be used for conducting METs. The few but better locations should be chosen to provide relevant information for OPV evaluation.

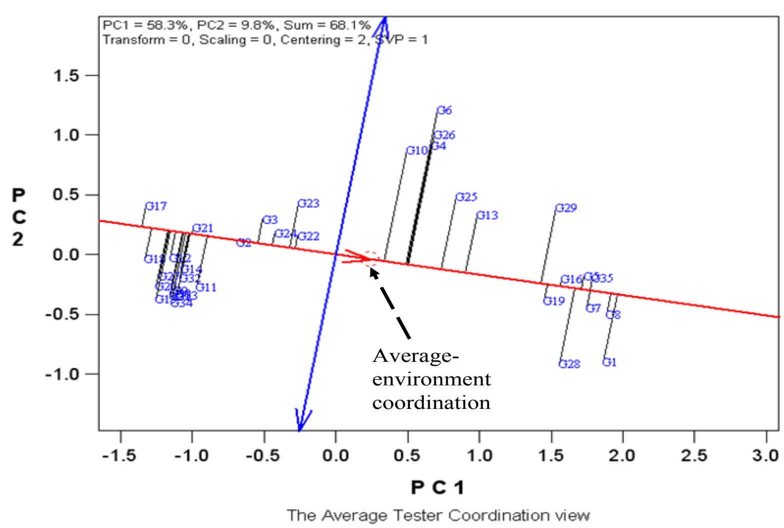


FIGURE 1: Mean performance and stability for grain yield across years and environments.

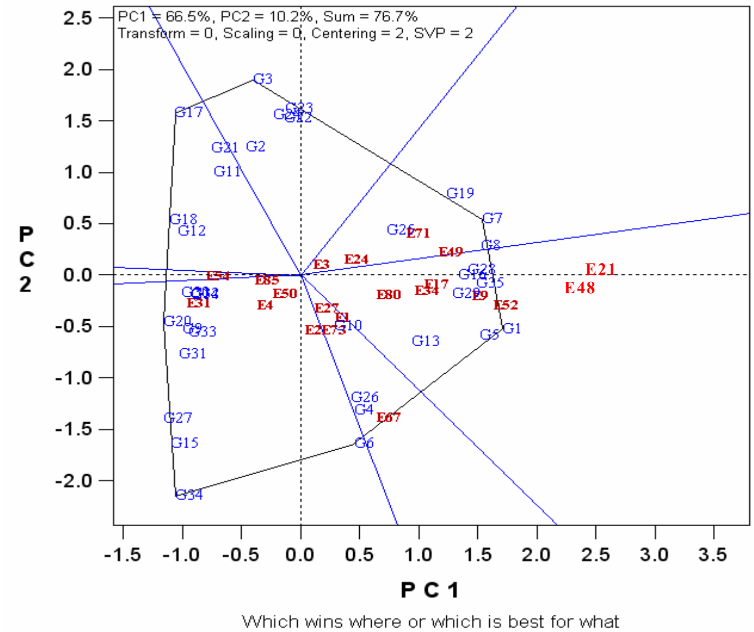


FIGURE 2: The polygon view of GGE biplot showing which maize OPVs (represented by G*n*) won in which locations (represented by F*n*).

SESSION 3: SEED DISTRIBUTION

Uptake of New Varieties in Southern Africa

Augustine Langyintuo, CIMMYT, PO Box MP 163, Mt. Pleasant, Harare, Zimbabwe

Improved maize seed embodying production technology and input characteristics is fundamental to rural transformation. Sometimes it by-passes some rural populations either because it does not meet farmers' preferences (or preference constraint) or because of production and price risks (or risk constraint) that could render the input use unprofitable. If seed technological change must make a mark on the livelihoods of rural households, both the technological and input aspects of seed must be addressed simultaneously. This paper therefore employed a simultaneous equation approach (to account for the technology and input components of seed) to assess factors determining farm level seed demand by "well-endowed" and "poorly-endowed" households in Malawi, Mozambique, Zambia and Zimbabwe where adoption rates (in terms of area) are 14, 17, 23 and 55%, respectively (Table 1). A larger proportion of the "well-endowed" households are more willing to procure improved maize seed compared with their "poorly-endowed" counterparts (Table 2).

TABLE 1: Descriptive statistics of households in selected countries in southern Africa, 2003/04

	Malawi	Mozambique	Zambia	Zimbabwe
Household size (number)	6	7	8	7
Female headed households (%)	36	23	25	38
Cultivated area (ha)	4	4	3	2
Maize area (%)	61	75	50	65
Adoption rate (% of farmers)	61	54	66	99
Adoption rate (% of area)	14	17	23	55
Improved seed planted (kg)	6	12	9	30

TABLE 2: Improved variety adoption by wealth group

	Adopted improved varieties in 2003/4	
	No	**Yes**
Poorly endowed households (n=172)	42	58
Well endowed households (N=128)	23	77

The empirical results suggest that in general, improved seed demand at the farm level will increase by improving adoption rates through:

- Encouraging farmers to form associations for increased interactions to reduce information asymmetry, and
- Field demonstrations to show the superiority of given improved varieties over the local ones in terms of yield.

Seed demand among the "poorly-endowed" households will increase if households are encouraged to increase their wealth through asset accumulation, which would reduce their responsiveness to seed prices and hence increase purchases. Although input support programs may be used to encourage adoption, they negatively affect rural seed market development and must be handled with care.

Adoption rates among the "poorly-endowed" households could be improved through (1) reduced seed costs, (2) access to credit (through inventory credit programs), and (3) providing extension education to female farmers.

Among the "well-endowed" households with the potential to produce marketable surpluses, reducing the distance to market through community cereal banks, for instance, or other group-marketing means could increase seed demand. "Well-endowed" households prone to loose their seed stocks through various calamities are more likely to demand seed. Adoption rates among the "well-endowed" households could be enhanced if improved maize varieties are superior to the local ones in terms of field pest resistance and acceptable to consumers.

What Makes Markets Attractive for a Seed Company?

Walter Chigodora, Agriseeds, Harare, Zimbabwe

There are a number of factors that make markets attractive to a Seed Company namely:

- Good return
- Good distribution system
- Good opportunity for growth
- Ready markets

What is a Market?

A market is the set of actual and potential buyers of a product.

What is Marketing?

Two definitions have been proposed:

- Marketing is a social and managerial process by which individuals and groups obtain what they need and want through creating and exchanging products and value with others (Kortler, Armstrong, Saunders & Wong).
- Marketing is a process with a set of underlying tools for understanding markets and quantifying the future and present value in those markets or segments (Macdonald).

Key Terms in the Definition:

Need – a requirement
Want – these are the form human needs take as they are shaped by culture and individual personality.
Product – anything that can be offered to a market for the attention, acquisition, use or consumption that might satisfy a want or need.
Value – the customer's assessment's overall capacity to satisfy his or her needs.
Satisfaction – the extent to which a product's perceived performance matches a buyer's expectations.
Segments – market

The Marketing Environment:

There are basically three types of marketing environments:

1. Macro environment, which may be summarised under the acronym PESTPI
   - Political/Legal
   - Economic
   - Social
   - Technological
   - Physical/Natural
   - International

2. Micro/Task environment
   - Competitive forces
   - Competition
   - Customers
   - Distributors
   - Labour/Unions
   - Government
   - Other Stakeholders

3. The Marketing Environment

- Internal environment
- Vision/Mission
- Strategic Objectives and strategy
- Marketing Mix, defined by: Product, Price, Promotion, Place, People, Physical evidence and Processes

Marketing Environment and Segmentation:

In the Marketing Environment there is an aspect that is important to the attractiveness of a seed market – Segmentation. The criteria for segmentation are important to a seed company, namely:

- Substantiality- how big is the seed market?
- Sufficiency- again to do with the size of the market.
- Accessibility- is the market accessible?
- Profitably

<u>Generic Competitive strategy</u>

For a seed company to compete effectively in a seed market it should have a clear competitive generic strategy. Porter suggests three competitive strategies, as illustrated (Figure 1).

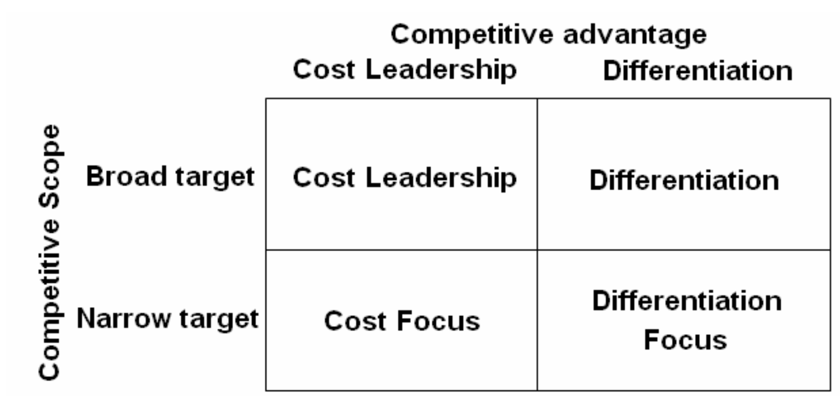


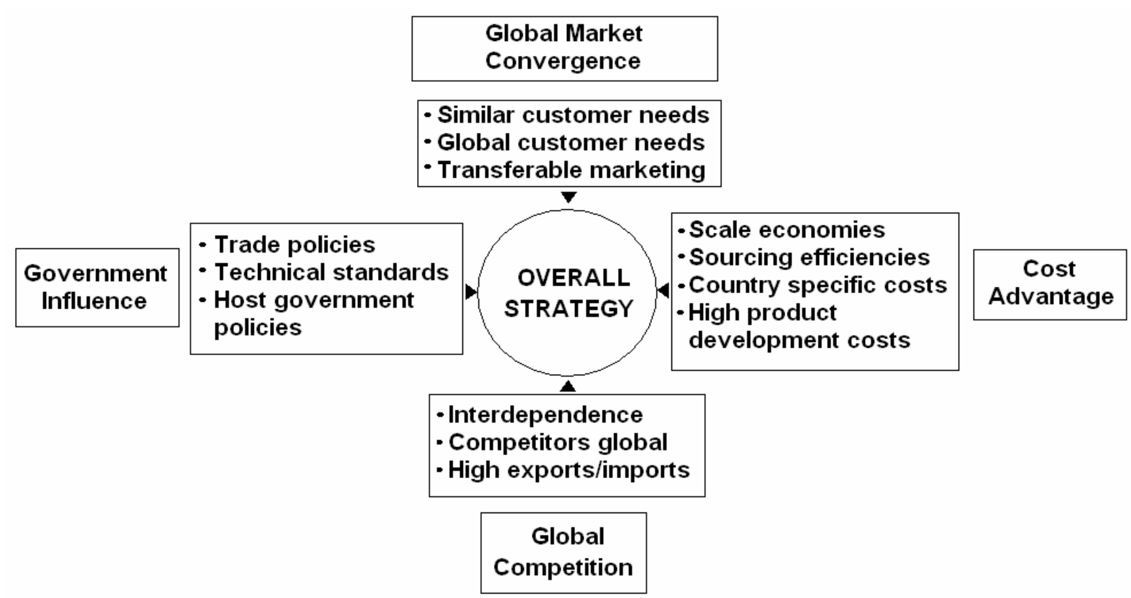
Figure 1: Porter's model of competitive strategies.

Direction for strategy development

COMPETENCE
Product

MARKET		Existing	New
	Existing	**A. Protect/Build** • Withdrawal • Consolidation • Market penetration	**B. Product Development** • On existing competencies • With new competencies
	New	**C. Market Development** • New segments • New territories • New uses	**D. Diversification** • On existing competencies • With new competencies

Development



Relief Seed: Simply Another Distribution Method?

David Rohrbach, ICRISAT, P O Box 776, Bulawayo, Zimbabwe

Agricultural research institutes in southern Africa face increasing pressure to assure their new varieties are reaching farmers. Too many released varieties remain on the shelf. As a result, agricultural productivity in the region continues to lag.

During the past 15 years, experience has been gained with a growing range of strategies for variety dissemination. Commercial seed markets are expanding for hybrid maize. More commercial seed companies are beginning to produce a wider array of seed crops. But most new varieties of open and self pollinated seed crops remain unavailable on the retail market. Access to these new varieties tends only to be gained through specialized production targeting relief seed programs.

This presentation outlines several development initiatives which may contribute to improving the development impacts of relief seed distribution, and highlights some of the development challenges underlying these efforts.

The harmonization of seed regulations in southern Africa, and the regionalized release of varieties will improve access to, and potentially reduce the costs of, regional seed security stocks. This may also create scale economies justifying larger investments in the commercial production of open and self pollinated seed crops. But the response of the regional seed industry remains uncertain. Many companies remain unsure of the size and consistency of the market for non-hybrid seed varieties – particularly of secondary food crops. This suggests the need for more market testing of consumer demand, for example, through small pack seed sales programs.

NGOs have commonly responded to the lack of seed of preferred open and self-pollinated varieties by promoting community seed production projects. These encourage small-scale farmers to produce a range of new varieties for sale to their neighbours. But virtually all of these schemes have proven unsustainable. Farmers rarely will pay a premium price for seed from their neighbours, and the costs of quality control are high.

Millions of dollars are spent each year on the distribution of free seed to vulnerable households. However, there is growing recognition of the quality problems characterizing too much of this seed, and of the fact that free distribution undermines the sale of seed through commercial wholesale-retail trade networks. This has stimulated the testing of alternative distribution strategies employing vouchers – redeemable through seed fairs or through retail shops. Stronger monitoring programs will assure lessons are being derived from these multiple efforts, and their contributions to sustainable market development are improved.

SESSION 4: SEED REGULATIONS AND HARMONISATION

Status of Harmonization of Seed Regulations in SADC

Edward D. Zulu, Senior Project Coordinator, SADC Seed Security Network

Introduction:

- Movement of seed across national boundaries a problem because of institutional barriers;
- Sourcing of seed by countries with deficits from those with surpluses is hampered;
- Farmers are denied choices of the best varieties available in the region;
- Restricted international seed trade retards investment, fragments the seed markets, and limits seed retail outlets; and
- Farmers remain seed insecure resulting in food insecurity.

Efforts to Address the Problem:

Proposals have been developed to harmonize seed regulations in SADC:

- Common SADC Variety Release System, in which a variety that has been registered in two or more SADC countries may be sold throughout SADC following listing in the SADC Common Variety Catalogue;
- Common SADC Seed Certification and Quality Assurance System, ensures that all SADC countries maintain equivalent standards in certification procedures; and
- Common SADC Quarantine and Phytosanitary Measures for Seed, which provides for commonly agreed pest lists and phytosanitary procedures for seed movement into and throughout SADC states.
- Recently a Common Draft Regional Plant Breeders Rights System has been prepared and presented to SADC states.

The adoption and implementation of these agreements in SADC will contribute to:

- Increased investment in the seed industry;
- Seed companies will project a bigger sale volume from a larger seed market;
- Seed companies will get the benefit of lower costs in dealing with regulatory agencies and release of varieties
- Farmers will gain access to improved varieties and seeds for crops that are currently ill served by the formal seed industry

Current Status of Harmonization:

The Permanent Secretaries of the Ministries of Agriculture of all SADC states have given their support to the harmonization of seed regulations in SADC. The SADC SSN is now in the process of organizing implementation of the harmonized seed systems. During 2007 – 2010, the performance and attractiveness of the Systems will be assessed and demonstrated.

- Seed companies will be encouraged to make use of the Systems and contribute with ideas concerning improvement.
- Adjustments in rules and standards will take place.
- Initially, no fees will be charged.
- Opportunities for future self-financing of the Systems will be studied and suggested.

During 2011-2012, when the Harmonization Systems have been tested and used by the seed industry, a SADC Seed Centre will be established.

- A fee scheme will be introduced with supplementary funding sourced from one or more donors.
- The design of the new Centre will be based on experiences gained so far and include appropriate representation of those stakeholders who use and fund the Systems.
- It should function as key adviser to SADC in all areas of seed policy and seed availability in the Region and assist in capacity building.

- The Centre should eventually be able to provide important support to agencies engaged in seed relief in disasters situations.
- It should also be able to facilitate a better coordination of the supply of Basic Seed for crops not serviced by seed companies.
- Successful implementation of the Systems requires that:-
  - Member States approve the proposed Systems not later than during the first part of 2007 and continue to provide strong political support,
  - the necessary donor support can be mobilised during 2007-2012;
  - plant breeders and seed companies will make increasing use of the Systems, and
  - the use of and benefits from the Systems will eventually generate enough income to sustain the Systems some time after 2012.

Impediments and Solutions to Implementing Regional Variety Release in SADC

Mary Chipili, Seed Control and Certification Institute, Ministry of Agriculture and Cooperatives, Zambia

Preamble:

A variety release system is the process of testing a variety that has been produced through crop breeding to determine its value for cultivation and use. Once the variety has been developed or improved successfully, the respective breeder applies for release of that variety through a National Seeds Authority. The variety is tested officially and if found suitable in terms of its stability and novelty, the variety is released for seed production. The approach to variety release differs from country to country in the SADC region. In some countries, the testing period maybe more than two years while in other SADC member states variety testing may not be a pre-requisite. In Zambia, a variety needs to undergo a mandatory field testing of two seasons before it can be released to farmers. The Variety Release system in Zambia is designed to assess adaptability, agricultural performance and produce value of pre-released varieties in order to ensure that only suitable varieties are released in Zambia. The candidate varieties are tested in different areas in order to establish the adaptability and performance of the new varieties in the different locations, selected based on the agro-ecological zoning.

Impediments to Implementing Regional Variety Release in SADC:

1. The majority of seed testing institutions or seed certification schemes in the SADC member states are either non-existent and weak, or the enforcement of the seed laws and regulations are inadequate.
2. The lack and slowness of certain SADC member states to put in place the Plant Breeders Rights legislation is an impediment to the successful implementation of the regional variety release in SADC.
3. There is need to map the whole SADC region according to the agro ecological suitability of the various crops which will be tested in the region.
4. Limited capacity in terms of human resource in some SADC member states and lack of proper structures and equipment to carry out proper variety assessment.
   i. Firstly, some member states have limited human resource to carry out variety testing activities at national level.
   ii. Secondly, lack of proper structures, equipment and other relevant facilities required in carrying out variety testing or if these facilities are there, they are in poor condition and utilize backward technical equipment. These imbalances with some countries having relatively good variety testing facilities while other regions having virtually none will disadvantage some SADC member states or the assessment will not be adequate. The main reason for this situation is insufficient public investment in agriculture by respective SADC members.

5. Other reasons maybe of secondary or indirectly affecting the objectives of regional variety release in SADC. The challenges facing the development and potential of agriculture in respective SADC member states are different and strategies to overcome these challenges depend on individual countries. These impediments will have an effect on any agricultural activity and they include:
    i. Despite the fact that agriculture in most SADC member states is one important sector contributing to poverty eradication, employment creation, food security and source of income for most rural people. The pace and will to making agriculture as a major sector in economic development is a major hindrance of regional implementation of agriculture protocols like the regional variety release. The will and pace is mostly centered on political will of respective SADC states, resource endowment and the overall economies of respective countries.
    ii. The region is still facing instability in politics and economics, and this could be a hindrance in implementing a regional variety testing.

What Needs To Be Done:

1. The region needs to be mapped and harmonized following the suitability of crop plants to grow in the agro ecological zones of the respective SADC states. To kick start the regional harmonization process some countries with well established variety testing institutions or seed certification schemes could be assigned to spearhead the regional variety testing, Then, as things in member states with no pieces of seed legislation improves in terms of enactments of the seed legislations, they can be assigned to start testing crop varieties which suits in that region.
2. Variety testing institutions or seed certification schemes in the region need harmonization and strengthening.
3. Capacity building in terms of training staff in variety testing and updating variety testing facilities in the region.
4. There is a need to help some countries in the SADC region who are still struggling to put in place Plant Breeders Rights legislation.
5. The Region's major challenges of agriculture need to be tackled starting at national and then at regional levels:
    - Improvement in the rural income levels especially the rural people who depend on agriculture as their main source of income.
    - There is need to improve productivity and competitiveness of the agriculture sector industry in the respective SADC member states
    - Chronical and widespread household food insecurity and vulnerability need tackling
    - Limited access to markets both locally and internationally

Standards in Quality Protein Maize (QPM) Breeding and Seed Production

B. Vivek, CIMMYT, Harare, Zimbabwe

Quality Protein Maize (QPM) contains double the quantity of lysine and tryptophan in protein compared to non-QPM, but the quantity of protein is the same in both types. Hence, only the quality of protein is enhanced in QPM. The breeding of QPM involves three genetic systems:

1. The *opaque-2* (*o2)* gene confers high lysine and tryptophan to the grain. This is a natural mutant (not a GMO) and recessive in nature. Thus, out-crossing with non-QPM leads to loss of high lysine and tryptophan. The *o2* gene on its own, while conferring high lysine and tryptophan to the kernel, leads to unacceptable soft and chalky texture, slow dry-down and predisposes the plant to ear rots.
2. Endosperm modifiers are a set of multi-genes that confer improved kernel characteristics to the *o2* genotype, thereby making the grain more acceptable to the market and more resistant to ear rots. These modifiers are selected on the light table.
3. Amino acid modifiers are additional genes, of which not much is known, but which contribute to high lysine and tryptophan laboratory values.

Consequently, acceptable QPM is that which has acceptable tryptophan and/or lysine laboratory test values, the presence of *o2* in homozygous recessive condition, and suitable modifiers of kernel texture. Furthermore, it is notable that QPM is only useful if the parent lines of the hybrids are producible, and the hybrids show performance comparable to non-QPM checks.

Steps in QPM breeding:

Cross non-QPM line to suitable QPM donor. Self pollinate the F1 and select the kernels on the light table. The following scheme summarizes the process from the S2 stage onwards:

S2 – cross to tester; 1 to 2 testers; analyze tryptophan of elite lines
S3 – Advance and test only those lines that show good quality
S4 – Cross to other elite germplasm; second tryptophan analysis
S5 – Advance and test only those that show good quality and perform well in the first test
S6 – Advanced generation test; Check tryptophan level of selfed hybrid seed

QPM seed production (Inbreds):

Increase inbred lines in big lots: grow at least ten rows (target 10 kg of seed per increase). Select the best (*per se*) row of the ten rows as your long term Breeder's seed stock. Bulk the remaining seed; send samples from both the bulked seed and the Breeder's seed to laboratory for tryptophan testing. Use bulk seed for any further increases and check tryptophan level for each increase. For laboratory testing of tryptophan, the sample size required is: 20 seeds for inbred lines and hybrids, and 50 seeds for OPVs. For inbred lines and hybrids, submit two or three replicates, and for OPVs submit five replicates. Always include QPM and non-QPM checks.

QPM Quality Index:

A Quality Index for QPM is defined as the ratio of tryptophan in sample to protein in sample, expressed as a percentage. Although there is no absolute value to define QPM, it is widely accepted that QPM grain should have a Quality Index of >0.8 for whole grain or >0.7 for endosperm analysis (Table 1). There is a negative correlation between protein quantity and quality, and therefore it is necessary to analyse for protein quantity as well as tryptophan. In all analyses, it is also important to compare the QPM samples with non-QPM checks. In addition, combining ability and agronomic characteristics must not be neglected. Select the best of what you have and keep your standards high.

TABLE 1: Quality indicators for QPM (all values in %).

		QPM		Non-QPM
Protein		9.5 – 10.0		9.0 – 10.0
In Protein	Lysine	4		2
	Tryptophan	>0.65		<0.60
		Whole grain	Endosperm	-
In Sample	Tryptophan	>0.08	>0.07	-
	Quality Index	>0.8	>0.7	-

SESSION 5: STRENGTHENING NARES AND COLLABORATION WITH PARTNERS

Needs of NARES Today and What Strategic Partners can Contribute

Danisile Hikwa and Joseph Gondo, Department of Agricultural Research & Extension, Zimbabwe

Challenges in Agricultural Research and Development faced by most NARES in southern Africa include national, regional and global changes in:

- macro-economics
- socio-economics
- climatic/environmental factors

Agricultural technology development must take these changes into account and even attempt to mitigate some, e.g., climatic change.

What are the needs of NARES today?

- Effective research for development
- Effective refinement of technology for adaptation & use by farmers
- Effective transfer of technology resulting in adoption by users
- End user utilization of products developed by research
- Effective publication vehicle for information
- Information management capacity and flow for easy access by end users
- Capacity building through training
- Institutional strengthening

Why NARES need partners:

Research and technology transfer done by NARES are a public good

- No meaningful income generation for self sustenance
- Fiscal public funding is always limited
- Research is nevertheless expensive and long term

Partnerships bring in complementary strengths:

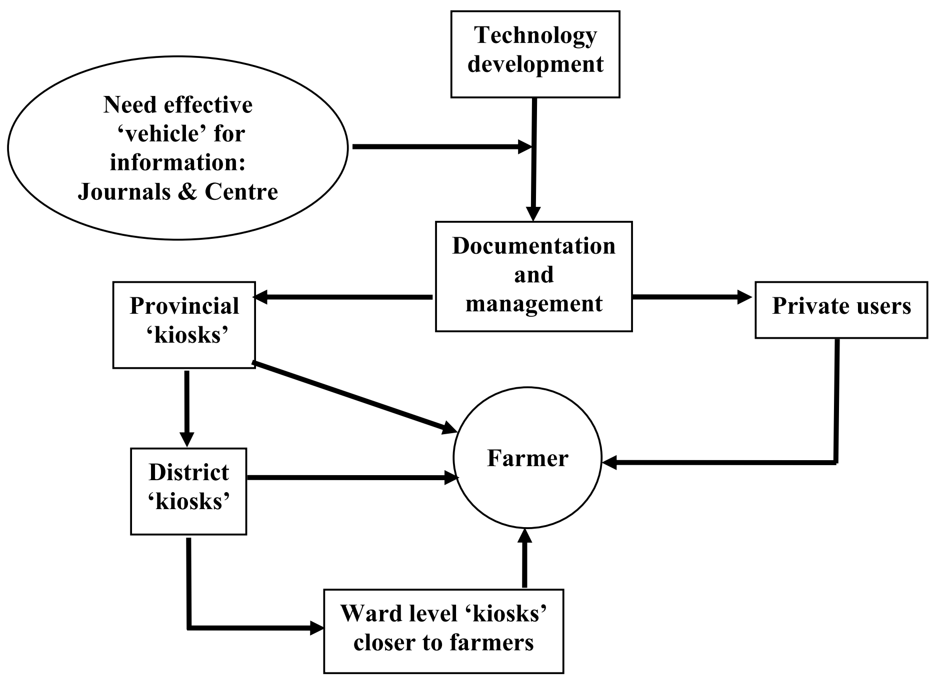
- Human resource capacity, e.g. international institutions

- Funding – both private national & international institutions
- Shared logistics – especially with farm-based activities

The private sector is also a beneficiary of public research and services:
- Products, e.g.,
  - Improved Varieties – support for emerging seed companies
  - Legume Rhizobia – enhance genetic potential of legumes
- Specialist services, e.g.,
  - Soil and seed testing

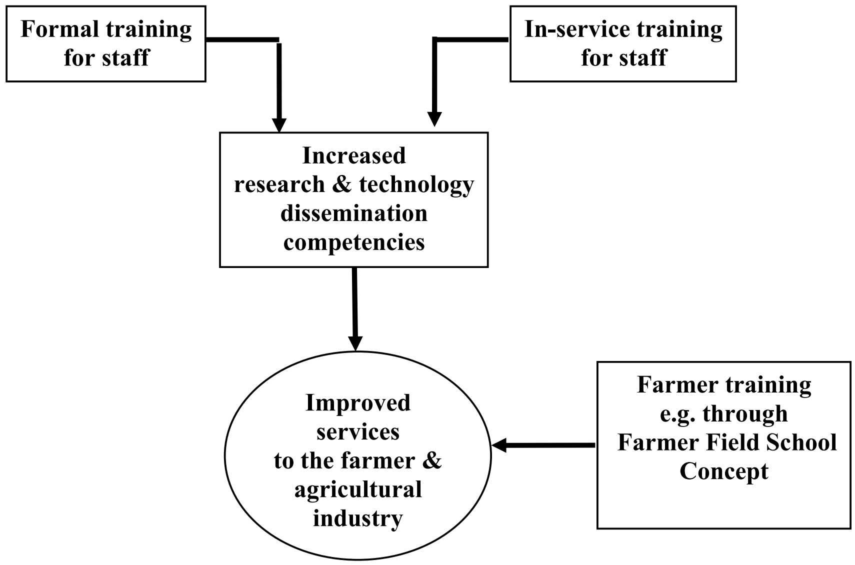
Hence there is a need for private sector participation, with partial or full funding in areas of direct benefit.

The needs and potential areas of cooperation:
Information management for effective access by end users
- Partners can play an effective role in establishing information networks



Effective research for development:
- Strengthen partnerships among NARES, IARCs & private sector in:
- Fostering participatory verification & refinement of promising technologies with farmers and extension agents – good example is the NSIMA Project
- Contributing to the national research and development agenda – ref NSIMA
- Occasional joint meetings to share views, to exchange information & create synergies

Capacity building through training:



Institutional strengthening:

This is happening to an extent with UN agencies such as UNDP and FAO:
- Laboratory equipment support
- Complimenting Government computerization efforts for improved communication
- Printing equipment

Conclusion: There is great value in working together

Seed Production Contracts and Options for Farmer Involvement in Seed Production

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Development of contract farming is seen as one significant priority option for small scale agricultural development in the Southern African Region (Sartorius and Kirstern, 2005). Seed maize is one fairly profitable crop which is commonly out-sourced by seed houses, under annual contract production, to mostly large farms and corporate farming organizations. Smaller farms are normally left out because it is argued that it is problematic for agribusiness to include small farms due to high transaction costs and low dependability amongst small farmers (Key and Rusten in Sartorius and Kirsten, 2005).

This problem is exacerbated by the fact that seed agribusiness organizations are situated in large cities, closer to bigger farms, in high rainfall areas, whilst small scale farms situated are mostly in low rainfall, agro-ecologically difficult areas, further away from towns. Smallholder farmers suffer from poor development of infrastructure and irrigation, and it is commonly argued that it is difficult and costly to deal with so many, dispersed, small entities (Louwars and Marrewijk, CTA).

For a farmer to be accepted as a certified seed maize producer, he is required to satisfy an array of conditions, which include isolation and rotation demands which can only be met on land above 40 ha for a 20 ha minimum contract. The farmer is also supposed to have a functional irrigation set up, adequate finance, management capacity, sheds, and certain machinery. While isolation requirements required to produce certified, open pollinated maize, sorghum, cowpeas, and sugar beans may be less strict, seed companies are not usually interested in these crops because they offer a smaller, and sporadic commercial market, and the seeds can be readily retained, further reducing demand. The conditions required to produce open pollinated and double cross seed maize varieties may be less demanding and may offer avenues for the involvement of a wider spectrum of farmers in seed production. This may open the opportunity for small scale communities, with the guidance of non governmental organizations, to produce such crops under special arrangements with private seed houses and parastatal bodies.

The following arrangements are offered as potential avenues that can be used to expand the involvement of a wider spectrum of farmers in contract seed maize production.
Firstly, potential seed farmers situated close to experienced seed growers may be asked to do contract seed production under mentorship of the experienced farmer.

Related with this approach, smaller farmers may be sub-contracted by a large individual seed grower to produce seed maize as 'tenant producers'. The tenant approach has been used successfully by Seed Co contracted farmers to produce maize seed in Malawi.

In Zimbabwe, large suitable areas have been isolated in small cotton producing areas as seed multiplication zones, and these seed zones have worked very well for cotton. A similar concept may be used where whole villages may be zoned out to produce open pollinated seed maize under contract to seed companies. The seed house will offer foundation seed and technical support to the seed producers. The zonal farmers will agree to sell part of their harvest as seed maize to the seed company at the end of harvest, and retain the rest as food. Zonal seed producers may be used as buffer or security sources of seed where late season crop forecast have indicated potential shortage of seed.

Experience in Zimbabwe by Seed Co shows that smallholder farmers may also join their fields together, register as a company, and approach seed houses, to be offered contracts to produce seed maize. This approach is suitable where the farmers want to be considered to produce hybrid seed maize. Hired managers and workers are used to run the seed production lands. Seed crops may also be grown under private seed house/farmer partnerships.

A more decentralized, location specific, crop and variety sensitive, approach to seed production and distribution, which to a greater extend involves local, small scale organizations, could reduce costs and increase efficiency (Cromwell, Friis-Hansen, and Turner, 1992, in Friis-Hansen, 1995). Business and logistics research by NGOs may indicate where opportunities for decentralized seed production by seed companies may offer business opportunities, and assist in more farmers being involved in seed maize production.

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Non Governmental Organizations' Seed Activities

Marx Mbunji, Seed Co Ltd

Non-governmental Organizations are involved in various seed-related activities, such as:

- Seed Shortage Mitigation and Food Security (Relief seed and food)
  - Mitigation and Rehabilitation Responses
  - Seed is procured from Formal Sector and mobilized from informal sector
  - Seed support is targeted on geographic basis at no or nominal cost to the farmer
  - Target is mostly by pack size
- Developmental (Community Seed Supply Systems)
  - Community seed production and supply
  - Training in seed production is mainstreamed
  - Interaction with formal sector at foundation seed level only
  - Can be targeted for niche crops
  - Coverage/expansion gradual
- Economical (Seed Entrepreneurship)
  - Promote seed entrepreneurship, especially in small-holder sector
  - Dynamic concept from on-farm sales to trading
  - Promotes trade between formal sector and retailers
  - Promotes trade between seed farmers and retailers

Implications of NGO Seed Activities:

1. Seed Shortage Mitigation:

NGO seed schemes saved formal seed industry from collapse at privatization, and gave rise to new seed enterprises of non-hybrid crops. However, it is donor driven and generally a short term intervention. Seed brokers thrive in these NGO schemes, as they are contracted to supply large volumes of seed. The chance for poor quality seed being delivered is therefore high. In the long run, it is not a reliable seed supply system.

2. Development Programmes:

National Government driven, based on tenders. Medium to long term interventions. However, these tend to limit freedom of choice of products by farmers. Limit freedom of choice. Problems in the system often come back on the formal market rather than the government.

3. Economical (Seed Entrepreneurship):

These interventions can develop niche crop-seed associations and promote the use of certified seed. Many of the community based seed enterprises are limited to self- and open-pollinated crops, but they may also be a building block to hybrid seed uptake, particularly in maize. Most interventions end before sustainability is achieved, and thus self sustenance problems arise. On small scale enterprises, over production problems can arise.

Conclusion:

NGO seed related activities are generally beneficial to formal seed industry. However, there is a need for specific management at design and implementation to enhance benefits.