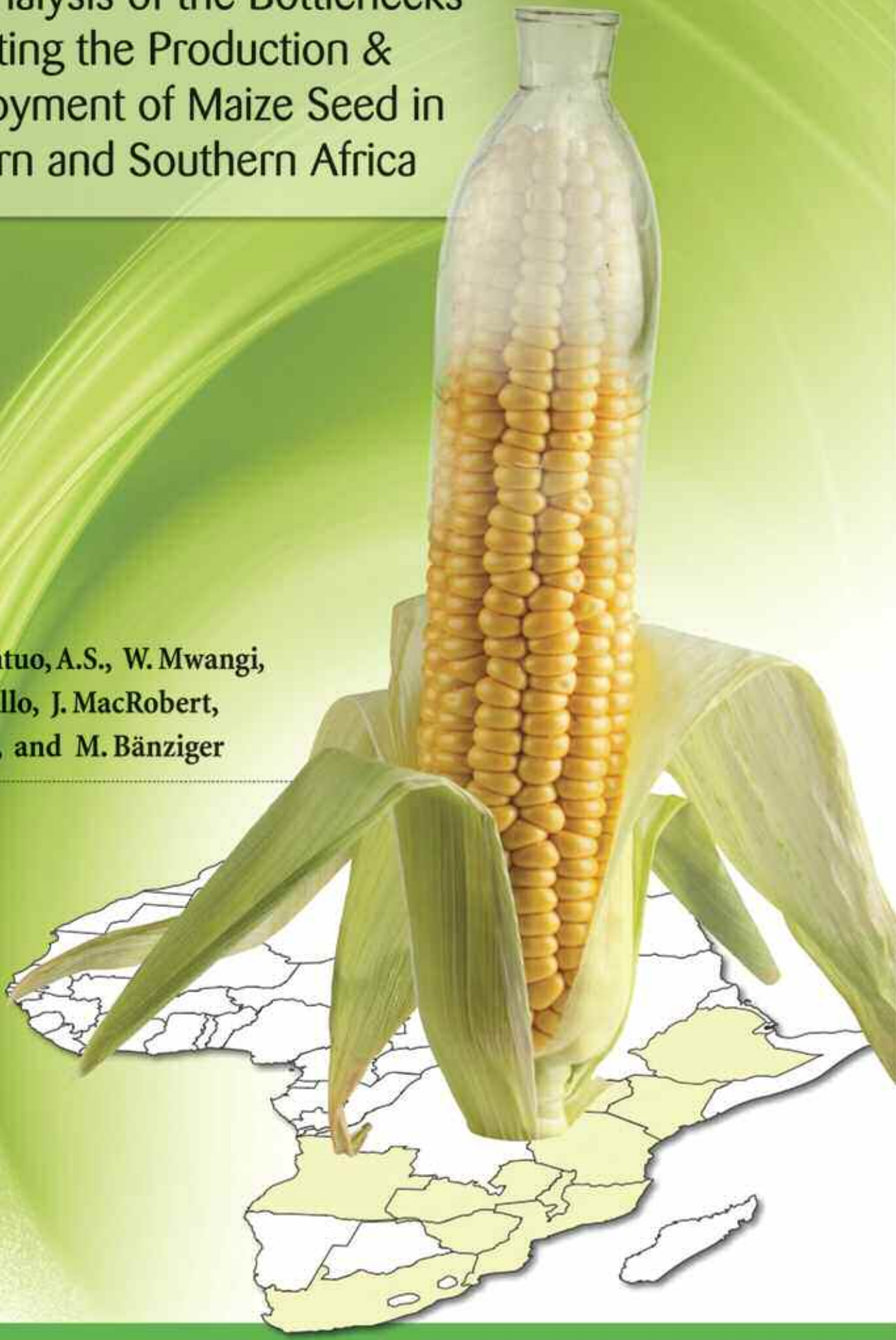
An Analysis of the Bottlenecks Affecting the Production & Deployment of Maize Seed in Eastern and Southern Africa

Langyintuo, A.S., W. Mwangi,
A.O. Diallo, J. MacRobert,
J. Dixon, and M. Bänziger



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Abstract: The publication describes outcomes of a study conducted in 2007/08 to analyze the bottlenecks affecting the production and deployment of maize seed in eastern and southern Africa. The objectives of the study were to provide a better understanding of the factors limiting the production and deployment of improved maize seed in Africa, and to contribute to increasing the efficiency of variety release, seed production and seed dissemination for new drought tolerant maize varieties. The study identified a number of institutional bottlenecks affecting the maize seed value chain, in particular in the area of policy, credit availability, seed production, germplasm and marketing. To address these bottlenecks and improve the efficiency of seed production and deployment to African farmers, the authors recommended a coordinated effort from policy makers, private and public organizations and farmers. The study was supported by the Bill & Melinda Gates Foundation and the Howard G. Buffett Foundation.

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Executive Summary

Introduction

Maize plays a dominant role in the farming systems of rural Africa. Enhancing its productivity through the use of improved, high yielding varieties, therefore, has the potential of improving the livelihoods of farm households. Within the last decade, the region has witnessed a four- to five-fold increase in the number of seed companies marketing various types of improved maize seed. Yet more than half of the maize area (or 6.7 million ha) is still under traditional, unimproved low yielding varieties. This is of great concern to policy makers, donors and researchers working to better the livelihoods of the rural poor. To provide a better understanding of the factors limiting the production and deployment of improved maize seed in Africa, this study was undertaken in 2007 under the auspices of the drought tolerant maize for Africa (DTMA) project supported by the Bill & Melinda Gates Foundation (B&MGF). The objectives of the study were to:

- Identify and characterize maize seed production organizations in eastern and southern Africa.
- Document maize varieties marketed by seed providers in Angola, Ethiopia, Kenya, Malawi, Mozambique, Tanzania, Uganda, Zambia and Zimbabwe,
- Identify factors preventing the efficient deployment of seed, and
- Make recommendations for addressing critical bottlenecks and contribute to the efficiency of variety release, seed production and seed dissemination.

A total of 107 representatives of seed providers made up of 73 seed companies (or 92% of all registered maize seed companies) and 35 National Agricultural Research Systems (NARO), non-governmental organizations (NGOs), community-based seed production schemes, and community-based seed production organizations (CBOs) were interviewed in Angola, Ethiopia, Kenya, Malawi, Mozambique, Tanzania, Uganda, Zambia and Zimbabwe. Of all the seed companies interviewed, 56% were private national companies, 19% each regional and multinational companies and 6% publicly owned companies. Additionally, nine maize seed companies were interviewed in South Africa to verify maize seed import data reported in the nine target countries.

Major findings

Seed supply and demand

During the 2006/07 crop season, an estimated 103,600 t of improved maize seed (80% hybrids) were marketed. Registered maize seed companies accounted for 100% and 91% of hybrids and OPVs, respectively. The quantities sold were sufficient to cover 35% of the total maize area compared with 26% observed in 1997. Based on seed sales, estimated adoption rates ranged from 5% in Angola to 80% in Zimbabwe. In each country the volumes produced and marketed varied tremendously between companies but averages ranged from about 230 t in Mozambique (where several seed companies are only just emerging) to about 3,000 t in Zimbabwe (with well established seed companies).

The shortfall in supply is attributed partly to institutional bottlenecks affecting the seed value chain, such as:

(i) the establishment of a seed company,
(ii) seed production and processing,
(iii) seed marketing and distribution,
(iv) seed demand at the farm level, and
(v) the seed policy environment.

The critical bottlenecks associated with each maize seed value chain are summarized below.

Bottlenecks affecting the establishment of a seed company

Challenges known to hinder the smooth establishment and running of maize seed businesses in the selected countries include (i) high initial investment costs necessary to set up and run an office, recruit and retain qualified personnel, procure and operate production and processing units, and finance storage costs; (ii) lack of qualified manpower especially breeders and agronomists to develop, maintain and test products and parental germplasm for ecological adaptability; and (iii) lack of access to operational credit. Among the three bottlenecks, high investment capital is ranked first in southern Africa and second to lack of qualified manpower in eastern Africa.

Seed production bottlenecks

At the regional level, the major seed production bottlenecks faced by seed providers are (i) lack of access to suitable germplasm, (ii) technical production constraints, and (iii) lack of financial resources especially by emerging seed companies to produce and process seed. In Kenya, Tanzania and Uganda, the dominant constraint is lack of suitable germplasm while in all other countries it is production constraints.

Seed marketing and distribution bottlenecks

Farmers are generally widely dispersed in different agro-ecologies and often far from major urban centers where most seed companies operate. This thus requires substantial investment in seed distributional networks. Currently, only about a quarter of all improved maize seed are sold to farmers in the low potential areas mainly through agro-dealers, large retail stores, NGOs and the governments. Retailing through these agents is, however, bedeviled by lack of credibility, adulteration of seed and poor storage facilities. In addition most agro-dealers lack adequate operational capital so companies deliver the seed on consignment basis and have to retrieve unsold seed at high costs as a result of their poor storage facilities. Furthermore, most retail agents lack adequate knowledge on the characteristics of the varieties they retail to be able to educate farmers so that they can purchase the right varieties for their (farmers') ecologies.

Constraints limiting seed demand at the farm level

One of the reasons seed providers perceive as being a challenge to seed demand at the farm level is the low adoption rates, which they attribute to lack of awareness and economic value of available varieties, high relative price of seed, uncompetitive grain prices, farmers' reluctance to change from their old practices, and lack of access to credit to buy seed and/or complementary inputs such as fertilizer. Another problem is thought to be poor extension coverage due to limited financial and human resources. Seed providers also believe that their inability to accurately estimate seed demand limits their operations and hence demand at the farm level. It is further claimed that lack of insurance against drought risk discourages farmers from investing in new varieties. In addition, deployment of non-adapted varieties is also thought to reduce the confidence of farmers in improved varieties thus discouraging them from subsequent purchases.

Policy related bottlenecks affecting seed production and deployment

Various governments in the region have instituted varietal registration and seed certification laws aimed at controlling the genetic and physical purity of commercial seed sold on the market. Unfortunately, some of these policies or their implementations have tended to serve as impediments to the development of the seed industry. In particular, unfavorable seed policies (such as taxation, import and export restrictions), lengthy variety release processes, and controlled seed markets (such as price fixing) are seen as the most limiting impediments. In some countries where top government officials own shares in seed companies, such companies may be favored at the expense of others.

Policy implications of the results

The bottlenecks identified have differential impacts on the seed value chain depending on the country in question and the distribution methods (or operational levels) of seed providers (whether community-based seed

production units, emerging or established national, regional and multinational seed companies). This has implications for the quantities of seed produced and marketed. Based on the results of the survey, the following policy interventions are proposed to help address the critical bottlenecks so as to improve the production and deployment of improved, high yielding DT maize varieties in eastern and southern Africa.

(i) Facilitating the establishment and operation of seed companies

At current seed volumes, more than 100 additional seed companies would be needed to provide seed for the total area grown to maize. Given high initial investment costs, limited qualified manpower, and lack of access to operational credit, a more effective strategy may be to enhance the operations of existing seed companies and increase their reach. Four complementary strategies are proposed:

(1) Improving seed productivity levels: This can be done through a combination of the following:
   a. Use of appropriate and adapted stress tolerant maize germplasm,
   b. Production of seed in areas with reliable rainfall (or investment in irrigation facilities) to minimize drought risk,
   c. Education and training of contract growers in improved crop management,
   d. Increased access to production inputs at affordable prices,
   e. Linking seed companies and community-based seed producers to overcome constraints associated with isolation, quality assurance, distribution, and marketing, and
   f. Increasing reliability of breeder and foundation seed production.

(2) Supporting seed companies to run their seed production businesses efficiently through training and backstopping to circumvent the limited manpower problems observed.
(3) Facilitate access to contracts (seed relief and others) by small seed companies
(4) Providing insurance for companies against risks associated with variable production and demand.

(ii) Maintaining efficient seed production and processing programs

The following interventions are critical in ensuring the efficient production and processing of improved high yielding maize varieties for farmers in the region: (a) Access to suitable germplasm (stress tolerant and easy to produce) by seed producers. Granting limited exclusivity for public germplasm will facilitate branding of such materials to promote seed sales. Where applicable, breeder and foundation seed production should be executed or contracted by seed companies to overcome the bottleneck of limited public sector production, and (b) Loan financing from the government, donors and private financial institutions can relax credit constraints allowing seed providers to acquire relevant plant and machinery for seed production and processing.

(iii) Improving seed marketing and distribution

Governments' commitment in the investment in feeder roads can improve input and output marketing in the region in general. Agro-dealers who market a large proportion of all seed in outlying areas should be supported with targeted loans (from traditional and non-traditional lending institutions) that allow them to buy and sell seed (rather than relying on seed on consignment seed from seed companies) as well as maintain good storage facilities. For efficiency of operations, agro-dealers should also receive regular training in maize varietal characterization, good seed handling practices, and business management skills. Accreditation schemes that for instance interlink with a country's seed trade association could assist in increasing the performance of agro-dealers.

Given that the volume of seed marketed in a given area is positively related to demand, it is imperative to improve farmers' adoption rates through: (i) enhanced extension message delivery by seed companies, governments and NGO agents through field demonstrations, and research bulletins, as well as voice and print media, (ii) improved retail networks, (iii) improved access to credit, and (iv) improved and competitive grain prices.

(iv) Reforming seed policies and regulations

Strengthening internal seed laws and regulations to guard against fake seed; an increased liberalization of seed trade; avoiding undue delays in the release of varieties, and facilitating access to public germplasm with exclusivity will benefit the seed industry tremendously. Where applicable, the following measures are proposed to quicken the time it takes for a developed variety to reach farmers: (1) urgent implementation of regional seed laws and regulations – they have been extensively discussed, in some instances approved, but they may not be implemented (2) the distinctiveness, uniformity and stability (DUS) tests should be carried out alongside (and not subsequently) to the national performance trials (NPT), (3) use of breeders' data to support variety release with minimal need for NPTs– second and third year testing in NPTs should only be conducted if first year data contradict the breeders' data, (4) variety release criteria should be updated to take into account varieties with special traits including stress tolerance/resistance traits, nutritional traits, specialty maizes, varieties with lower seed production costs, (5) empower seed companies to execute or contract breeder and foundation seed production and allow breeder and foundation seed production in parallel to variety release , and (6) between public and private sector actors, device and enforce an agreed upon roadmap that would enable rapid variety release and scale-up of seed production at reasonable costs .

Concluding remark

The survey results suggest that a number of institutional bottlenecks hamper the smooth functioning of the maize seed sector in Africa. To address these bottlenecks and improve the efficiency of seed production and deployment to African farmers will require a coordinated effort from policy makers, regulatory agencies, national research and extension organizations, seed companies and associations, NGOs and farmer organizations, credit institutions, sub-regional organizations and donors. The collection, processing, dissemination and management of information on varietal release and adaptation remain vital in ensuring success of the coordinated effort.

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Acronyms

ARI	Advanced Research Institute
B&MGF	Bill and Melinda Gates Foundation
CBOs	Community Based Organizations
CGIAR	Consultative Group of International Agricultural Research
CIMMYT	International Maize and Wheat Improvement Center
DT	Drought Tolerant
DTMA	Drought Tolerant Maize for Africa
DUS	Distinctiveness, Uniformity and Stability
EIAR	Ethiopian Institute of Agricultural Research
IDF	Import Declaration Form
IITA	International Institute of Tropical Agriculture
KEPHIS	Kenya Plant Health Inspectorate Service
NARO	National Agricultural Research Organization
NGO	Non-Governmental Organization
NPT	National Performance Trials
NSIMA	New Seed Initiative for Maize in Southern Africa
OECD	Organization for Economic Co-operation and Development
OPV	Open Pollinated Variety
PBR	Plant Breeders' Rights
SADLF	Southern African Drought and Low Soil Fertility
SRO	Sub-Regional Organizations
SSA	sub-Saharan Africa

An Analysis of the Bottlenecks Affecting the Production and Deployment of Maize Seed in Eastern and Southern Africa

1. Introduction

Maize is a major food crop in eastern, southern, central and western Africa. It accounts for 56% of total harvested area of annual food crops and 30-70% of total caloric consumption (FAOSTAT, 2007). Annual production over the past one and half decades (1990-2005) has averaged 34 million t on an estimated 24 million ha (Appendix 1). Southern Africa accounted for 43% of the total production, eastern Africa 28% and western and central Africa 29%. In southern Africa where per capita consumption is particularly high, averaging about 181 kg in Malawi, 195 kg in South Africa, 168 kg in Zambia, and 153 kg in Zimbabwe (Hassan *et al.*, 1999), the importance of maize is epitomized by the Malawian adage that "maize is life". Therefore, enhancing the productivity of maize through the use of improved, high yielding varieties has the potential of improving the livelihoods of rural farm households.

In the past one and half decades, the growth rates of maize area, production and yield in eastern and southern Africa have averaged 1%, 4% and 3% per annum, respectively (Figure 1). Yields ranged from 0.2 t ha^{-1} in Botswana to 2.4 t ha^{-1} in South Africa. Based on the historical yield trend, Figure 2 suggests that the probability of finding a country in which yields are greater than the observed regional average of 1.2 t ha^{-1} is slightly less than 50%.

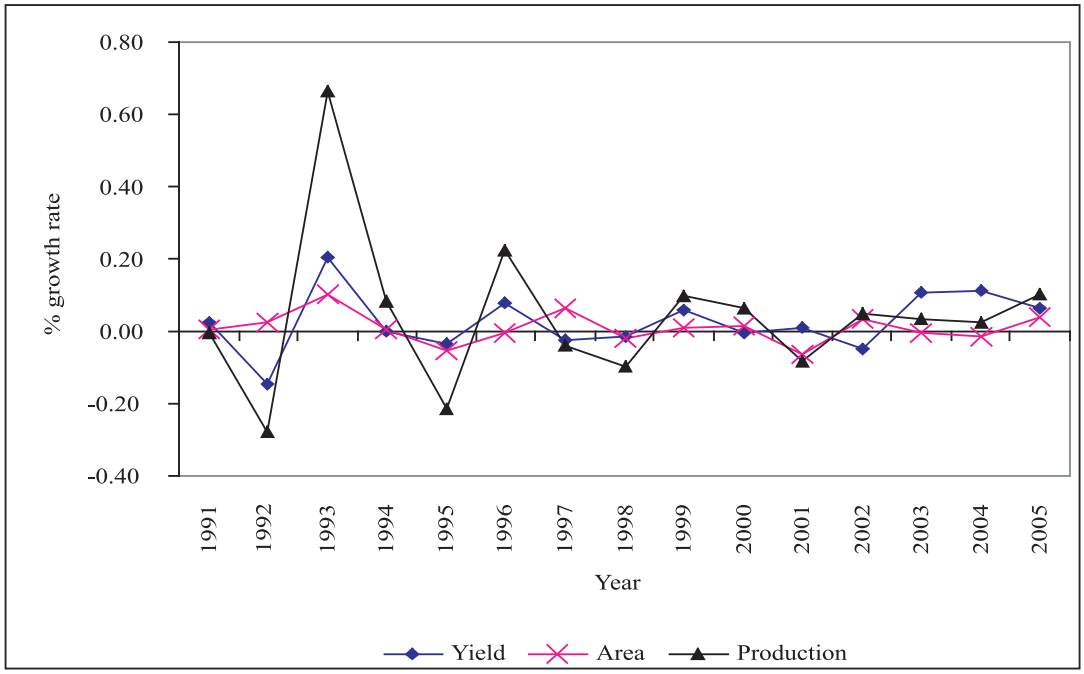

Figure 1: Annual growth rate of maize yields in eastern and southern Africa
Source: Computed from FAOSTAT, 2007

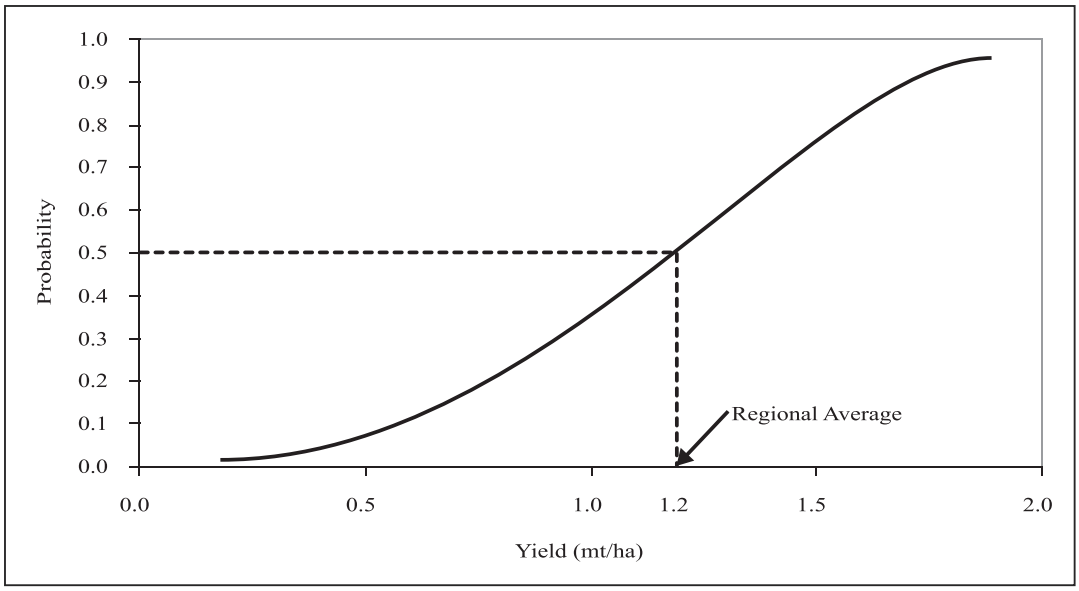

Figure 2: Cumulative probability distribution approximation of maize yields in sub Africa
Source: Computed from FAOSTAT, 2007

One of the major causes of low maize productivity in the region is the insufficient use of certified or quality seed of improved maize varieties (CIMMYT, 1998; 2002). National and international, public and private organizations are continuously developing new maize varieties but they seem to inadequately reach farmers, both in space and time. Use by farmers of recently developed maize varieties that contain value adding traits such as higher yields, disease, insect or Striga resistance, drought tolerance, better storage characteristics or lower mycotoxin levels is urgently needed if agricultural productivity levels in Africa are to be increased. Maize streak virus resistant varieties have been available for more than twenty years, yet many African farmers do not have access to such seed. Recently, drought tolerant maize hybrids and open-pollinated varieties have become available from CIMMYT that outperform current varieties by twenty percent and more under farmer-typical yield conditions and provide increased protection in years' of drought (Pixley and Bänziger, 2004). The question is how long will it take for them to be released and seed to become available in large scale to African farmers.

Recognizing the importance of drought on farmers' food security, income, livelihoods, and use of improved technologies, the Drought Tolerant Maize for Africa (DTMA) project, with financial support from the Bill & Melinda Gates and Howard G. Buffett Foundations, is emphasizing the development and deployment of drought tolerant varieties to African farmers. This study was undertaken in 2007 to obtain a better understanding of the factors currently limiting the production and deployment of improved maize seed in eastern and southern Africa and facilitate the design and implementation of interventions to ensure increased adoption of Drought Tolerant (DT) varieties being developed under the DTMA project. The specific objectives of the study were to:

- Identify and characterize maize seed production organizations in eastern and southern Africa,
- Document maize varieties marketed by seed providers in Angola, Ethiopia, Kenya, Malawi, Mozambique, Tanzania, Uganda, Zambia and Zimbabwe,
- Identify factors preventing the efficient deployment of seed, and
- Make recommendations for addressing critical bottlenecks and contribute to the efficiency of variety release, seed production and seed dissemination.

This report is organized as follows: Section 2 discusses the sources of the data. This is followed by a presentation on the supply and demand for maize seed in Section 3. Section 4 analyses the bottlenecks hindering seed deployment followed by an assessment of the factors affecting the deployment of newly released varieties in Section 5. The report ends with the policy implications of the results in Section 6.

2. Data sources

Data for the analysis were collected from a total of 117 seed providers made up of 82 maize seed companies (representing 92% of all registered maize seed companies), 10 National Agricultural Research Organizations (NARO) and 25 Community-Based Organizations (CBOs)/Non-Governmental Organizations (NGOs) in Angola, Ethiopia, Kenya, Malawi, Mozambique, South Africa, Tanzania, Uganda, Zambia and Zimbabwe (Table 1). Focus was on characterizing the maize seed sector in Angola, Ethiopia, Kenya, Malawi, Mozambique, Tanzania, Uganda, Zambia and Zimbabwe while South Africa based organizations were interviewed as a reference point (e.g. for variety release) or to verify seed import to the other countries.

Table 1: Number of seed providers interviewed in eastern and southern Africa

Region/country	Registered maize seed companies			Number of NARO and NGOs/CBOs interviewed[2]	Number of seed providers interviewed[3]
	Total number[1]	Number interviewed	No. with research facilities		
Eastern Africa	***40 (8)***	***37***	***12***	***12***	***49***
Ethiopia	7 (2)	7	1	6	13
Kenya	12 (3)	11	6	2	13
Tanzania	14 (2)	13	3	2	15
Uganda	7 (1)	6	2	2	8
Southern Africa	***40 (11)***	***36***	***11***	***22***	***58***
Angola	4 (2)	3	0	2	5
Malawi	5 (1)	4	2	6	10
Mozambique	14 (1)	14	1	2	16
Zambia	6 (2)	6	2	5	11
Zimbabwe	11 (5)	9	6	7	16
Whole region	***80 (19)***	***73***	***23***	***34***	***107***

Note: [1]In parentheses represent number of companies observed in 1997 by Hassan *et al.* (2001).
[2]NGOs interviewed are those involved in seed production.
[3]Note that nine seed companies and one NARO were interviewed in South Africa (a non-DTMA country). This gives a total of 117 seed providers interviewed in eastern and southern Africa.

Sources: DTMA seed sector survey, 2007/08; Hassan *et al.* (2001)

Of the 82 seed companies interviewed, 57% are private national seed companies, 17% regional seed companies, 21% multinational seed companies and 4% publicly owned (Table 2). Interviews were conducted between January and July 2007 by CIMMYT and NARO scientists using structured questionnaires covering (a) institutional establishment and operation, (b) bottlenecks in disseminating new maize varieties, (c) seed prices and sales trends, and (d) limitations to expanding seed sales. Most questions were open-ended because it was not possible to pretest and pre-code them due to the relatively small number of seed providers. The downside of open-ended questions is the enormous analytical challenge they pose. On the other hand, they afford the opportunity to solicit a dearth of information from respondents. The response rate was 100%.

Table 2: Distribution of seed companies interviewed in eastern and southern Africa

	Type of seed company[1]				Total number of seed companies
Region/country	Private national	Private regional	Private multinational	Public	
Eastern Africa	***15***	***10***	***8***	***4***	***37***
Ethiopia	-	6	-	1	7
Kenya	6	1	4	-	11
Tanzania	7	1	2	3	13
Uganda	2	2	2	-	6
Southern Africa	***26***	***4***	***6***	***0***	***36***
Angola	3	-	-	-	3
Malawi	2	-	2	-	4
Mozambique	12	2	-	-	14
Zambia	3	2	1	-	6
Zimbabwe	6	-	3	-	9
Whole region	***41***	***14***	***14***	***4***	***73***

Note: [1]**"-" implies none observed**
Source: DTMA seed sector survey, 2007/08

3. Estimated seed supply by seed providers in eastern and southern Africa

Seed production and distribution is organized by registered seed companies, complemented by CBOs/NGOs and a limited number of NAROs. Seed companies and the NAROs often market certified seed while CBOs/NGOs sometimes market uncertified seed[1]. During the 2006/07 crop season, an estimated 103,600 t of improved maize seed (80% hybrids and 20% OPVs) were marketed in the selected countries in eastern and southern Africa (Table 3). Based on the estimated maize area of 12 million ha and a seeding rate of 25 kg ha-1, the total quantity of improved maize seed sold fell short of the quantity of seed planted in the region by as much as 65%. This implies that about 8 million ha of maize area was not planted to fresh and improved maize seed. Adoption rates (based on seed sold in 2006/07) for both improved OPVs and hybrids ranged from 5% in Angola to 80% in Zimbabwe (Table 3). Compared with the adoption rates observed by Hassan *et al.* (2001) in 1997, the rates dropped in Angola, Zambia and Zimbabwe but rose in the other countries (Figure 3) but the overall change was an increase by nine percentage points at the regional level.

The unmet need for maize seed is typically fulfilled through recycling grain as seed from the previous harvest at the risk of yield decline. According to Pixley and Bänziger (2004), the average yield loss of recycled maize grain as seed may vary between 5 per cent (OPV seed) to more than 30 per cent (for hybrids).

Assuming that farmers recycle similar quantities of improved OPV seed purchased for at least two seasons, one would expect that in the 2006/07 crop season, seed purchased in 2004/05 will be in their second year of recycling and those purchased in 2005/06 in their first year. Based on the 2004/05 – 2006/07 OPV sales figures (Table 3 columns 4 - 6), adoption rates for improved maize in eastern and southern Africa could be adjusted by 4 and 14

[1]In countries such as Tanzania, the community-based seed is sometimes referred to as "quality-declared" seed if certified seed is used as sourced seed.

Table 3: Estimated maize seed supply and need in eastern and southern Africa

Region/country	Maize area (1990-2007 average in 10^6 ha)	Estimated seed need (1000 t)[1]	Improved OPV maize seed sales (1000 t)			Hybrid maize seed sales in 2006/07 (1000 t)	Adoption rate 2006/07 (as % of maize area)[2]	Adjusted adoption rate in 2006/07 (as % of maize area)[3]
			2004/05	2005/06	2006/07			
Eastern Africa	***6.6***	***161.8***	***4.0***	***3.5***	***11.1***	***42.0***	***33 (23)***	***37***
Ethiopia	1.7	42.4	0.4	0.4	2.0	6.2	19 (8)	21
Kenya	1.6	38.9	0.6	0.1	1.7	26.3	72 (71)	74
Tanzania	2.6	64.0	0.6	2.0	3.9	7.3	18 (4)	22
Uganda	0.7	16.5	2.3	1.0	3.5	2.2	35 (9)	54
Southern Africa	***5.4***	***133.4***	***9.3***	***9.8***	***12.0***	***38.5***	***38 (28)***	***52***
Angola	0.8	19.3	0.8	0.1	0.8	0.2	5 (12)	10
Malawi	1.4	35.3	5.2	4.5	5.4	2.5	22 (14)	50
Mozambique	1.2	30.3	1.2	2.2	3.1	0.2	11 (9)	22
Zambia	0.6	14.1	0.3	1.0	0.5	9.7	73 (23)	81
Zimbabwe	1.4	34.4	1.8	2.1	2.2	25.9	80 (82)	93
Regional total/av.	***12.0***	***295.1***	***13.3***	***13.3***	***23.1***	***80.5***	***35 (26)***	***44***

Note: [1]Estimate based on area and planting rate of 25 kgha-1.
[2]In parentheses are figures observed in 1997 by Hassan *et al.* (2001). Only seed sales in 2006/07 were used in the estimation.
[3]Adjusted for OPV sales in 2004/05, 2005/06 and 2006/07 assuming that similar quantities purchased in the first two years were recycled in 2006/07. That is, total improved OPV seed planted is aggregated over 2004/05, 2005/06 and 2006/07. Notice that total area under improved maize varieties is 4.2 million ha (0.92 million ha under OPV) before and 5.3 million ha (2 million ha under OPV) after adjustment with previously purchased OPV seed.
Sources: DTMA seed sector survey, 2007; Hassan *et al.* (2001); FAOSTAT (2007)

percentage points higher. This means that about 5.3 million ha of maize area is under improved maize of which 38% or 2 million ha under OPV maize. This leaves about 56% (or 6.7 million ha) of maize area under recycled grain of hybrid maize, traditional varieties and intercrosses between all types of maize.

Looking at the 2006/07 seed production and sales figures alone, Table 4 suggests that over 91% of all OPV maize seed and nearly 100% of all hybrids sold on the market are accounted for by established maize seed companies, the remainder by NAROs and known community-based seed organizations. Compared to a similar study done in 1997 (Hassan et al.., 2001), this study found a four fold-increase of the number of registered seed companies (Table 1).

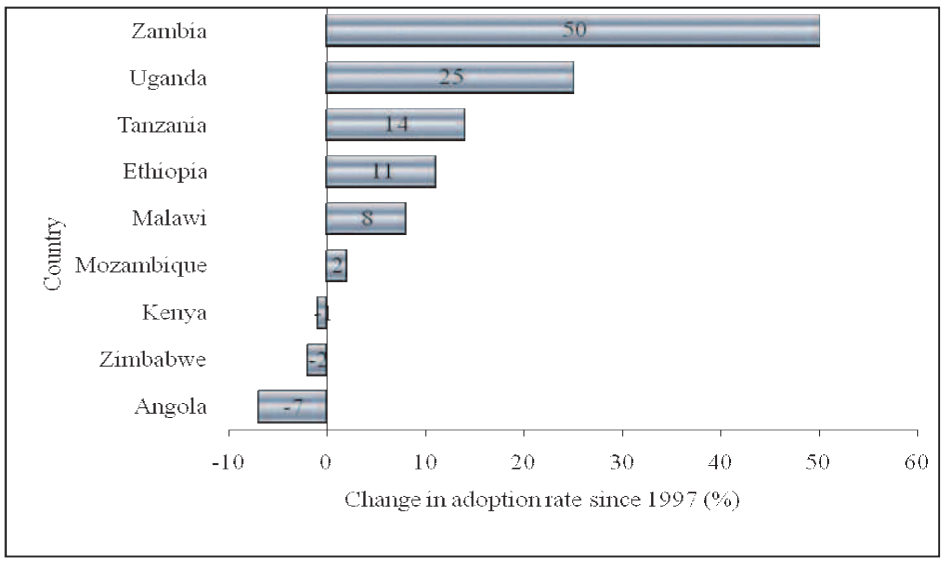

Figure 3: Changes in improved maize varieties' adoption rates in 2007 compared with 1997
Source: DTMA seed sector survey, 2007

The average amount of seed produced per company decreased from 2,578 tons in 1997 to 1385 tons in 2006, an indication that a large number of new maize seed companies have been registered over the past decade however each producing a lower seed volume.

The average seed production per company in the selected countries varies from about 230 tons in Mozambique where the majority of seed companies are just emerging to as high as 3,000 tons in Zimbabwe with well established companies. At current productivity levels, about 140 additional seed companies would be needed to meet the shortfalls in supply over seed needed to plant the entire maize area in the region. At the country levels, the number ranges from 2 in Zambia and Zimbabwe where company production levels are relatively high to 115 in Mozambique, which has seed companies with the lowest average seed production volumes. In Angola average production levels are also low but the estimated seed need of 19,000 – tons is far less than the 30,000 tons estimated for Mozambique thus influencing the relatively smaller number of additional seed companies needed to meet the shortfall in supply. Similar reasoning applies to the case of Zambia versus Kenya. These low production levels of seed companies and low adoption rates of improved varieties at the farm level are the results of a number institutional bottlenecks discussed below.

Table 4: Estimated productivity levels of seed companies in 2006/07

Region/country	Maize OPVs sold		Hybrids maize sold		Average production of all improved seed per company (tons)[1]	Additional number of seed companies needed to meet shortfall[2]
	Quantity (x 1000 tons)	Proportion of total reported in Table 3	Quantity (x 1000 tons)	Proportion of total reported in Table 3		
Eastern Africa	***10.5***	***0.94***	***41.8***	***1.00***	***1,412***	***78***
Ethiopia	1.8	0.92	6.1	0.98	1,131	30
Kenya	1.7	1.00	26.3	1.00	2,545	4
Tanzania	3.7	0.94	7.3	1.00	844	63
Uganda	3.2	0.91	2.2	1.00	898	12
Southern Africa	***10.6***	***0.88***	***38.3***	***0.99***	***1,357***	***62***
Angola	0.8	0.98	0.2	1.00	328	56
Malawi	2.4	0.44	2.5	1.00	1,219	25
Mozambique	3.1	1.00	0.2	0.97	235	115
Zambia	0.5	0.99	9.7	1.00	1,699	2
Zimbabwe	2.2	1.00	25.9	1.00	3,122	2
Total/average	***21.0***	***0.91***	***80.1***	***1.00***	***1,385***	***140***

Note: [1]**Estimates made based on total number of registered seed companies in the country**
[2]**Assuming that seed companies operating at current productivity levels**
Source: DTMA seed sector survey, 2007/08

4. Regional overview of bottlenecks limiting maize seed production and deployment

Seed provision in Africa can be categorized into formal and informal seed systems (Tripp and Rohrbach, 2001). Whereas the formal seed system is dominated by institutions, public and private, and generally governed by seed laws, the informal system of seed provision is carried out mainly by farmers, CBOs and NGOs with limited access to institutionalized mechanisms for quality control or seed delivery. The survey data presented in Tables 3 and 4 suggest that CBOs and NGOs – to the extent as they are known to local authorities –and the NAROs account for only 4% of all seed marketed in the region. Therefore, discussions in this section on the bottlenecks hindering the smooth functioning of the seed sector will be dominated by responses from seed company representatives.
Like any other business or enterprise, to start operating a seed company in a country requires first registering the company with the relevant government authority to obtain a business license. Most African governments are encouraging the establishment of seed companies and are therefore making efforts to facilitate the processes. Nevertheless, 10% of seed companies mainly in Mozambique and Zimbabwe are of the opinion that these processes are non-transparent and lengthy and government employees in the registration office do not adequately support registration by new companies. In Zimbabwe, the exodus of qualified staff due to the economic downturn in the country aggravates the situation.

After registration of the company, a number of institutional bottlenecks can affect the maize seed value chain and contribute to a shortfall in maize seed supply. The major maize seed value chain "nodes" include (i) establishing and running a seed company, (ii) seed production and processing (including germplasm collection, breeding and evaluation), (iii) seed marketing and distribution (including storage), (iv) seed demand at the farm level, and (v) seed policy and regulatory environment (including release processes, intellectual property rights, phytosanitary regulations, and quality control/assurance) (Figure 4).

The bottlenecks observed to be affecting the five value chain nodes are loosely grouped under (a) establishment bottlenecks (e.g., high investment cost, lack of manpower, and lack of operational credit), (b) production bottlenecks (e.g., lack of access to germplasm, lack of production credit, and technical constraints), (c) marketing bottlenecks (e.g., delivery constraints, poor infrastructure, and competition), (d) demand bottlenecks (e.g., poor grain markets, poor extension services, and low adoption rates), and (e) policy bottlenecks (e.g., lengthy varietal release process, and import/export restrictions), respectively. The remaining part of this section examines how seed companies perceive the relative significance of the value chain node-specific bottlenecks constraining seed production and deployment while the following sections examine the relative impacts of the individual bottlenecks at each node.

Among respondents in the region, nearly twice as many of them consider bottlenecks affecting seed production and processing as the dominant constraint followed by those related to seed policies (Figure 5). Seed company establishment bottlenecks rank third, while marketing and distribution bottlenecks fourth. Farm level demand constraints ranked fifth but cannot be overlooked in any policy drive to improve seed deployment since the objective ultimately is to make seed available on farmers' fields.

Examining the value chain node-specific bottlenecks at the country levels in eastern Africa, Table 5 suggests that whereas more than half of the seed companies in Ethiopia regard production bottlenecks the most challenging, less than 40% of those in Kenya, Tanzania and Uganda view production bottlenecks similarly. Rather, seed companies in Kenya consider the stringent seed policies being implemented by the Kenyan Plant Health Inspectorate Services (KEPHIS) as the top ranking bottlenecks. About 25% of the respondents in Tanzania and Uganda think it a big challenge to set up a seed company.

In southern Africa, bottlenecks related to production dominate except in Zimbabwe where they are comparable with seed policies and regulations (Table 5). Over 25% of the seed companies in Malawi are concerned more about farm level seed demand constraints than seed policies and bottlenecks affecting the establishment of seed companies.

Disaggregated by company size, Figure 6 suggests that bottlenecks related to seed production remain dominant for both types of companies. The second important bottlenecks for the large-sized companies (those producing 1000 t or more per year) are those related to seed policies, mainly lengthy varietal release processes that delay the

release of new varieties and export restrictions preventing them from marketing seed abroad. Among small-sized companies (most of them being emerging and producing less than 1000 t a year), on the other hand, bottlenecks affecting the setting up and running a seed company are the second most important constraints. High establishment costs of the company usually erode their financial resources making it difficult for them to run their seed businesses without access to credit.

In summary, the bottlenecks affecting seed production and processing are the top ranking constraints at the regional level in all the nine DTMA project countries except in Kenya and Zimbabwe where they are second. Incidentally, in the two latter countries together with Zambia where seed laws and regulations appear well established, seed policies are the first and second ranking bottlenecks, respectively. As will be shown in a later section, these bottlenecks relate mainly to varietal registration and market controls. The sections that follow discuss the specific bottlenecks in detail.

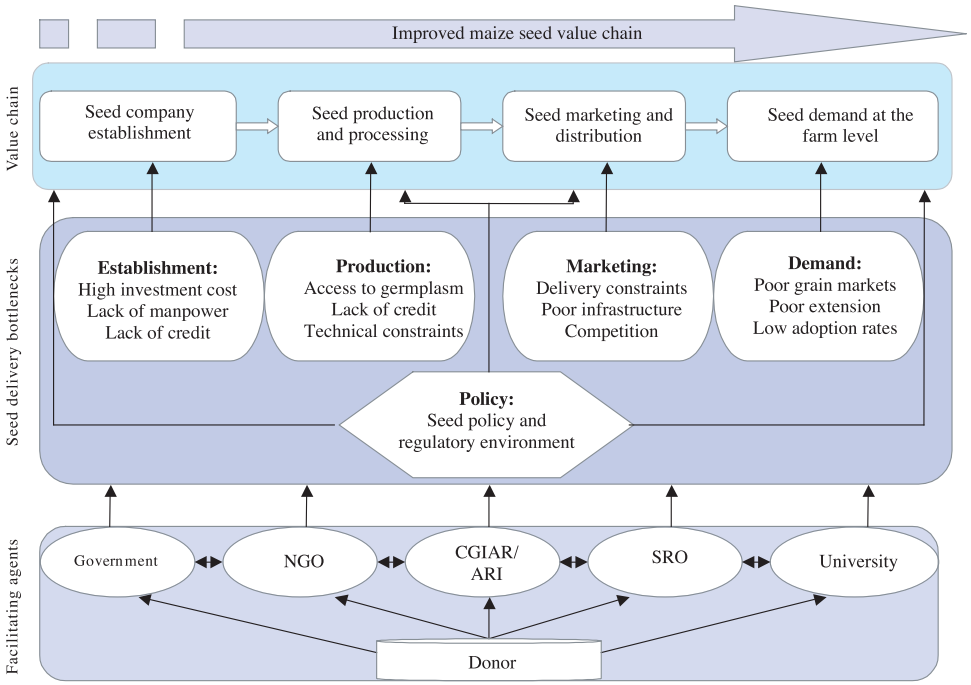

Figure 4: Schematic diagram of bottlenecks affecting the seed value chain

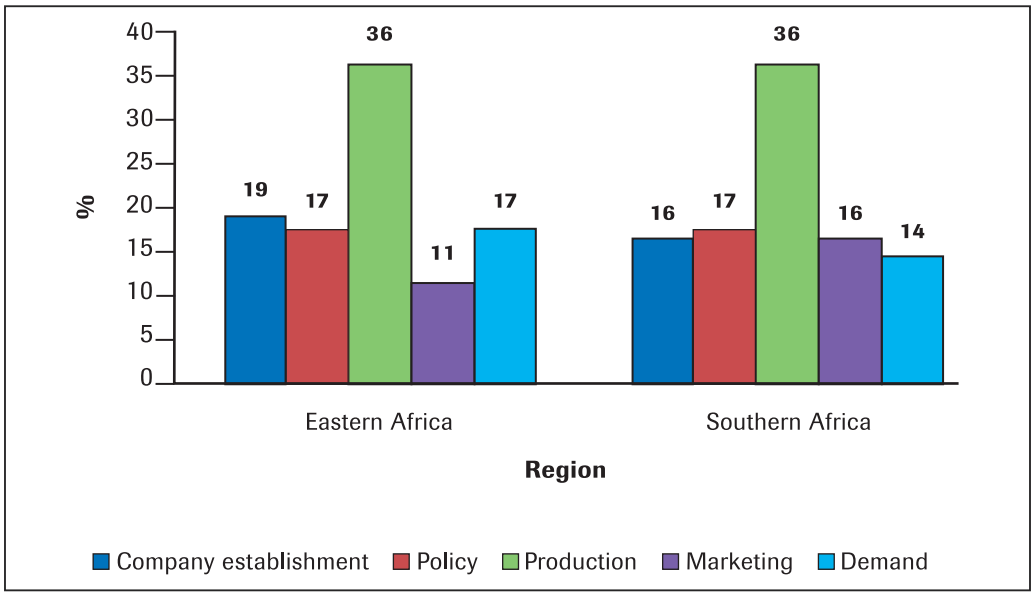

Figure 5: Bottlenecks to seed deployment in project countries in eastern Africa
Source: DTMA seed sector survey, 2007/08

Table 5: Relative significance of maize seed value chain node-specific bottlenecks (%)

Region/country	Company establishment	Policy	Production	Marketing	Demand
Eastern Africa	***19***	***17***	***36***	***11***	***17***
Ethiopia	13	9	56	6	16
Kenya	14	32	26	8	21
Tanzania	24	14	34	12	17
Uganda	26	14	29	20	12
Southern Africa	***16***	***18***	***36***	***16***	***14***
Angola	20	15	40	15	10
Malawi	12	8	39	19	23
Mozambique	14	11	39	17	20
Zambia	13	28	34	12	13
Zimbabwe	24	26	26	17	7
Whole region	***17***	***17***	***36***	***14***	***15***

Source: DTMA seed sector survey, 2007/08

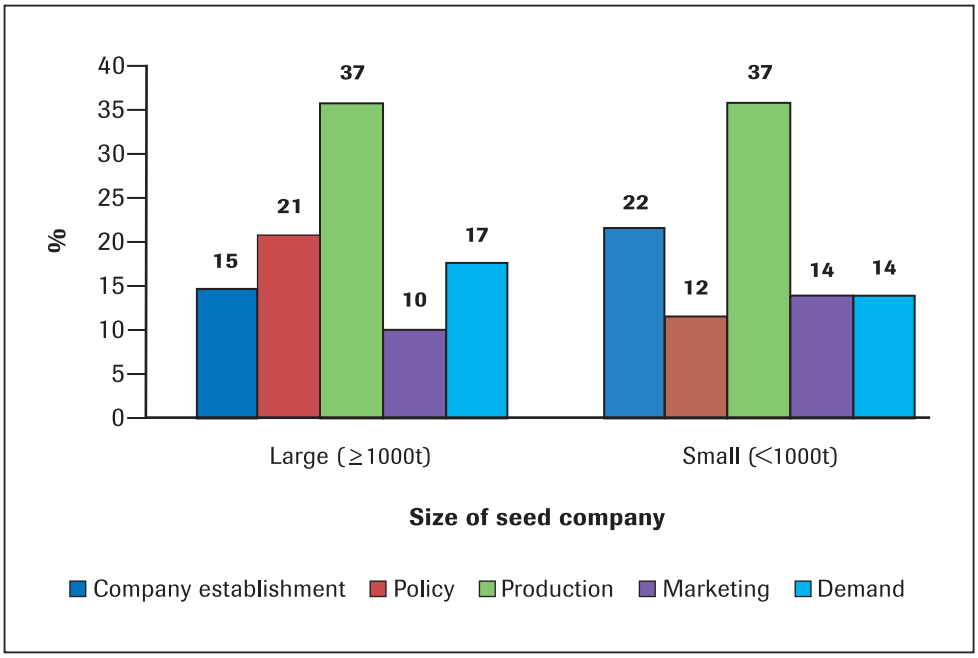

Figure 6: Bottlenecks to seed deployment by size of company
Source: DTMA seed sector survey, 2007/08

4.1 Bottlenecks affecting the establishment of a seed company

In many of the countries in southern Africa, the maize seed sector is dominated by well established, large-sized seed companies. In contrast, the maize seed sector in many eastern African countries is dominated by small-sized, emerging seed companies. This has implications for the regional view of the bottlenecks affecting setting up and running of seed companies, namely: (i) high initial investment costs, (ii) lack of qualified manpower, and (iii) lack of access to operational credit. In eastern Africa, because the majority of the companies are emerging, they are faced with the challenge of getting qualified manpower, especially breeders and agronomists for varietal development and maintenance of parental lines (where necessary), as well as testing varieties for ecological adaptability, which is not an issue in southern Africa (at the regional level) mainly because the seed sector is dominated by established seed companies with a full complement of staff (Figure 7).

As shown in Figure 8, lack of qualified manpower accounts for over 40% of the cases related to seed company establishment bottlenecks in eastern Africa but less than 20% in southern Africa. Staff attrition and death have become a real challenge making it difficult for all seed companies to maintain a pool of qualified manpower. This is an equally an important bottleneck for NARO and NGOs.

The second most important problem in eastern Africa is the high initial investment cost, which is the top ranking problem in southern Africa because of the size of the their operations. Substantial investment is required to establish and maintain an office, recruit and retain qualified personnel, procure and operate production and processing units and finance storage costs as well as maintain a portfolio of improved varieties.

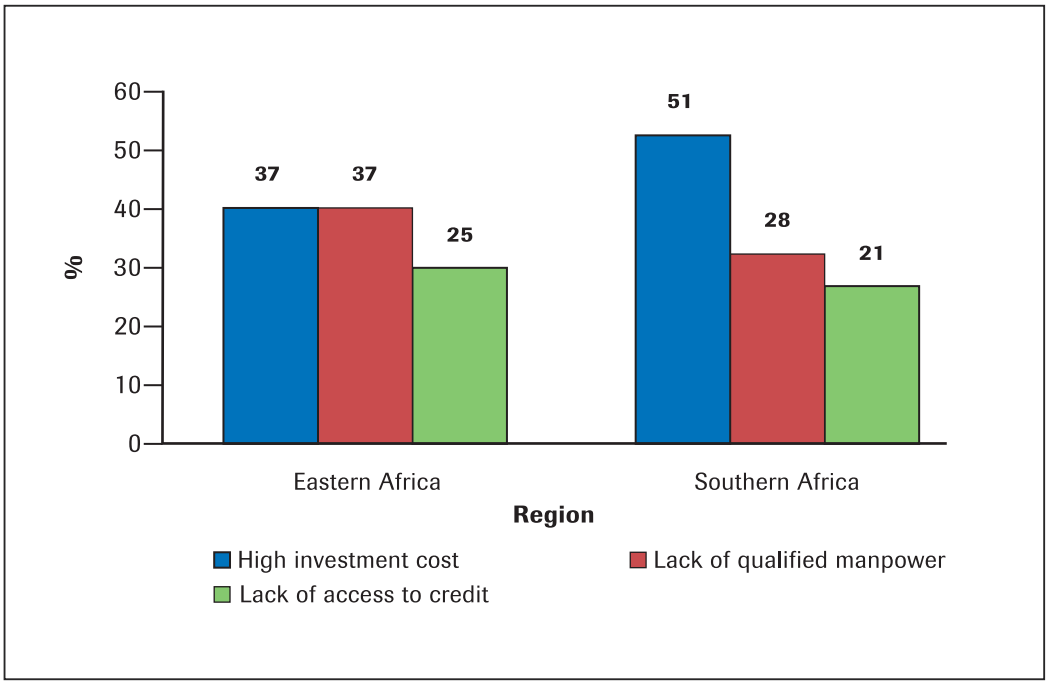

Figure 7: Seed company establishment bottlenecks in eastern and southern Africa
Source: DTMA seed sector survey, 2007/08

The relative significance of these bottlenecks at the county levels is influenced by the nature and scale of operations of the dominant seed companies. That is, whether or not the companies have breeding programs, or they are mainly national, regional or international companies. Among eastern African countries except Ethiopia, lack of qualified manpower remains the dominant bottleneck to the establishment of seed companies (Table 6). In Ethiopia, on the other hand, high initial investment costs are the dominant factors and qualified manpower less of an issue. This is possibly due to the restrictive nature of the seed policy environment and the associated need for personnel. Breeding and variety testing is done by the Ethiopia Institute of Agricultural Research only. The Ethiopian Seed Enterprise, a parastatal, is the only foundation seed producer whereas all other seed companies rely on the Bako Research Station for their foundation seed. Hence there is a somewhat lesser demand for personnel qualified in variety development, testing and breeder and foundation seed production.

In southern Africa, seed companies in all the selected countries are worried first about the high investment cost except in Malawi where bottlenecks are mostly around operational credits. In Malawi, seed companies are have little engagement in research, and carry out varietal trial for ecological adaptation and seed multiplication of varieties developed by their parent companies in Zambia, Zimbabwe or South Africa (Table 6). Because of the expanding seed sector in Zambia, seed companies are hampered by poor access to qualified manpower to meet the increasing demand. In Zimbabwe, on the other hand, lack of access to credit for operations is the second most important bottleneck seed companies face. In Angola, the seed sector is not fully developed so seed companies consider all the three problems equally important in the establishment and running of seed companies in that country.

Table 6: Bottlenecks affecting the establishment of seed companies in eastern and southern Africa (%)

Region/country	High investment cost	Lack of qualified manpower	Lack of access to credit
Eastern Africa	***37***	***37***	***25***
Ethiopia	43	28	28
Kenya	56	33	11
Tanzania	29	43	29
Uganda	22	44	33
Southern Africa	***51***	***28***	***21***
Angola	25	50	25
Malawi	100	-	-
Mozambique	40	20	40
Zambia	50	50	-
Zimbabwe	40	20	40
Whole region	***44***	***33***	***23***

Source: DTMA seed sector survey, 2007/08

4.2 Seed production and processing bottlenecks

Maize seed production requires competent growers who can meet the isolation requirements and production standards for seed certification. Seed companies prefer to produce their own seed but due to lack of adequate land and limited access to other production resources to meet their projected supply volumes, they contract individual farmers[2], CBOs or NGOs annually to produce and deliver seed to them for processing.

Contracting farmers, in particular, is associated with problems such as difficulty in achieving isolation distances to ensure genetic purity and seed quality, and side selling of seed to competitors. In principle, optimum field sizes for quality seed production are considered to be less than 20 ha, particularly for hybrid seed production. Very small fields (<5 ha), typical of small holder farmers, however, are prone to greater risks from foreign-pollen contamination, and therefore isolation becomes a particularly important factor. As a result of small land holdings, companies are often compelled to contract a large number of individual (15 to > 200) farmers. This requires significant investment outlays to train, develop agreements, inspect and transport seed produced. In addition, the majority of these small-scale farmers farm under rain-fed conditions due to lack of access to irrigation and are therefore often exposed to drought risk and consequently crop failure. Moreover, they also lack the necessary financial resources to purchase production inputs and control field pests and diseases thereby compromising on the quality and quantity of output.

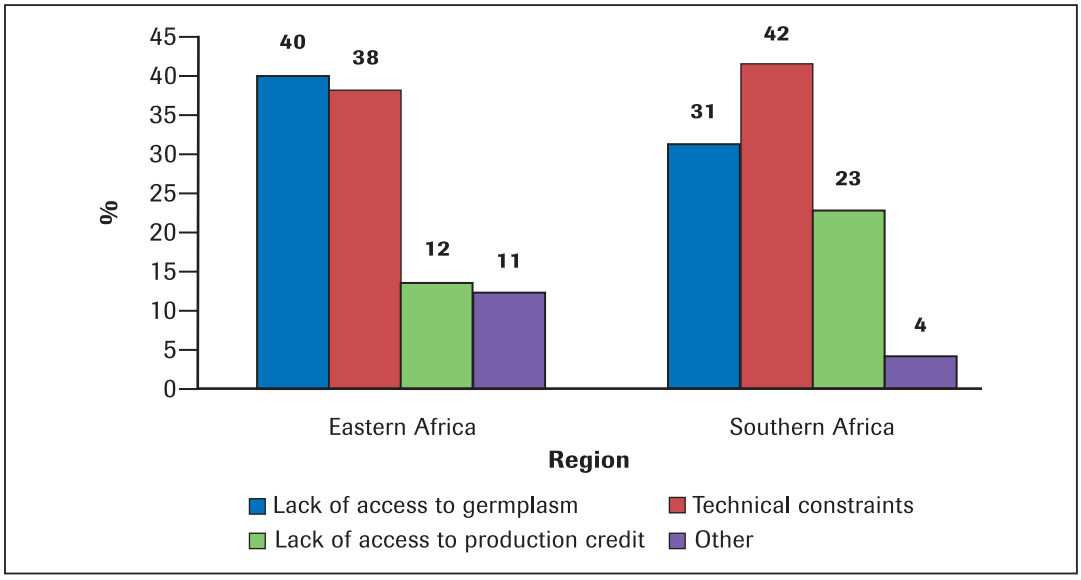

Figure 8: Production bottlenecks faced by seed companies in eastern and southern Africa
Source: DTMA seed sector survey, 2007/08

To contract an individual grower, therefore, seed companies consider farmers' access to (a) cash to hire labor and control pests and diseases, (b) irrigation facilities for a good crop, and (c) relatively better managerial skills. Based on their assessment, the farmer is contracted to grow OPV or hybrid seed. Invariably, mostly large-scale commercial farmers are contracted to produce hybrid seed, which often imply growing delicate inbred lines, while their small-scale counterparts are contracted to produce OPV seed, parental material of which is less prone to crop failure. In some cases, large-scale commercial farmers contracted also sub-contract tenant farmers to grow hybrids but provide them with adequate resources to produce and deliver good quality seed.

A few community-based organizations and NGOs produce and sell certified seed. If not contracted by a seed company, CBOs and NGOs usually grow OPVs as a direct response to the lack of timely provision of seed of desirable characteristics to farmers in outlying areas. Based on the type of seed produced, three models of CBOs and NGOs seed production systems can be identified (Pixley and Bänziger, 2004). In Model 1, CBO or NGO may acquire foundation/basic seed from a seed company or public research institute to produce certified seed under

[2]See Langyintuo *(2004) for details on farmer contractual processes

the supervision of the company and a government certified seed services unit. Model 2 is similar to Model 1 except that instead of using foundation seed, they use certified seed. In this case, the seed eventually produced and marketed is termed "quality declared" seed; a system only possible in some countries, e.g., Tanzania. In Model 3, certified seed is also used instead of foundation seed as in Model 2 but the production process is not supervised by a seed certification unit, as such, the seed produced is of unknown quality and type. In Kenya, Zambia and Zimbabwe, maize seed from Models 2 and 3 is not allowed on the market.

Table 7: Production bottlenecks faced by seed companies in eastern and southern Africa

Region/country	Lack of access to suitable germplasm	Technical constraints	Lack of production credit	Other
	---------- % ----------			
Eastern Africa	***40***	***38***	***12***	***11***
Ethiopia	49	35	10	6
Kenya	35	41	12	12
Tanzania	45	35	15	5
Uganda	30	40	10	20
Southern Africa	***31***	***42***	***23***	***4***
Angola	13	50	38	-
Malawi	40	50	10	-
Mozambique	14	36	50	-
Zambia	55	27	9	9
Zimbabwe	35	46	9	9
Regional average	***35***	***40***	***18***	***7***

Source: DTMA seed sector survey, 2007/08

The major bottlenecks during seed production are (i) lack of access to suitable germplasm, (ii) technical constraints, and (iii) lack of production credit (Figure 8). Technical constraints referred to lack of production infrastructure, unfavorable land policies, poor climatic conditions, and field pests and diseases. In eastern Africa, lack of access to suitable germplasm and technical constraints account for over 80% of all the production problems. Similar results are observed in southern Africa, except that production constraint is ranked ahead of lack of access to suitable germplasm. Table 7 shows that in Ethiopia and Tanzania where foundation seed production is controlled by the government, lack of suitable germplasm is the dominant constraint. In Kenya and Uganda where seed companies produce their foundation seed, production technical constraints dominate.
The relative importance of bottlenecks affecting seed production among southern African countries are now discussed. In Zambia, seed companies are having difficulties accessing suitable germplasm to satisfy the diverse and expanded demand in the country. In Malawi and Zimbabwe, production constraints dominate followed by access to suitable germplasm to cover market niches. In Angola, seed companies are concerned about production constraints and access to credit to pay for seed production. Seed companies in Mozambique are concerned about access to production credit followed by technical constraints.

Looking at the production bottlenecks by size of seed company, Table 8 suggests that in eastern Africa, large companies apparently have access to germplasm and are concerned about technical constraints while small companies worry about access to suitable germplasm more than other constraints. It is not clear why the reverse is true in the case of southern Africa. These bottlenecks are further discussed in detail in the following sections. After production, the seed have to be processed for sale. Most large seed companies with research facilities own processing facilities. Companies without processing facilities, CBOs and NGOs outsource processing services. Seed companies with processing facilities rent them out only when not in use, a process that can cause undue delay in processing seed.

Table 8: Seed production bottlenecks as perceived by region and size of seed company

	Eastern Africa		Southern Africa	
Production bottleneck	Established	Emerging	Established	Emerging
Lack of access to suitable germplasm	30	47	43	28
Technical constraints	60	29	36	43
Lack of production credit	-	16	14	28
Other	10	9	7	3

Source: DTMA seed sector survey, 2007/08

4.2.1 Lack of access to suitable germplasm

Producing maize seed to process and sell to farmers requires access to germplasm suitable for the given agro-ecology. Varietal development is a very costly activity in terms of time, which may take up to 10 years. A seed company can invest in varietal development if it has qualified manpower and associated resources to invest in it. The ease of access to germplasm may be related to whether or not the company has its own research facilities and/or has access to public germplasm. Among seed companies in eastern and southern Africa, 36% and 60%of them, mostly large seed companies, carry out their own research. CBOs and NGOs mostly rely on public germplasm from the international research systems and NARO.

Seed companies with research facilities and NARO set breeding priorities in line with their corporate objectives. In eastern Africa, seed companies place priority on commercial value addition while those in southern Africa consider disease tolerance the top priority for both OPVs and hybrids (Table 9). NARO breeders, on the other hand, consider drought tolerance, pests and disease resistance and yield potential as their top three breeding priorities (Table 10). Whether the company manager is a breeder or not influenced the breeding priorities of the company. For instance, non-breeder managers consider yield potential, stress and quality enhancement as the three top priorities for an OPV whereas breeder managers consider quality enhancement as first priority, followed by yield and then diseases tolerance (Table 11). For hybrids, breeder managers consider similar goals as for OPVs while non-breeder managers consider earliness as the first priority followed by yield potential and then quality enhancement.

Table 9: Ranking of maize breeding goals of seed companies in eastern and southern Africa

	Eastern Africa		Southern Africa	
Breeding goal	OPVs	Hybrids	OPVs	Hybrids
Quality/commercial value addition	1	1	3	3
Disease/pest tolerance	2	2	1	1
Drought/stress tolerance	2	3	3	4
Yield improvement	3	2	2	2
Early maturing	4	4	4	6
Standability/lodging resistance	5	5	6	5
Other	6	6	5	7

Source: **DTMA seed sector survey, 2007/08**

Table 10: Ranking of maize breeding goals of NARO in eastern and southern Africa

	Eastern Africa		Southern Africa	
Breeding goal	OPVs	Hybrids	OPVs	Hybrids
Disease/pest tolerance	1	1	4	4
Drought/stress tolerance	2	2	1	1
Yield improvement	2	3	3	3
Early maturing	2	3	5	5
Quality/commercial value addition	3	4	2	2
Standability/lodging resistance	3	3	5	6
Other	3	5	6	7

Source: **DTMA seed sector survey, 2007/08**

Table 11: Ranking of maize breeding goals by company managers

	OPV		Hybrid	
	Non-breeder	Breeder	Non-breeder	Breeder
Yield improvement	1	2	2	2
Quality enhancement	3	1	3	1
Stress tolerance	2	4	5	4
Early maturity	5	5	1	6
Disease tolerance	4	3	4	3
Standability/lodging	6	6	6	5
Storability	-	8	7	7
Other	-	7	-	7

Source: **DTMA seed sector survey, 2007/08**

In 1996, CIMMYT introduced a drought tolerance breeding methodology based on managed drought screening to eastern and southern Africa. At the time of the study, less than a quarter of the breeding programs used this knowledge-intensive method (Figure 9). Instead, companies select for earliness or drought-escaping materials, and evaluate materials under low rainfall conditions which typically are quite unreliable for producing reproducible results. NARO breeders use managed drought at a somewhat higher rate (36%) in addition to earliness (35%), and evaluation under low rainfall (24%). This indicates that CIMMYT remains a main provider for drought tolerant germplasm in eastern and southern Africa.

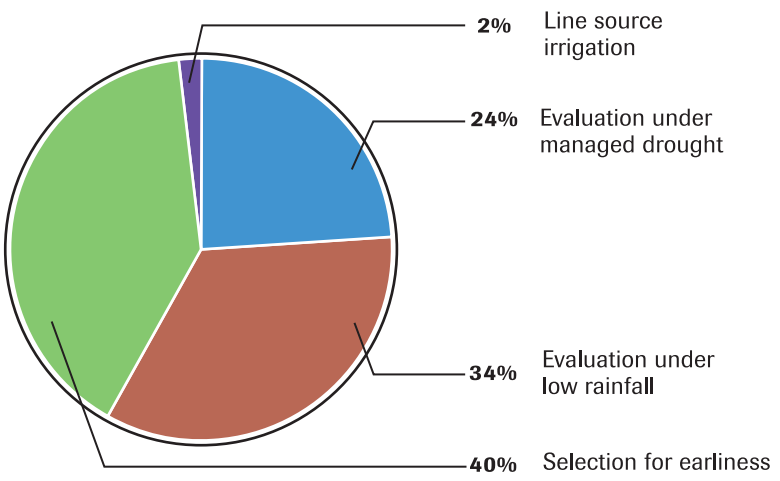

Figure 9: Drought screening methods mainly used by seed companies
Source: DTMA seed sector survey, 2007/08

To complement their breeding efforts, seed companies and NARO source public germplasm from CIMMYT and IITA, guided by their breeding priorities. Among companies in southern Africa, greater emphasis is placed on OPV (Table 12). Table 13 shows that the types of materials seed companies want when sourcing germplasm from CIMMYT and IITA are those that help them widen their genetic basis or product range (27%), have high yield potential (18%) and are tolerant to stress and pest/diseases (17% each). NARO, on their part seek materials that are tolerant to the major stresses (28%), help widen their genetic basis (26%), and are of high yield potential (14%). Breeders from seed companies and NAROs think it "very easy" or "easy" to access hybrids and OPVs from CIMMYT whereas some experience bottlenecks with accessing hybrids from IITA (Table 14). Those that find it difficult cite delayed delivery of materials as the main difficulty. It is somewhat of concern that more than half of the seed companies think it is difficult or very difficult to access germplasm from NARO.

Table 12: Proportion of CIMMYT and IITA germplasm used in breeding programs by public and private breeders (%)

	CIMMYT	IITA
Eastern Africa		
Proportion of OPV germplasm	53	37
Proportion of hybrid germplasm	52	13
Southern Africa		
Proportion of OPV germplasm	65	5
Proportion of hybrid germplasm	36	7

Source: DTMA seed sector survey, 2007/08

Table 13: Interest in CIMMYT and IITA germplasm

	Seed companies (%)	NARO breeders (%)
Widening genetic base, product range	27	26
High yield potential	18	14
Diseases and pests resistance	17	12
Improved nutritional qualities	12	11
Stress tolerance	24	45
Early maturity	7	4
Other	2	4

Source: DTMA seed sector survey, 2007/08

Table 14: Ease of access to germplasm from CIMMYT, IITA, and NARO by regional breeders

	CIMMYT		IITA		NARO	
Level of ease	OPV	Hybrids	OPV	Hybrids	OPV	Hybrids
Very easy	59	65	25	50	18	-
Easy	41	30	75	25	18	45
Difficult	-	5	-	25	45	36
Very difficult	-	-	-	-	18	18

Source: DTMA seed sector survey, 2007/08

The major weaknesses of the materials from CIMMYT and IITA are identified by seed companies and NARO as disease susceptibility, limited ecological adaptability, lack of nicking between male and female hybrid parents in some ecologies, and non-exclusivity of the inbred lines (Table 15). Many breeders in the public sector as well as regulatory bodies do not pay attention to the seed production aspect when developing and releasing varieties. At the end of the day, seed companies end up with very high yielding varieties which are very expensive to produce and hence attract high seed costs.

Some seed companies in eastern Africa, believe that the NARO are blocking their access to CIMMYT's germplasm or that NARO do not enter adequate numbers of suitable CIMMYT varieties in the variety release process to be able to meet the demand for public varieties by the seed industry. Bottlenecks in accessing NARO germplasm on the other hand are linked to inadequate numbers, NARO continuing to monopolize and often limit breeder and foundation seed production, and slow or non-transparent tender processes.

Table 15: Observed weaknesses in CIMMYT and IITA germplasm

	Seed companies	NARO
Limited ecological adaptability/seed production characteristics	21	33
Amount given is always limited	11	-
Poor information	7	-
Non-exclusivity of inbred lines	20	-
Poor grain quality	4	8
Susceptibility to diseases	37	58

Source: DTMA seed sector survey, 2007/08

Poor climatic conditions compound the problems of seed production, as in particular hybrid seed production under unreliable conditions is very risky. Access to irrigation facilities has the potential of mitigating drought risk but the majority of seed producers are unable to acquire them. Farmers in high rainfall areas may have more reliable production conditions, they however rarely have access to suitable drying facilities. If seed is harvested at high moisture content, both inadequate drying and storage may result in the deterioration of seed quality. Tractors and equipment are important for land preparation of larger production fields but not readily available to the majority of seed producers either because of high cost or limited land holdings to warrant the acquisition of the tractors. Another technical constraint to seed production is management of pests. Contract growers are expected to control field pests (eg stem borers) and seed companies prefer to contract farmers that have the means and knowledge to do so.

In summary, the lack of germplasm claim is more related to NARO germplasm than CG centers germplasm. Even if seed companies are licensed to market NARO germplasm, they are restrained by the lack of breeder and foundation seed as they cannot get the parental lines to produce the seed themselves.

4.2.2 Production technical constraints

The main technical constraints to seed production are (i) lack of production infrastructure, (ii) unfavorable land policies, (iii) poor climatic conditions, and (iv) field pests and diseases (Figure 10). As mentioned earlier, the first two bottlenecks result in significant competition by seed companies for contracting large-scale commercial farmers that either have favorable production conditions or access to irrigation. Contracting small-scale farmers typically results in higher production costs due to the problems noted in Section 4.2. Even if finances were available, existing land policies may not be conducive for seed companies acquiring large pieces of land for seed production.

4.2.3 Lack of access to production credit

Seed production is an expensive venture. Cash is needed to pay for the husbandry practices as well as processing the seed, especially when the producer does not own a processing plant. Purchase of seed from contract growers usually occurs some months prior to sales and requires significant cash resources to pay contract farmers. The selling period on the other hand is concentrated and seasonal (1-2 months). Whatever is not sold during that time period is costly stock unless it can be exported to countries with different planting periods. In the case of introducing a new variety, lead times can be up to four years for breeder, foundation, parental and certified seed production

As a result, seed companies require a robust and extended cash flow. Unfortunately, traditional lending institutions are unfamiliar with these investment portfolios and working capital needs of seed businesses. They view seed businesses as a higher risk than other trading businesses with shorter production and sales cycles. Therefore, seed companies hardly have access to production credit. In addition, inefficient variety release and seed certification schemes can unduly delay product lead times and export restrictions can force companies to greater stock holding. Both have negative implications for a seed company's establishment, viability and success. To the farmers, these costs materialize as higher seed prices or unavailability of seed.

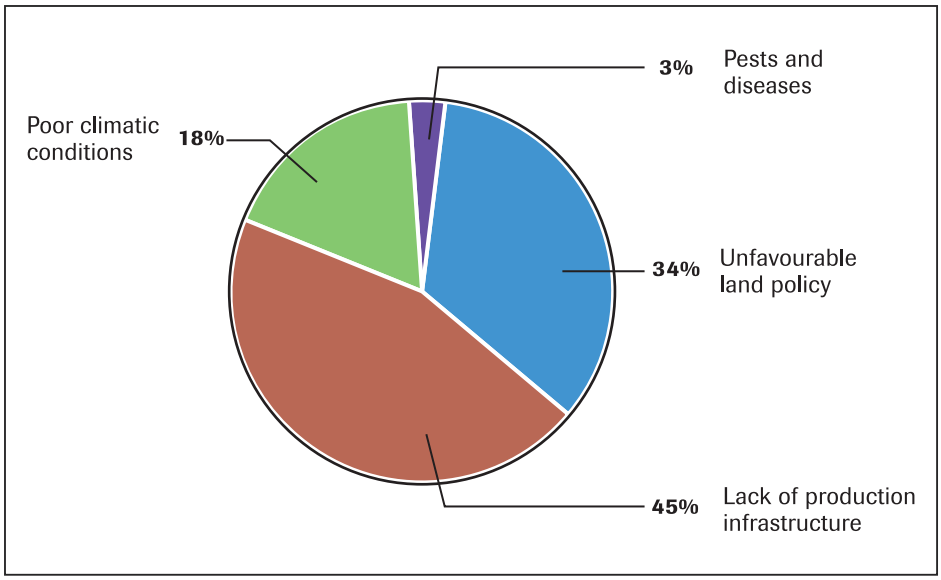

Figure 10: Production technical constraints to seed production in Africa
Source: DTMA seed sector survey, 2007/08

4.3 Seed marketing and distribution bottlenecks

After production, processing and certification, seed has to be sold to farmers who are widely dispersed and often distant from major cities in which seed companies are located. Most farmers grow small areas of maize and therefore buy small quantities of seed, therefore, no individual farmers or even group of farmers account for a significant proportion of a seed company's total sales (Krull et al., 1998). Poor transport infrastructure in rural areas, high transaction costs of dealing with many small distributors, and problems of establishing reliable credit systems with rural traders do not encourage companies to have widely distributed networks. Consequently, seed companies often maintain only a limited distribution network and sell the remainder of the seed through agro-dealers, NGOs, retail chain stores and government agents.

Seed companies pay more attention to farmers in the high and medium potential areas because those farmers tend to have relatively higher purchasing powers than their counterparts in the drought prone, low potential areas. The current seed deployment pattern suggests that only a quarter of all improved maize seed sold by seed companies goes to farmers in the low potential areas. CBOs and NGOs to a minor extent (given their scope) alleviate this problem by deploying 37% of their community-based seed production in lower potential areas (Figure 11)..

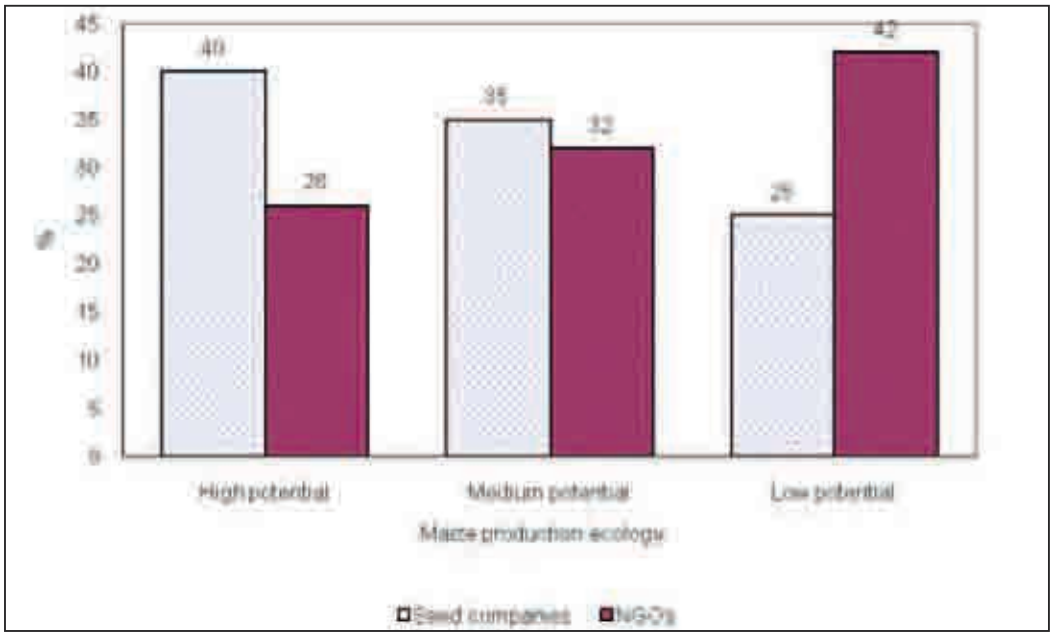

Figure 11: Deployment of improved seed to maize growing ecologies by seed provider in eastern and southern Africa
Source: DTMA seed sector survey, 2007/08

As shown in Figure 12, the two most important difficulties seed companies face distributing seed to farmers are poor infrastructure and seed delivery problems. These are discussed in detail below.

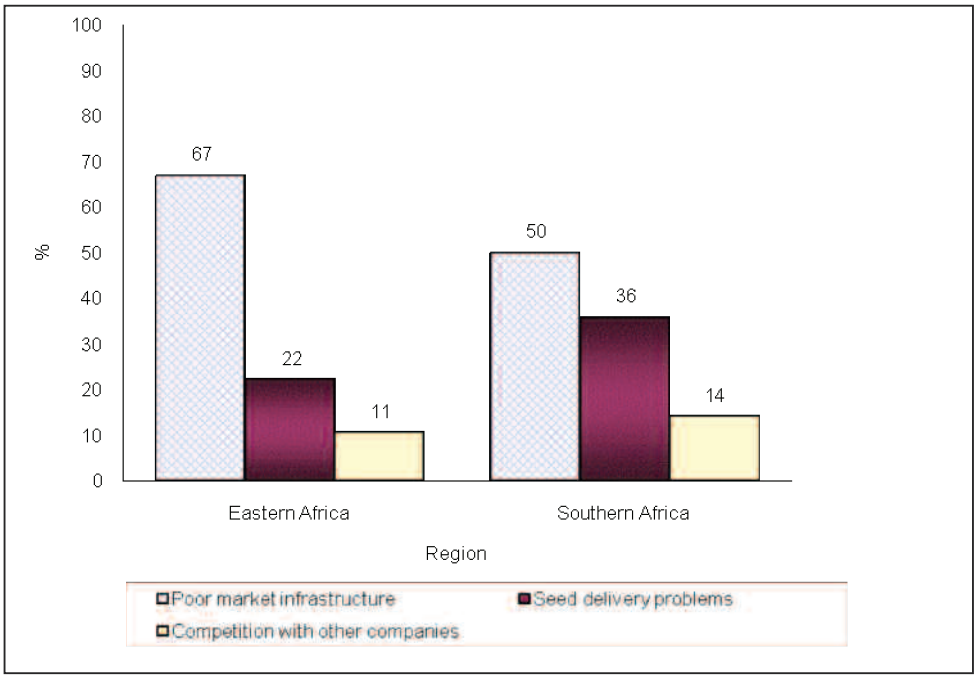

Figure 12: Marketing problems of seed companies in eastern and southern Africa
Source: DTMA seed sector survey, 2007/08

4.3.1 Poor market infrastructure

The principle factors that hinder the establishment of a dispersed and competitive distribution network are the poor market infrastructure such as poor road networks (45%) leading to limited access to transportation facilities (33%) and poorly established storage infrastructure (22%). Many farming communities are difficult to reach, especially during the rainy season when road conditions deteriorate. As a result of the bad roads, transport services are limited and drive up the cost of carting seed on those roads, which has implications for higher seed prices.

4.3.2 Seed delivery problems

With seed companies retailing a bulk of their seed through agro-dealers, large retail stores, NGOs and the government (Table 16), they encounter problems associated with the intermediary such as lack of credibility, poor storage, seed adulteration and lack of knowledge on varietal characteristics (Table 17). Seed companies cited instances when agro-dealers sold seed but failed to remit the proceeds. Some are also known to adulterate the seed with grain and repackage before selling thereby causing disloyalty among farmers for given brands of seed. Another problem with using agro-dealers (and sometimes government agents) is the lack of suitable storage facilities. Seed and chemicals may be stored side-by side, exposed to sun, heat or humid conditions for extended periods. These practices lead to reduced viability of the seed.

Table 16: Distribution of seed sales by seed companies through various retail outlets (%)

	Eastern Africa		Southern Africa	
Retail outlet	OPV	Hybrid	OPV	Hybrid
Own retail outlets	28	27	29	19
Wholesalers	15	15	8	10
Private retailers	28	51	8	42
Government	9	5	31	25
NGOs	20	3	25	5

Source: DTMA seed sector survey, 2007/08

Table 17: Challenges seed companies face in retailing seed through retailer agents

	Retail agent (%)			
Challenge	Wholesalers	Retailers	Government agents	NGOs
Lack of knowledge on varietal information	18	18	20	-
Poor storage facilities	9	28	20	5
Seed adulteration	10	9	-	5
Lack of credibility	31	22	27	64
Other	32	23	33	26

Source: DTMA seed sector survey, 2007/08

At the end of the marketing season, companies that deliver seed to retailers on consignment basis incur additional costs to collect unsold seed for storage and the seed may be returned with variable quality.
Seed companies face a challenge in seed production planning when selling seed through NGOs that rely on donors' support to finance their operations. These seed requests may be quite large and make a significant proportion of a company's potential sale but they are also unpredictable. Until funds are assured, no firm commitments can be made and forward contracting of seed production of suitable varieties is rarely practiced. Moreover, donors and hence NGOs change their priorities at very short notice which cannot sustain seed supply planning.

Problems associated with seed tender systems have been widely documented (Ravinder Reddy et al., 2006). While a successful tender may provide a lucrative opportunity for a seed company selling significant seed quantities at little dissemination costs, many NGO lack credibility at company and farm level because they may purchase low cost seed lots that either are adulterated or from obsolete stocks. Few countries are able to implement improved controls for dealing with such culprits.

4.4 Constraints limiting seed demand at the farm level

Farm level seed sales are known to be negatively influenced mainly by (i) low adoption rates, (ii) poor extension coverage, and (iii) difficulty in estimating seed demand (Figure 13). Inadequate purchase power due to drought, farmers' inability to purchase complementary inputs such as fertilizers, and inappropriate targeting of varieties to agro-ecologies (categorized as "other" in Figure 13) are also known to be important demand side constraints. To meet farmers' demand for specific seed types, seed companies need reliable seed demand estimates for better production planning. All seed companies interviewed agreed that it is a challenge for them to carry out such estimates and therefore may oversupply or undersupply certain geographic areas which results in costly stocks, losses or unavailability of seed that is in demand.
It is commonly observed that extension coverage in the region is very low thereby depriving farmers of access to

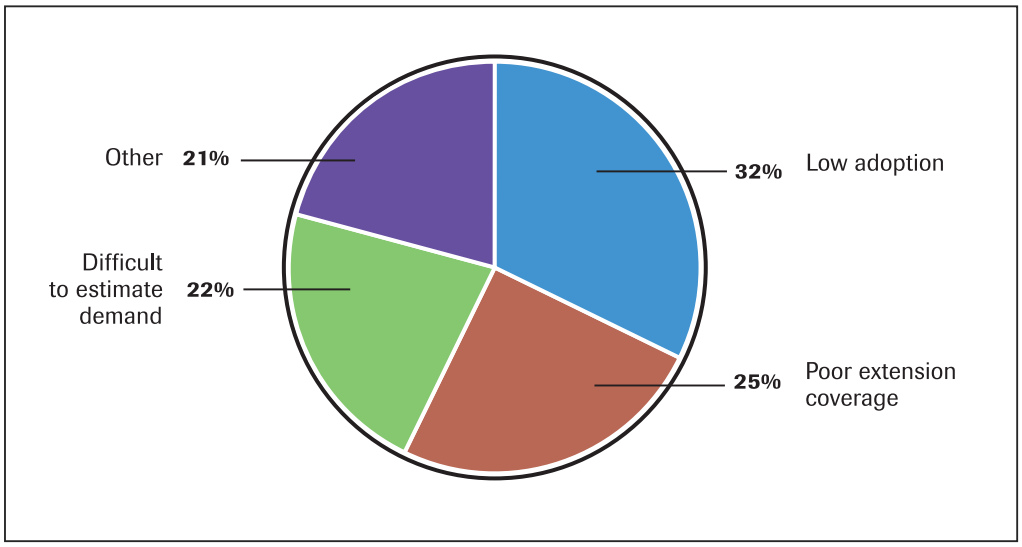

Figure 13: Bottlenecks influencing farm level seed demand
Source: DTMA seed sector survey, 2007/08

up to date extension education. Farmers are often not aware of the availability of new, improved varieties that can improve their productivity and have little basis for making informed decisions based on simple and transparent variety characterizations.

4.4.1 Perceived causes of low adoption rates of improved maize varieties among smallholder farmers

Seed providers attribute the observed low adoption rates of improved maize varieties to (i) lack of awareness of the availability and value of existing varieties, (ii) high relative price of seed because of poor and uncompetitive grain prices, (iii) farmers' reluctance to change from their old practices, (iv) lack of access to good quality seed, and (v) lack of credit, in that rank order (Table 18). It is believed that the majority of small holder farmers are unaware of the types of varieties on the market and/or the benefits they could derive from planting such varieties. For many seed providers, the lack of awareness stems from the fact that there seems to be numerous varieties released onto the market without adequate farmer education. Giving farmers options by putting on the market different varieties is a good idea but not when they bear unfamiliar names and the characteristics' details/information on them are scanty. Some of the seed retailers are not sufficiently knowledgeable about the characteristics of the seed they carry in their stores to be able to educate farmers when they visit their stores to buy seed.

It is also believed that some unscrupulous retailers engage in unethical advertising practices or selling of dyed grains under the name of known and trusted genuine varieties at cheap prices. By doing so, they not only cheat farmers but also permanently damage the loyalty farmers have built for the variety over the years.
Market imperfections can cause misalignment of seed and grain prices and can be caused both by lack of competitive market situations or interference by policy makers. In many countries, grain prices collapse after harvest due to local surplus situations making investments in seed and fertilizer unattractive. In some instances, policy makers attempt to improve the welfare of consumers by imposing price ceilings on outputs as part of their market reforms strategy without considering its negative impact on farmers' input use. Also, seed prices can be kept artificially high by not allowing more players to enter seed markets due to slow registration or certification processes and import/export restrictions or delays. In the same country, seed: grain price ratios can vary considerably as shown in Figure 24 for Malawi.

In the opinion of seed companies' representatives interviewed, the adoption rate among farmers can be improved through enhanced extension message delivery (46%), subsidy on inputs (21%), improved access to credit (12%), improved grain markets (11%) and improved retail outlets (11%).

Table 18: Ranking of low adoption rates by farmers as perceived by seed providers

	Eastern Africa		Southern Africa		
Variable	Seed companies	NGOs	Seed companies	NGOs	Overall rank
Lack of awareness	1	1	2	1	1
High relative price seed	2	1	1	2	2
Poor grain markets	3	3	3	3	3
Reluctance to change	5	2	3	4	4
Lack of access to quality seed	4	2	3	6	5
Lack of access to credit	5	4	4	5	6

Source: DTMA seed sector survey, 2007/08

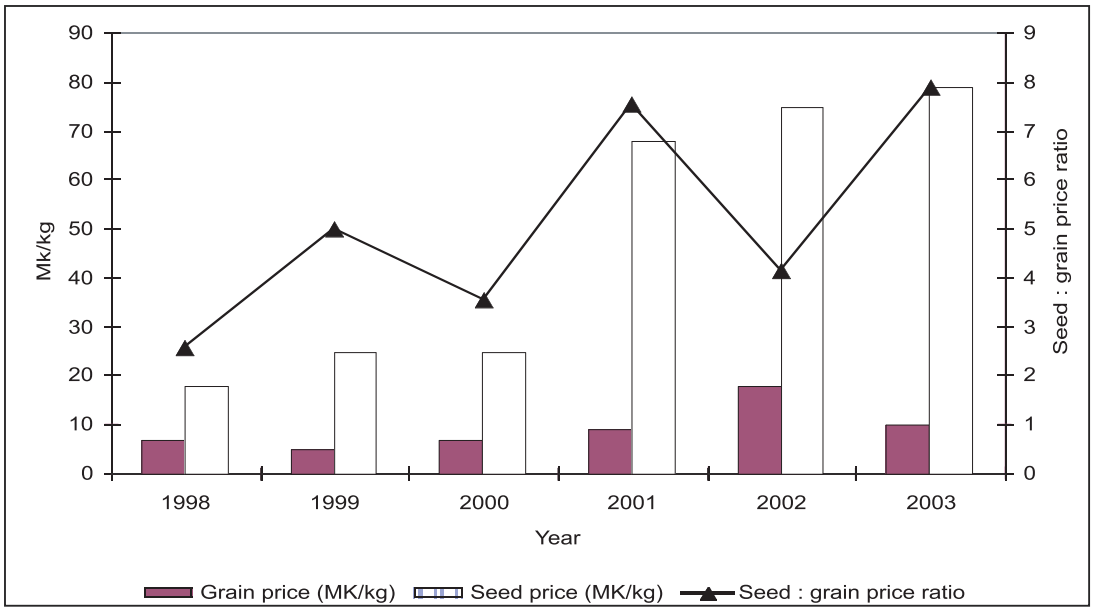

Figure 14: Seed – grain price differences in Malawi
Source: DTMA seed sector survey, 2007/08

4.5 Policy related bottlenecks affecting seed production and deployment

The maize seed industry in Africa often receives special attention from policy makers given the importance of seed as a key technology component (Tripp, 1998). One such intervention is the relaxation of restrictions on participation in the seed industry in recent times leading to the active private sector participation in the industry. To regulate the seed industry, various governments have instituted variety registration and seed certification laws ostensibly to control the genetic and physical purity of commercial seed sold on the market. However, few countries have comprehensive and functioning legislation that facilitate the development of the seed sector (Tripp and Rohrbach, 2001). The lack of plant variety protection (PVP) legislation in many countries is viewed by most seed companies as a major obstacle to expanding seed businesses for fear of losing control of their genetic resources. This is particularly the case with self-pollinated crops and hybrid maize seed production. Seed certification standards are not equivalent in all countries in Africa, and only a few countries have ISTA accreditation, which often impedes seed trade amongst nations. Strict government regulations on the other hand may act as a disincentive for the emergence of a commercial seed sector.

The major bottlenecks of the seed policy environment known to impede seed sector development include (i) unfavorable seed policies, (ii) lengthy variety release procedures, and (iii) controlled seed markets through price fixing by governments (Figure 15). Looking at the policy constraints from the perspective of the size of the seed company, Figure 16 suggests that a large seed companies are more concerned than small ones about unfavourable seed policies, possibly because they may interfere with import/export decisions. In contrast, small companies are concerned about lengthy variety release processes.

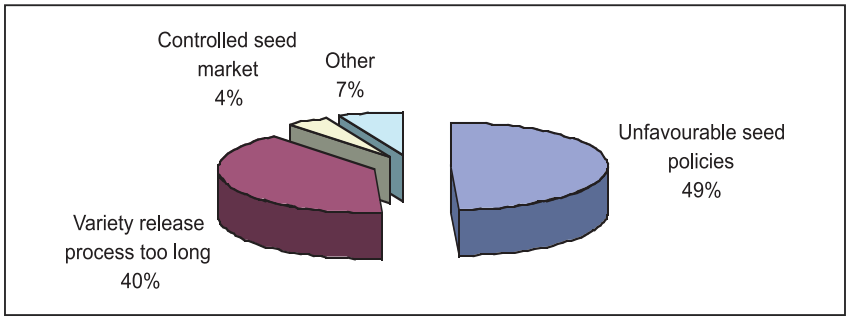

Figure 15: The major seed policy related bottlenecks hindering the production and distribution of seed in Africa
Source: DTMA seed sector survey, 2007/08

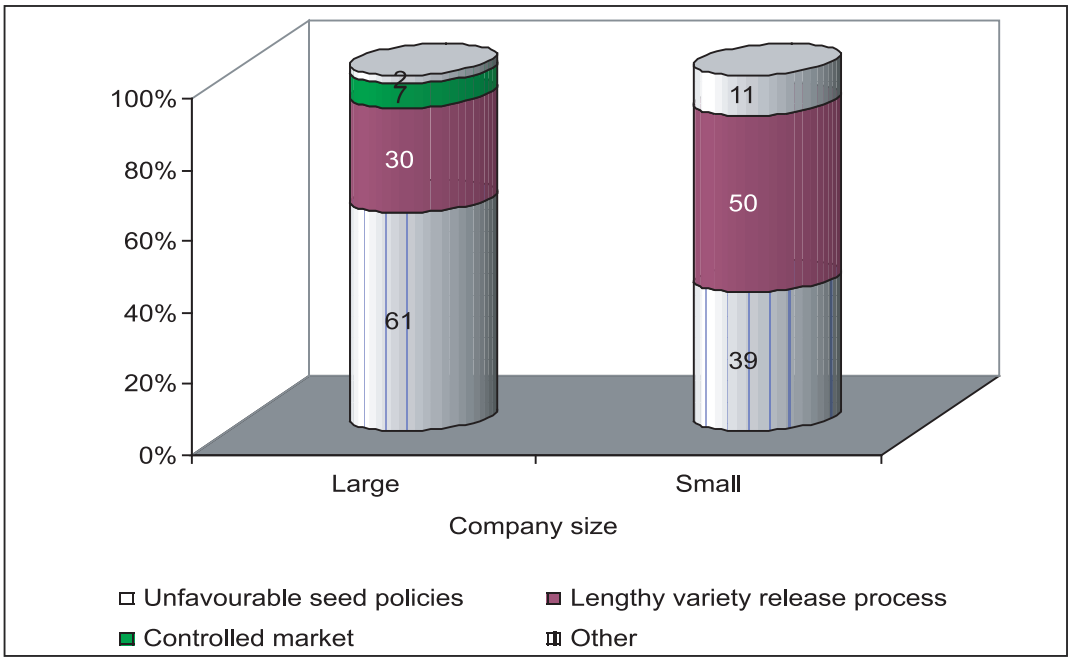

Figure 16: Seed policy constraints as perceived by small and large companies
Source: DTMA seed sector survey, 2007/08

The main elements of unfavorable seed policies include taxation, import and export restrictions. In general, importation of seed can be cumbersome and lengthy in the region. To illustrate the point, in Tanzania, importing less than 3 t (or about US$5,000 worth) of seed takes about a week but can go up to five weeks if more than 3 t are imported. Another example is, when a country is not Organization for Economic Co-operation and Development (OECD) accredited, it cannot export seed to an OECD accredited country without the seed being inspected by certification staff of the importing country (Table 19).

The time it takes to release a new variety is sometimes too long. In South Africa where the seed sector is well developed, it takes a maximum of two years to release a variety compared to significantly longer time periods in eastern and southern African countries (Table 20). Variety registration procedures can be lengthy and sufficiently cumbersome for only a few companies being able to do it in the minimum time period. In Kenya, with its very elaborate regulatory framework, new varieties take de-facto the longest to get released and reach farmers' fields, an indication that regulation has become highly detrimental to technology deployment to farmers. In some countries (e.g. Uganda), companies are not allowed to bulk when registration is still in the process thereby delaying deployment to farmers after the variety has been released. These delays have implications for costs to the farmer and the seed company.

Table 19: Current status of seed control legislation in eastern and southern Africa

	Seed control legislation				
	Seed Act	Plant Variety Protection	Variety Registration	ISTA Accreditation	OECD accreditation
Eastern Africa					
Ethiopia	No	Yes	Yes	No	No
Kenya	Yes	Yes	Yes	Yes	Yes
Tanzania	Yes	Yes	Yes	No	No
Uganda	No	No	Yes	No	No
Southern Africa					
Angola	Yes	No	Yes	No	No
Malawi	Yes	No	Yes	Yes	Yes
Mozambique	Yes	Yes	Yes	No	No
South Africa	Yes	Yes	Yes	Yes	Yes
Zambia	Yes	Yes	Yes	Yes	Yes
Zimbabwe	Yes	Yes	Yes	Yes	Yes

Source: DTMA seed sector survey, 2007/08

Table 20: Length of seed release process in selected countries

	Actual time to seed release (years)			Time from release to time significant quantities of seed is available (years)		
Country	Mean	Minimum	Maximum	Mean	Minimum	Maximum
Kenya	3.1	1.5	6.0	2.4	0.0	9.0
Malawi	3.0	2.0	7.0	1.9	0.5	3.0
Tanzania	2.2	1.0	3.0	2.0	1.0	3.5
Uganda	2.2	1.0	4.0	2.1	1.0	4.0
Zambia	2.1	1.0	3.5	2.5	2.0	3.0
Zimbabwe	2.2	1.0	3.0	2.4	1.5	4.0
South Africa	2.0	2.0	2.0	2.5	2.0	3.0

Source: DTMA seed sector survey, 2007/08

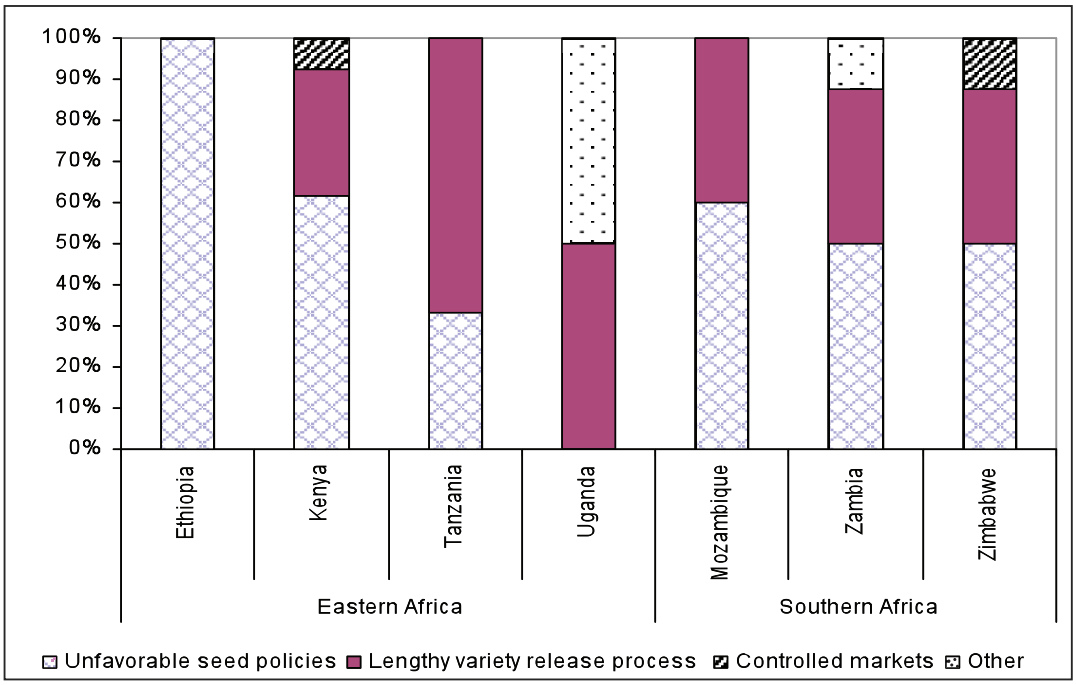

Figure 17: Major seed policy related bottlenecks hindering the development of the seed sector in Africa
Source: DTMA seed sector survey, 2007/08

The significance of policy problems are viewed differently at the country level. In Ethiopia, seed companies are mostly concerned about unfavorable seed policies but not so much about the lengthy process of releasing varieties, possibly because all seed companies except the Ethiopian Seed Enterprise do not even test varieties (Figure 17). Seed companies in Kenya, Tanzania and Uganda consider lengthy seed release process to be a highly important bottleneck. Seed companies in Mozambique, Zambia and Zimbabwe are more concerned about unfavorable seed policies than lengthy variety release processes.

5. Factors affecting the deployment of newly released varieties

This section discusses bottlenecks that impede the deployment of newly released maize varieties in the region. The key bottlenecks believed to hinder the rapid deployment of a newly released maize variety are tabulated in Table 21. In eastern Africa, the 3 most important bottlenecks hindering the rapid deployment of a new variety are lack of awareness of the new variety by farmers, shortage of foundation seed for bulking and suitability of the variety for the various agro-ecologies. The first 2 bottlenecks are similar for southern Africa but poor retail networks and inaccessibility of farmers rank third. Lack of awareness is ascribed to poor promotional activities by weak extension service in the region. Small-scale seed companies in particular are also unable to mount widespread demonstrations of a new variety and hence very few farmers get to know about such varieties when they are released.

Except in countries where a minimum amount of breeder and foundation seed is a prerequisite for variety release, scaling up of breeder and foundation seed is typically delayed until a variety has been accepted for release. This can put several years between variety release and large-scale availability to farmers. Those relying on public sector production of breeder and foundation seed are often hampered by low public seed production capacities and lack of effective contracting agreements. In many instances, scale-up of seed production may be greater if companies were given the right to produce breeder and foundation seed themselves given that they have an vested interest to succeed.

Table 21: Bottlenecks impeding the rapid deployment of new varieties to farmers in selected countries in eastern Africa

	Eastern Africa					Southern Africa					
	Ethiopia	Kenya	Tanzania	Uganda	Regional average	Angola	Malawi	Mozambique	Zambia	Zimbabwe	Regional average
Bottlenecks to rapid deployment of new variety (%)											
Lack of awareness	44	16	39	36	34	13	47	44	24	19	29
Shortage of foundation seed	19	31	8	32	22	38	-	6	29	17	22
Suitability of germplasm	26	6	8	16	14	13	24	11	10	10	13
Poor retail network	-	10	10	12	11	-	18	17	-	12	15
High price of seed	-	12	8	-	10	-	-	-	5	19	12
Reluctance to change	4	16	8	-	9	13	6	11	-	2	8
Limited resources	4	8	10	4	6	-	6	6	14	12	9
Farmers inaccessible	4	2	10	-	5	25	-	6	19	10	15
Bottlenecks to deployment of large quantities of new variety (%)											
Shortage of foundation seed	40	13	42	48	36	43	26	40	6	30	29
Suitability of germplasm	13	32	33	33	28	-	4	30	38	33	26
Lack of awareness	33	13	9	5	15	14	22	10	13	28	17
Un-conducive economy	-	23	9	10	14	-	17	10	-	2	10
Poor retail network	7	10	-	-	8	-	17	10	13	-	13
High price of seed	7	-	-	-	7	-	4		19	2	8
Farmers inaccessible	-	7	6	5	6	29	9	-	-	5	14
Farmers reluctance to change	-	3	-	-	3	14	-	-	13	-	13

Source: DTMA seed sector survey, 2007/08

At the country levels, lack of awareness ranks first in Ethiopia, Tanzania, Uganda, Malawi, Mozambique and Zimbabwe, second in Kenya and Zambia and third in Angola. The deployment speed will relate to ecologies that the given variety is meant to satisfy. If the variety fits an ecology that is far removed from the operational areas of the respective seed company, deployment will be slow. In Ethiopia, Uganda, Malawi, Mozambique Zambia and Zimbabwe, unsuitability of the released variety for given ecologies is among the top three bottlenecks. Regarding the deployment of large volumes of a newly released variety, (i) shortage of foundation seed (ii) suitability of the variety for given ecologies, and (iii) lack of awareness are among the top three important bottlenecks in both eastern and southern Africa (Table 21). In Kenya, Zambia and Zimbabwe where seed companies have well established research facilities, shortage of foundation seed is not the top ranking bottleneck. Rather, variety adaptation to particular ecologies limits the quantity of seed produced and deployed. For instance a variety meant for the marginal areas with limited retail outlets and inhabited by farmers with relatively low purchasing powers will not be produced in large volumes. CBOs/NGOs, on the other hand, will be willing to promote such varieties but are often constrained by inadequate access to foundation seed. Inaccessibility to farmers is a problem of seed deployment in all countries especially in Angola.

In order for seed companies to expand seed sales, a number of interventions are necessary as listed in Table 22. Improving farmers' access to credit is the overriding priority in the whole region. In eastern Africa building capacity within the NARO to support seed related activities and increased supply of foundation seed are the second and third most important interventions necessary to expand seed sales, in southern Africa, improved rural infrastructure and extension support are key.

Table 22: Strategies to help expand seed sales in Africa

	Eastern Africa	Southern Africa	Regional average
Improve farmers' access to credit	26	37	32
Capacity building for production	18	9	14
Increased quantity of foundation/basic seed	15	1	8
Extension support to create awareness	11	13	12
Improvement in infrastructure	10	20	15
Improve grain markets	7	1	4
Provide exclusivity of varieties	5	3	4
Other	8	17	13

Source: DTMA seed sector survey, 2007/08

6. Policy implications of the results

Improving maize productivity has the potential of enhancing the livelihoods of farm households in Africa because of the dominant role the crop plays in their cropping systems and calorie intake. This can be achieved partly through the adoption of improved, high yielding maize varieties. Within the region, a number of seed companies, CBOs/NGOs and NARO produce and deploy seed to farmers. Nonetheless, more than half of the maize area (or 6.7 million ha) is still planted to grain recycled as seed and unimproved maize varieties.
Results from this seed sector survey conducted during 2007/08 identified a number of institutional bottlenecks that affect the following components of the maize seed value chain: (1) the establishment and operation of a seed production unit, (2) seed production and processing, (3) seed marketing and distribution, (4) seed demand, and (5) seed policy environment. The bottlenecks have differential impacts on the value chain depending on the country in question and the type of seed company, whether large or small, established or emerging, national or multinational. This is manifested in the quantities of seed produced and marketed in the countries examined in this study. Based on the results of the survey the following policy interventions are proposed to help address critical bottlenecks at the institutional level so as to increase the production and deployment of improved, high yielding maize varieties in eastern and southern Africa.

6.1 Facilitating the establishment and operation of seed companies

Over 91% of certified OPV and almost all certified hybrid seed is supplied by registered maize seed companies with government community-based organizations only producing small amounts of improved seed. Therefore, much of the proposals here will concern the facilitated establishment and operation of seed companies. The data so far gathered suggest that the number of seed companies vary from 4 in Angola to 14 in Tanzania and Mozambique. The majority of them are emerging companies. The annual average production per company varies from 240 t in Mozambique to 3,000 t in Zimbabwe. Consequently, a huge capacity of potential seed demand is not met by the existing companies.

To improve competition in the seed sector and hence better serve farmers, it is imperative to support the establishment of new companies, especially in countries where few companies exist, and to increase the success rate and growth of new companies. Establishing and running a seed company can be limited by (a) high investment costs, (b) lack of qualified manpower, and (c) lack of access to operational credit. It is recommended that governments and donors should be encouraged to provide entrepreneurs with long-term investment capital to start new companies and/or run existing ones. There is also the need for financial institutions to appreciate the investment profile of seed companies and support them to finance their operations at reasonable loan rates. This has to start with seed companies providing high quality business plans and hire qualified personnel to demonstrate their economic viabilities. Public sector engagement in providing applied long- and short-term training of seed companies' staff in all aspects of a seed business (research, production, marketing, business management) is important for rapidly increasing the success rate of new companies. A long-term goal of seed companies should be to work towards better remuneration and recognition of staff to reduce or minimize staff attrition.

6.2 Maintaining efficient seed production and processing programs

Increasing average production levels of seed companies to from 1,400 t to at least 2,000 t a year will decrease the number of additional seed companies required by about 70% in the region. For instance, in Mozambique, only 14 additional companies will be needed instead of 114 at current seed production volumes. In Tanzania the number will decrease from 63 to 27 and in Angola from 56 to 9. In this way, the overall need for investment capital to set up new seed companies will be reduced considerably. Technically, productivity increase would require a combination of any of the following:

(1) **Access to appropriate and adapted stress tolerant maize germplasm:** Seed companies will seek to acquire public germplasm if they do not have access to suitable germplasm needed to service their target markets. NARO and CG centers need to make their germplasm distribution policies better known and transparent to seed companies. NARO are requested to increase the number of varieties tested so to increase the number of produceable and release maize varieties that are available to the private seed sector. Seed companies, on their part, should be more open to cross-licensing of germplasm (especially to community-based seed production schemes). Governments should implement faster tender processes for public germplasm.

(2) **Production of seed in areas with reliable rainfall or investment in irrigation facilities to minimize drought risk:** Land use and land policies in some countries prevent seed companies from accessing suitable lands for seed production. Land reforms that facilitate seed production in larger fields, allow isolation and good productivity level will both increase seed production and lower seed costs significantly as transaction costs and the frequency of production failure are being reduced. Financing of the acquisition of irrigation, drying and processing facilities can boost the reliability and quality of seed production.

(3) **Facilitating breeder and foundation seed production:** Foundation seed production in countries such as Angola, Ethiopia and Tanzania should be liberalized and companies enabled to manage or contract their own breeder and foundation seed production. Emerging seed companies and CBOs/NGOs rely solely on seed companies with research facilities as well as NARO and international research centers for their foundation seed so ways that will facilitate their access to foundation seed should be pursued.

(4) **Education and training of contract growers in improved crop management:** Seed production is a specialized activity and poor seed crop management can lead to huge losses through rejection by the certification authorities. Building up a country's number and qualification of contract growers through public and private partnerships for regular in-service training in good seed crop management practices, growers' associations and accreditation schemes are at the core of increased quality seed production.

(5) **Increased access to production inputs at affordable prices:** Access to inputs at affordable prices can encourage the production of good quality seed at low cost and subsequent sale at affordable prices to farmers. Therefore smart subsidies could be given to registered seed growers.

(6) **Access to production credit:** Maintaining breeding lines, financing seed production and processing are very expensive cost outlays requiring credit lines. Traditional lending institutions are often reluctant to provide credit for agricultural activities including seed production. While making the effort to increase the awareness of traditional lending institutions on the need to support seed companies through demonstration of the economic viability of such operations, it is imperative to identify non-traditional financiers, e.g., donors interested in supporting rural development initiatives to provide soft loans to companies for seed production. With credit facilities, plant and machinery necessary for seed production and processing as well as inputs could be pre-financed to enhance seed production and distribution.

Seed companies encounter significant risks due to production failure under rain-fed conditions and variable demands due to droughts, variable grain prices and government policies. These risks are much greater within a particular country and for a particular company than across the continent, indicating that an appropriate insurance system could decrease the risk and increase the credit- worthiness of seed companies.

6.3 Improving seed marketing and distribution

A large proportion of the seed is marketed through agro-dealers. However, most of the agro-dealers lack the capital to stock the seed especially when seed companies do not provide credit or consignment stock. They also lack knowledge on the characteristics of the seed they sell to be able to educate farmers who visit their shops. Therefore, providing credit and training to existing retailers on varietal characteristics and good seed handling practices will boost seed sales and encourage more entrants into the seed retailing business thereby widening the seed retail networks.

6.4 Enhancing farmers' demand for improved maize seed

The adoption rate of improved maize varieties among smallholder farmers will improve through (i) enhanced extension message delivery, (ii) targeted subsidy on inputs, (iii) improved access to credit, (iv) improved grain markets, and (v) improved retail networks. Farmers need information on the nature and types of varieties as well as the economic benefits that can be obtained from planting appropriate improved varieties. Some of the seed packs carry limited information to allow farmers to make informed decisions. Some seed companies attempt to simplify this information gap by labeling varieties with symbols that depict the maturity group of the variety, e.g. SeedCo Ltd uses an elephant to symbolize a variety that is long maturing and a zebra for an early maturing variety. Simple and reliable information delivered on seed packs and through the media will facilitate marketing

of new varieties. Given weak extension systems, seed companies need to likely increase their investment in extension message delivery, through improved information and the development of a reliable retail network and clientele base in distinct focal areas where their varieties prove to be adapted and profitable to farmers and where field demonstrations can be mounted in collaboration with public extension and NGOs.

Farmers buy seed to produce an output. If their returns on investment in seed are not encouraging they will be reluctant to invest in the future. Efforts to make the maize value chain profitable at farm and national level are interrelated with improved seed use and can be supported with direct, smart subsidies on inputs, facilitating farmers' access to credit, and supporting a diverse seed industry.

6.5 Reforming seed policies and regulations

A number of policy reforms will support seed sector growth and increase seed availability

(1) **Strengthening internal seed laws and regulations:** To police fake seed and protect genuine seed producers and farmers, national seed laws should be strengthened. Most countries lack the legislative framework to deal with culprits. Where such frameworks exist, they seem outdated and penalties imposed do not seem to be punitive enough to deter others and should therefore be revised.

(2) **Avoiding undue delays in the release of new varieties:** Actual time to variety release should take no longer than two years and if most varieties take longer to pass through the process, there is indication that the overall approach is too bureaucratic and contra-productive to its purpose. Faster variety release can be achieved by adopting the following: (1) implementation of regional seed laws and regulations – they have been extensively discussed, in some instances approved, but they may not be implemented (2) the distinctiveness, uniformity and stability (DUS) tests should be carried out alongside (and not subsequently) to national performance trials (NPT), (3) use of breeders' data to support variety release with minimal need for NPTs – second year testing in NPTs should only be conducted if first year data contradict the breeders' data, (4) variety release criteria should be updated to take into account varieties with special traits including stress tolerance/resistance traits, nutritional traits, specialty maizes, varieties with lower seed production costs, (5) between public and private sector actors, device and enforce an agreed upon roadmap that enable rapid variety release and scale up of seed production at reasonable costs. This includes procedures that allow breeder and foundation seed production in parallel to variety release.

(3) **Facilitating access to public germplasm:** To promote branding and increased investment in advertising, it is important to grant exclusivity for public germplasm to seed companies through transparent tender processes. Seed companies should be empowered to manage or contract their own breeder and foundation seed production of public varieties.

(4) **Regional seed laws and regulations:** For rapid spillovers of varieties released in one country to similar agro-ecologies in different countries, the implementation of regional seed laws and regulations should be expedited. Regional seed laws and markets can lead to a drastic reduction in the time lag between the release of a variety in one country and its access by farmers in similar agro-ecology in other countries, more rapid seed availability of new varieties, and lower seed costs due to more competitive markets. Seed movement across borders should be facilitated within regions with similar phytosanitary requirements.

(5) **Promoting seed production at the community levels:** In countries such as Kenya and Zimbabwe where policies prohibit the sale of non-certified seed, NGOs are unable to facilitate the formation of CBOs. In the interest of service to the poor and marginalized farmers, CBOs should be allowed to produce seed under some minimal control and sell as "quality declared" or "truthful labeling" to farmers at least within the communities in which the seed is being produced. CBO schemes should progressively be linked to seed companies to overcome constraints associated with isolation distances, quality assurance, distribution, and marketing of seed.

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Appendix 1

Maize production in selected countries in Africa (1990 – 2005 Average)

	Area (x 1000 ha)	Production (x 1000 tons)	Yield (tons/ha)
Southern Africa	***9,265.20***	***14,780.80***	***1.595***
South Africa	3,777.5	9,097.8	2.408
Malawi	1,368.7	1,638.4	1.197
Zimbabwe	1,307.3	1,455.5	1.113
Zambia	595.4	941.5	1.581
Mozambique	1,114.9	917.5	0.823
Angola	777.3	401.6	0.517
Madagascar	186.3	193.4	1.038
Swaziland	65.3	96.7	1.480
Namibia	29.4	29.3	0.998
Botswana	43.1	9.1	0.211
Eastern Africa	***7,656.20***	***9,726.40***	***1.270***
Tanzania	2,211.9	2,645.6	1.196
Kenya	1,496.4	2,481.9	1.659
Ethiopia	1,645.1	2,256.6	1.372
Dem Republic of Congo	1,407.4	1,128.9	0.802
Uganda	593.7	931.6	1.569
Burundi	116.1	141.0	1.214
Rwanda	82.2	79.8	0.970
Sudan	76.6	46.9	0.613
Eritrea	18.3	7.1	0.387
Congo, Republic of	8.5	7.0	0.819
Western/central Africa	***7,444.50***	***9,877.10***	***1.327***
Nigeria	4,232.3	5,586.6	1.320
Ghana	685.6	1,010.6	1.474
Cameroon	384.9	710.9	1.847
Benin	580.6	631.8	1.088
Côte d'Ivoire	465.3	592.2	1.273
Burkina Faso	274.4	430.3	1.568
Togo	376.0	408.6	1.087
Senegal	101.9	152.0	1.491
Chad	107.1	98.4	0.919
Guinea	84.9	89.5	1.054
Central African Republic	90.0	83.8	0.931
Gabon	16.3	26.8	1.640
Gambia	14.7	19.8	1.340
Guinea-Bissau	15.8	19.4	1.227
Sierra Leone	10.3	13.4	1.297
Niger	4.4	3.0	0.694
Total/average	24,365.7	34,384.1	1.173

Sources: FAOSTAT (2007); DTMA seed sector survey, 2007/08

Appendix 2

List of seed companies interviewed

	Company	National	Regional	Multinational
1	Seed Company Limited			
2	Pannar			
3	Monsanto Limited			
4	Pioneer Hi-brid			
5	Ethiopian Seed Enterprise			
6	Hadia Seeds			
7	Coffee Plantation Development			
8	Kenya Seed Company			
9	Western Seed Company			
10	Lagrotech Seed Company			
11	FRESHCO International Limited			
12	East African Seed Company			
13	Limited			
14	Leldet			
15	Oil Crop Development			
16	Zanobia Seeds			
17	Alpha Seed Company			
18	Kibo Seed Company			
19	Fica seeds Limited			
20	SATEC Limited			
21	Tanseed International Limited			
22	Mbegu Technologies			
23	Mount Meru Seeds			
24	Bytrade Limited			
25	Mountt Elgon Seed Company			
26	Victoria Seeds Limited			
27	NASECO			
28	LAUSSENA			
29	Mundo Verde			
30	ZUM Seeds			
31	Qualita			
32	Agro Alfa			
33	AgriFocus			
34	Agrotech			
35	Dengo commercial			
36	Semente Perfeita			
37	SEMOC			
38	Zambia Seeds			
39	Maize Research Institute			
40	Prime Agricenter			
41	Kamanos Seeds Limited.			
42	National Tested Seeds			
43	Agric. Seeds and Services			
44	Prime Seeds			
45	Pristine Seeds			
46	Nhimbe Seeds			
47	Agpy			

Source: DTMA seed sector survey, 2007/08

Appendix 3

Bottlenecks to seed production and distribution in eastern and southern Africa

	Ethiopia	Kenya	Tanzania	Uganda	Angola	Malawi	Mozambique	Zambia	Zimbabwe
Organizational establishment	**14**	**15**	**24**	**25**	**20**	**12**	**15**	**12**	**25**
High initial investment cost	6	8	7	6	5	12	6	6	10
Lack of qualified manpower	4	5	10	10	10	0	3	6	5
No credit facility	4	2	7	9	5	0	6	0	10
Seed policy environment	**9**	**30**	**14**	**15**	**15**	**8**	**12**	**28**	**26**
Unfavorable seed policies	9	18	5	3	5	8	6	16	19
Licensing process too long	0	9	9	6	5	0	6	9	7
Controlled seed markets	0	3	0	6	5	0	0	3	0
Seed production	**58**	**26**	**33**	**29**	**40**	**40**	**36**	**34**	**25**
Access to suitable germplasm	22	9	12	9	5	12	6	19	7
Production constraints	20	11	12	11	20	20	14	9	12
Access to production credit	6	3	5	3	15	4	16	3	2
Not OECD accredited	4	3	1	6	0	0	0	3	2
Poor quality germplasm	6	0	3	0	0	4	0	0	2
Seed marketing	**6**	**8**	**12**	**20**	**15**	**19**	**16**	**12**	**17**
Poor infrastructure	6	8	8	14	10	6	8	12	9
Seed marketing problems	0	0	4	6	5	13	8	0	8
Farm level demand	**13**	**21**	**17**	**11**	**10**	**21**	**21**	**14**	**7**
Low adoption rate by farmers	0	8	7	3	0	8	9	2	3
Poor extension coverage	0	8	5	3	5	0	3	3	2
High seed prices	2	0	3	3	0	0	3	0	0
Difficult to estimate local Demand	6	0	2	2	0	9	3	3	0
Other	5	5	0	0	5	4	3	6	2

Source: DTMA seed sector survey, 2007/08

Appendix 4

	Ethiopia	Kenya	Tanzania	Uganda	Angola	Malawi	que	Zambia	Zimbabwe	
1	AMH 800	DK8031	DH01	DK 8031	CM-1	30G97	Changa	GV 412	MMV 600	ZS 255
2	BH-541	DK8053	DH04	DK 8051	Dente cavalo	30H83	Changalane	GV 470	PAN 473	ZS 108
3	BH-542	DK8073	DK 8031	DK 8071	MA-1	DK 8051	Manica	GV 512	PAN 6549	ZS 421
4	BH-543	KA500-31A	DK 8051	H 513	Matuba	DK 8071	MATUBA	GV 659	PGS 53	ZS 521
5	BH-670	KA600-16A	DK 8053	H 614	SAM	DK8031	PAN 413	GV 704	PGS 61	ZS 259
6	CM-1	KDV3	DK 8071	H 623	SAM-4	DK8033	PAN 6243	GV 722	PGS 71	ZS 261
7	Dente cavalo	KDV4	DK 8073	H 624	ZM421	DK8073	PAN 67	HR 1421	PHB 30B50	PAN 14
8	Gambela comp	KDV6	H 513	H 625	ZM521	H 628	SC 407	HR 1455	PHB 30G19	PAN 53
9	Gibe-1	KH600-15A	H 515	H 625	ZM621	NSCM41	SC 513	HR 1455	PHB 30G97	PAN 5303
10	Horra	KH600-21A	H 625	H 626		SC 403	Sussuma	HR 1514	PHB 30H83	PAN 6243
11	MA-1	Lagrotech early	H 628	H 627		SC 407		HR 1534	PHB 30V53	PAN 6363
12	Matuba	LH1	H 628	Katumani		SC 513		HR 1594	ZM 421	PAN 6479
13	Melkassa-1	LH2	Kalima	Longe 1		SC 621		HR 1600	ZM 521	PAN 67
14	Melkassa-2	LH3	Katumani	Longe 2H		SC 627		HR 1614	ZS 108	PAN 6777
15	Melkassa-3	Masemo Double Cobber	Kito	Longe 3H		SC 709		HR 1624	ZS 255	PAN 8M-95
16	Melkassa-4	PAN 15	Lishe	Longe 4		SC 715		HR 1634	ZS 257	PAN 473
17	Melkassa-5	PAN 33	Lishe H1	Longe 5		SC 717		HR 1651	ZS 259	PAN 6549
18	NOMAA-1	PAN 5243	Lishe H2	Longe 6H		Staha St		HR 1694	ZS 261	SC 513
19	NOMAA-2	PAN 77	Lishe K1	Longe 7H		ZM 421		HR 1711	ZS 421	SC 627
20	NOMAA-3	PHB30G19	Longe 2H	Longe 8H		ZM 521		HR 1724	ZS 521	SC 709
21	NOMAA-4	PHB30G97	Longe 42	SC 407		ZM 623		HR 1HP		PHB 30B50
22	Rare-1	PHB30V53	Longe 6H					MM 441		PHB 30G97
23	SAM	PHB3253	PHB 30G97					MM 502		PHB 30G19
24	SAM-4	QPM 1	PHB 3252					MM 603		PHB 30V53
25	ZM421	QPM 2	SC 403					MM 604		PGS 71
26	ZM423	SC DUMA 41	SC 407					MMV 400		PGS 53
27	ZM521	SC DUMA 43	SC 513					MMV 600		PHB 30R73
28	ZM523	SC Pundamilia 51	SC 621					MR1 EP		PHB 30G97
29	ZM621	SC Pundamilia 53	SC 627					Obatanga		PHB 30G19
30	ZM623	SC Simba 61	SC 713					PHB 30G97		PHB 30V53

Appendix 4: (continued)

	Ethiopia	Kenya	Tanzania	Uganda	Angola	Malawi	Mozambi-que	Zambia	Zimbabwe
31		SC Tembo 73	Situka 1					PHB 30H83	PGS 71
32		WH 403	Situka M1					PHB 30R73	PGS 53
33		WH 404	Staha St					PHB 30V53	PHB 30R73
34		WH 502	TMV1					POOL 16	
35		WH 504	TUXPENO					POP 10	
36		WH 505						POP 25	
37		WH 699						ZM 421	
38		WHSQM 105						ZM 521	
39		WHSQM 109						ZM 621	
40		WS 202						ZMS 402	
41		WS 909						ZMS 606	
42								ZMS 737	

Sources: FAOSTAT (2007); DTMA seed sector survey, 2007/08

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