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Abdoulaye Tahirou[1]*, Diakalia Sanogo[1], Augustine Langyintuo[2], Simeon A. Bamire[3], and Adetunji Olanrewaju[1]

October 2009

[1] International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria, and corresponding author; email: T.Abdoulaye@cgiar.org
[2] International Maize and Wheat Improvement Center (CIMMYT), Harare, Zimbabwe.
[3] Department of Agricultural Economics, Obafemi Awolowo University, Ile-Ife, Nigeria.

Ibadan, Nigeria

To Headquarters from outside Nigeria:
IITA, Carolyn House
26 Dingwall Road, Croydon CR9 3EE, UK

Within Nigeria:
PMB 5320, Oyo Road
Ibadan, Oyo State

ISBN 978-131-342-0

Printed in Nigeria by IITA

Correct citation: Tahirou, Abdoulaye, Diakalia Sanogo, Augustine Langyintuo, Simeon A. Bamire, and Adetunji Olanrewaju. 2009. Assessing the constraints affecting production and deployment of maize seed in DTMA countries of West Africa. IITA, Ibadan, Nigeria. 40 pp.

Cover photo: Maize plant. Photo by IITA.

Contents

Tables

Figures

Annexes

Executive summary

Seeds are the sources of most food, and therefore have the greatest socioeconomic benefit to human welfare. However, many developing countries, particularly in sub-Saharan Africa, have difficulty coping with seed supply, especially in emergency situations where recurrent droughts have become a fact of life. Hence, understanding the seed supply system and the factors limiting the production, multiplication, and marketing of improved maize seeds in Africa is of paramount importance for promoting maize production, improving farmers' income, alleviating poverty, and ensuring food security. This study was conducted in 2007 and 2008 under the auspices of the Drought Tolerant Maize for Africa (DTMA) project supported by the Bill and Melinda Gates and Howard G. Buffet foundations. The objectives of the study were to:

- Identify and characterize maize seed production organizations in DTMA countries of West Africa (WA).
- Document maize varieties marketed by seed providers in each country.
- Identify factors militating against the efficient deployment of seeds.
- Make recommendations for addressing critical bottlenecks which will contribute to the efficiency of variety release, seed production, and seed dissemination for new drought tolerant (DT) maize varieties in West Africa.

The study involved the collection of data on seed prices, sales trends, and limitations to expanded seed sales from 39 representative seed providers in four West African countries, namely, Benin republic, Ghana, Mali, and Nigeria. Other relevant pieces of information were gathered from the national agricultural research systems (NARS), national seed services, and secondary sources.

Overview of seed markets

The results of the study showed that 49% of the surveyed seed providers were community-based (seed retailers), 28% were private seed companies, and about 20% were cooperative seed providers. Only 3% were from the NARS. Maize seeds, open-pollinated varieties (OPVs), and hybrids, accounted for a large proportion of the total seed by seed providers in West Africa. The estimates showed that maize seed needs (total sowing requirement) far outweigh the supply, as seed supply accounted for only 46.6% of total seed requirements in Nigeria, 10.8% in Ghana, and 33.2% for West Africa for the period from 1997 to 2007.

Seed supply

The shortfall in seed supply over sowing requirement is attributed partly to institutional problems related to (i) the establishment of a seed production unit, (ii) seed production and processing, (iii) seed marketing and distribution, (iv) seed demand at the farm level, and (v) the operational environment of seed production and distribution. Another major constraint to the development of the seed sector in this region includes the low adoption of improved varieties in some areas. In West Africa, an increase in the number of seed companies is crucial to the future development of the seed sector. Improvement in the seed policy and regulation environment in terms of varietal release and support to emerging seed companies will therefore be vital to the sector.

Factors limiting maize seed production and deployment in selected countries in West Africa

At the regional level, seed production constraints and poor seed policies constitute the major constraints to the development of the seed sector. Lack of financial and human resources, inadequate and inappropriate germplasm material, and the unavailability of a sufficient quantity of foundation seeds constitute the problems in seed production. Major factors that constrain the establishment of a seed company include lack of access to production credit, high initial investment costs, and lack of access to seed production and processing

infrastructure. The lack of infrastructure and poor extension support systems are the main problems for seed marketing and distribution. Farmers' perception of yield, seed price, and prices of other inputs, weather conditions, and the effectiveness of promotional campaigns affect the demand for maize seeds. Policy-related impediments include unfavorable seed policies such as taxation, import and export restrictions, a lengthy variety release process, and controlled seed markets.

Factors constraining the deployment of newly released varieties

In the four study countries, the major limitations to the rapid dissemination of newly released varieties included the unavailability of seeds in a commercial quantity, lack of awareness of available varieties and hybrids, lack of access to credit facilities by farmers, and the high relative price of seed. Also, sometimes monopolistic distribution of seeds through a single intermediary, slow reimbursement of seed credit sales, difficulty in getting access to other maize seed buyers, and low demand from farmers' lack of awareness were identified. The demand for improved seeds was also relatively low, due mainly to poor promotion and marketing efforts, high prices, and the inability of farmers to purchase complementary inputs, especially fertilizer. Most rural areas are inaccessible due largely to the poor roads, which often prevent extension staff from getting to the rural communities.

Policy implications of the results

The most critical policy recommendations from the study are related to increasing the number of seed companies and the adoption rates of improved maize varieties, and improving the policy/seed regulation environment.

Facilitating the establishment and operation of seed companies

In the four countries, only 11 seed companies were interviewed (eight of them in Nigeria). Therefore, apart from Nigeria, there are too few seed companies in west Africa to drive a viable seed sector. To facilitate the establishment and operation of seed production units, financial institutions should be encouraged to support seed companies with credit facilities at affordable interest rates, while promoting farmers' seed cooperative schemes. Efforts should be made to provide sufficient and good quality foundation seed to seed producing organizations and farmers, and to ensure an adequate and effective extension service delivery system to readily disseminate information on the seeds available. There is also the need to develop databases and information exchange networks that will include seed varieties and their distribution, setting up a guaranteed insurance system, and building the capacity of seed companies and institutions engaged in seed development.

Increasing the adoption of improved maize

Dissemination and diffusion of improved varieties largely determines the extent of the demand for quality seeds. Efforts made to increase farmers' awareness and adoption of improved maize varieties will increase demand for them and provide more incentives for the establishment of new seed companies. Currently, adoption rates in some areas of West Africa are still too low to motivate the seed companies. However, most of the seed providers in the west African subregion have future plans to increase the production and marketing of their OPV and hybrid maize seed, and also have a reasonable chance to scale-up their businesses. Accelerating seed dissemination in all the different agroecologies of the four study countries, encouraging participatory breeding programs, strengthening of extension services, and increasing seed retail outlets through input stockists, are essential to make seed readily available to the majority of maize growers. Maintaining efficient seed production and processing programs requires easy access to suitable germplasm by seed producers, a decentralized foundation seed production system to optimize the benefits of improved germplasm, improved access to finance, a stable and conducive macro-policy environment, development and implementation of regulatory framework with timely release of seed varieties, and improved human capital for market development. Improved seed

marketing and distribution channels could be achieved through seed information awareness and motivation, an adequate supply of good quality seeds at affordable prices, as well as promotion of marketing efforts and complementary input packages to farmers at subsidized rates.

Improving varietal release process and related policies

Although most West African countries studied currently have varietal release committees, these are less effective due primarily to their infrequent meetings to discuss release of new varieties. Due to lack of operating funds, the committees often meet on a very irregular basis, thus extending the time taken for varieties to be released. Seed policies and regulations could also be reformed by harmonizing seed standards and regulations to facilitate the orderly movement of seeds across borders, ensuring uniformity of regulations controlling the sale of seeds throughout a region to encourage fair and equitable trade, and establishing regional seed associations and networks. ECOWAS has started work on this and it needs to be accelerated.

T. Abdoulaye[1]*, D. Sanogo[1], A. Langyintuo[2], S.A. Bamire[3], and A. Olanrewaju[1]

1 International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria, and corresponding author; email: T. Abdoulaye@cgiar.org
2 International Maize and Wheat Improvement Center (CIMMYT), Harare, Zimbabwe.
3 Department of Agricultural Economics, Obafemi Awolowo University, Ile-Ife, Nigeria.

Acknowledgments

This work was funded by the Bill and Melinda Gates and Howard G. Buffet foundations under the Drought Tolerant Maize for Africa (DTMA) grant. The support of IITA and CIMMYT is also acknowledged. The authors also acknowledge the support and contributions of several colleagues including Drs W. Mwangi from CIMMYT, M. Abebe, B. Badu-Apraku, and Victor Manyong from IITA. Thanks are also due to Anne Wangalachi of CIMMYT and Rose Umelo of IITA for their additional editing work, Bamikole Ayedun (IITA) for his inputs, and the anonymous external reviewers who provided very useful comments and suggestions that have greatly improved the quality this report.

Our gratitude goes to all the seed providers and resource persons in the four countries who filled in our questionnaire, discussed with us, and provided us with relevant literature. We acknowledge the contribution of DTMA collaborators from the NARS in Bénin, Ghana, Mali, and Nigeria for the organization and conduct of the surveys in the selected communities. Any errors or omissions remain the responsibility of the authors.

Abbreviations and acronyms

ADP	Agricultural Development Project
CBO	Community-based organization
CIMMYT	International Maize and Wheat Improvement Center
CSV	Cellules Semencières Villagoises
DT	drought tolerant
DTMA	Drought Tolerant Maize for Africa
ECOWAS	Economic Community of West African States
F CFA	Franc Communauté Financière Africaine
GH.C	Ghana Cedis
IITA	International Institute of Tropical Agriculture
IARC	International Agricultural Research Center
IGO	Inter-Governmental Organization
MAAN	Maize Association of Nigeria
MOFA	Ministry of Food and Agriculture
NASC	National Agricultural Seed Council
NARS	national agricultural research systems
NGO	nongovernmental organization
OECD	Organization for Economic Cooperation and Development
OPV	open-pollinated variety
PVO	Private Volunteer Organization
QPM	Quality Protein Maize
SEEDPAG	Seed Producers Association of Ghana
SSA	sub-Saharan Africa
SSN	Service Semencier National
UN	United Nations
WCA	West and Central Africa
WAEMU	West African Economic and Monetary Union
WECAMAN	West and Central Africa Maize Network

Introduction

Seeds are first and foremost, the source of most food, at least of plant origin, and therefore have the greatest socioeconomic benefit to human welfare of any known biological device. According to Louwaars and Marrewijk (1999), the development and use of high yielding seed varieties have been the technological forces behind the successful green revolution, the availability of food at prices profitable for farmers and affordable by the populace, and a reduction in rural poverty. Thus, seed provision, both in normal and disaster years, is a prerequisite for increasing food production, improving farmers' income, alleviating poverty, and ensuring food security.

Seeds represent a key technology component for the improvement of agricultural productivity (Tripp 1998) and in many countries of sub-Saharan Africa (SSA), concerted institutional and policy provisions are in place to ensure that the national seed sector performs well (Hassan et al. 2001). In most of these countries, a range of regulations and policies have been adopted to protect farmers from the harmful effects of low quality seeds. These include the enforcement of minimum standards, mandatory seed certification, import restrictions, licensing and registration of seed companies and legal mechanisms and protocols for testing seed quality (Minot 2008; Hassan et al. 2001). Seeds are the most precious resource of farmers, and concern about the viability of agricultural systems usually centers on the diversity and stability of the seed supply system (Tripp 2001).

Van Amstel et al. (1996) defined the seed system as the totality of the physical, organizational, and institutional components that determine seed supply and use in quantitative and qualitative terms. A seed system denotes the activities that start from selection and breeding to the marketing and use of seeds by farmers for growing crops, and it has close linkages with other systems, particularly research and extension (Venkatesan 1994). An efficient seed system involves a complex combination of public sector support and private sector commercial activities. The public sector plays a bigger role in plant breeding and some aspects of regulations; the private sector makes contributions in the area of seed multiplication, processing, and distribution (Minot 2008). Furthermore, the character of an appropriate seed system for a country is determined by economic policies and the level of development of the country's infrastructure (Venkatesan 1994). It is important to note that with the possible exception of a few countries (such as Nigeria and Ghana), the seed system in West Africa is not well developed and is largely controlled by government agencies in the public sector, which play dominant roles (Joshua 1997).

Drought has emerged as a major threat to agricultural productivity and food security in SSA as a result of global climate change (Benson and Clay 1998, Clover 2003). The region receives most food aid, with some 30 million people relying on emergency food assistance in any one year (Clover 2003). Many countries have difficulty in coping with seed supply, especially those where severe droughts have become endemic.

An understanding of the seed supply system and the factors currently limiting the production and deployment of improved maize seeds in SSA is therefore of paramount importance in promoting maize production, improving farmers' income, alleviating poverty, and ensuring food security. Van Amstel et al. (1996) identified that the factors contributing to food insecurity in SSA include deficiencies in the supply and delivery of farm inputs, in which adequate, reliable, and sustainable seed systems play an important role. Previous research results have shown that the dissemination of improved maize germplasm is dependent on the timely availability and affordability of high quality seeds (Morris 2002). However, most seed consumers in SSA are poor and risk-averse; cash constraints often limit their ability to make investments of any kind (Minot 2008). The drought tolerant maize for Africa (DTMA) project seeks to contribute to food security through improved maize production by the development and dissemination of drought tolerant (DT) maize varieties suitable to the various agroecologies of SSA.

This study was conducted in 2007 and 2008 in four pilot countries of West Africa (Benin, Ghana, Mali, and Nigeria) under the auspices of the DTMA project supported by the Bill and Melinda Gates and Howard G. Buffet foundations. The study is part of the maize seed development and deployment activities carried out by the DTMA project in nine countries in eastern and southern Africa[1] in addition to the four West African countries. The overall objective was to help bridge the knowledge gaps in the composition and the current level of development of the seed sector in these pilot countries, the constraints that operators (seed companies and seed vendors) are facing, as well as the opportunities and threats to the release of new maize varieties. The knowledge would assist in the eventual dissemination of DT maize varieties in SSA and also assist policy makers and future research to identify critical areas that require more interventions (e.g., capacity building of actors in the public and private seed sectors [nongovernmental organizations (NGOs) and community-based organizations (CBOs)].

The specific objectives of the study were to:

- Identify and characterize maize seed production organizations in DTMA countries of West Africa (Benin, Ghana, Mali, and Nigeria).
- Document maize varieties marketed by seed providers.
- Identify factors preventing the efficient deployment of seeds.
- Make recommendations for addressing essential areas that will contribute to the efficiency of variety release, seed production, and seed dissemination.

The DTMA project is presently carrying out varietal development, testing, and promotion in 13 countries in SSA. The seed sector (comprising the public sector and private seed companies, NGOs/CBOs, and cooperative societies) in those countries would be the pivot for the final release and dissemination of DT maize varieties. Furthermore, as a result of the similarities in the economies of the countries in West and Central Africa (WCA), findings from this study would provide background information on the modalities for scaling-out the new technologies (DT maize varieties) to other countries in WCA that are not part of the pilot scheme. This report presents the findings of the study and provides information on the organizational and institutional strategies for maize seed deployment to improve seed availability in the region.

Methodology and data sources

The survey was conducted in Benin and Nigeria (2007) and Ghana and Mali (2008). These are the four DTMA countries in West Africa[1] and this sequence of survey was imposed by project funding. As there were few seed companies/providers in any country, our goal was to interview all the important ones (by the size of activity in the sector). The list of those to be interviewed was established together with the national seed authorities and the NARS scientists who collaborated in the DTMA project. The list includes any person and institution known for selling seeds. All potential respondents responded, except one from Mali who could not be reached. A total of 39 seed providers were surveyed (Table 1), with 10% of total sample from Benin, 36% from Ghana, 15% from Mali, and 39% from Nigeria. In this study, a generic term of seed providers is used to include seed companies, community-based seed producers, seed growers, input stockists, as well as national programs that produce foundation and/or certified seeds.

Data were collected for the period 1997 to 2006 on the institutional establishment and operations of seed organizations, the extent of varietal development and use of CIMMYT and IITA germplasm, the reasons for delay in disseminating new maize varieties, agroecologies or environments where seeds are deployed, and the sales outlets used for seed distribution. Data were also collected on seed prices, sales trends, and limitations to expanded seed sales. Other useful information was gathered from key informants, such as members of the national seed services staff, NARS scientists, and also from secondary data sources.

Primary data were collected through direct interviews conducted by scientists with respondents using a formal questionnaire. Most questions were close-ended with predetermined response options among which respondents could choose. Therefore, very often, the respondents chose more than one answer, and this gave us multiple responses.

Data analysis, mainly descriptive statistics showing key features of the selected indicators relating to maize seed production and marketing, was carried out using the statistical package for social scientists, SPSS. In most of the tables, respondents could choose more than one option, therefore multiple response frequencies were used and we report percentages of valid cases, which can be less or more than 100%. The results are a compilation of responses provided by those interviewed, based on the survey questionnaire. Additional key informants were selected in collaboration with the NARS representatives based on their participation in the seed value chain in each country. Secondary information was collected through published documents (articles and reports) on seed systems in the region.

Overview of seed markets

Thirty-nine institutions were surveyed (Annex Table A1). About 28% of the surveyed seed providers were private national companies (no single international seed company was found operating in the study countries); 49% were seed retailers. The remaining 23% of the survey sample were either farmer's cooperatives or NARS-supported seed providers. The preponderance of seed retailers and the low number of private seed companies confirm the low level in development of the seed industry in West Africa. However, empirical results (e.g., Joshua 1997) have shown that the private sector-led seed industry is important for a reliable and sustainable seed system of a country. Minot (2008) found that seed programs, since the mid-1980s, have changed from supporting state seed enterprises and have focused efforts on the development of a more diverse and competitive seed sector that includes private seed companies, NGOs, and farmers' associations.

The distribution by type of seed providers interviewed in the four countries is shown (Table 1). The seed production arrangements in Nigeria, Ghana, and Mali was such that the private seed companies obtained breeder seeds from the research institutes[1] (national and/or international), and foundation seeds from the national agricultural seed council (NASC). Some of the seed companies in Ghana and Nigeria produced foundation seeds from the breeder seed collected from the research institutes, which were then used in producing certified seeds on the company's own farm or through out-growers (i.e., contract growers). There was no seed company in Bénin at the time of study but several community seed producers existed.

Estimated seed supply in selected countries in West Africa

Seed supply is mainly influenced by the availability of foundation seeds from which certified seeds are produced, the regulatory mechanisms for registration and release of varieties, and seed production (Olayide and Heady 1980, Kormawa et al. 2000). The market demand for certified seeds, represented by the total quantity bought by consumers at a specific time and location, may be influenced by factors such as farmers' perception of the yield or quality advantages of improved over local seeds, the price of seeds, prices of other inputs, the price of crops, farmers' forecast of weather conditions, and the cost of reaching the distribution (retail) outlets. The demand for improved seeds can also be influenced by the effectiveness of promotional campaigns, the efficiency of distribution, and the availability of credit and other complementary inputs, such as fertilizer (Falusi 1994, Utoh 1994).

The estimates of the amount of maize seed needed (total sowing requirement) and supply over the 1997 to 2006 period for the study countries in West Africa are shown (Table 2). These showed that seed needs far outweighed supply over the period, as seed supply accounted for only about 47% of the total seed requirement in Nigeria, 11% in Ghana, 3% percent in Mali, and 33% in the region. There is therefore the potential to increase seed supply significantly to meet total requirements to achieve self-sufficiency in maize production.

Table 1. Types of seed providers surveyed in DTMA project countries in West Africa.

Type of seed company	Nigeria	Bénin	Ghana[6]	Mali	West Africa
Private national seed company	8	–	1	2	11
National agricultural research system	1	–	–	–	1
Cooperative association	5	1	1	1	8
Community-based seed producers	1	3	12*	3	19
Total	15	4	14	6	39

*Not exclusively dealing with seed, four of them are input distributors selling other agricultural inputs such as pesticides and fertilizers. Source: DTMA seed survey, 2007/2008.

Table 2. Estimated maize seed needs and supply in the selected countries in West Africa.

Country	Maize area (× 000 ha) (1997–2006 average)[¦]	Estimated seed need (× 000 t)[†]	Seed supply from the formal seed sector (× 000 t)		
			OPVs	Hybrids	% of total seed need
West Africa	**5273**	**131.84**	**25.84[‡]**	**17.98[+]**	**33.2[¦]**
Bénin[§]	651	16.28	–	–	–
Nigeria[§]	3567	89.18	23.60[#]	17.96[#]	46.6
Ghana[§]	746	18.65	2.00[¦¦]	0.01[++]	10.8
Mali[§]	309	7.73	0.23	–	3.0

Note:
[¦] Source: FAOSTAT (2008).
[†] Estimated based on a planting requirement of 25 kg/ha.
[§] Estimates are computed over the period 1997–2006.
[‡] Estimate for West Africa excludes Benin.
[+] Estimate for West Africa excludes Benin and Mali.
[#] Seed supply by the seed companies, formal suppliers of the maize association of Nigeria (MAAN).
[¦¦] Source: Ewool (2007).
[++] Source: Alhassan and Bissi (2006).

Trend of maize seed production and sales in the project countries in West Africa

Seed production from 1997 to 2006

The production and sales figures from 1997 to 2006 are shown in the Annex (Table A2a and A2b). In Nigeria, the figures for 2003 showed that more hybrid seed varieties were produced than for open pollinated varieties (OPVs). This is highly influenced by the increased hybrid seed production, and this has been increasing steadily since then (Fig. 1). Private seed companies with breeding programs can obtain germplasm directly from IITA and/or CIMMYT. Companies and/or providers preferred hybrid maize seed production as it was more profitable than producing OPV seeds.

However, only Nigeria and Ghana produced hybrid seeds in West Africa, with Nigeria being the largest producer in the region. Commercial production of hybrid seeds in Nigeria took off in 2000 with an output of about 61 t, reaching a high record production of 775 t in just one year (i.e., 2001), more than a 10-fold increase over the previous year.

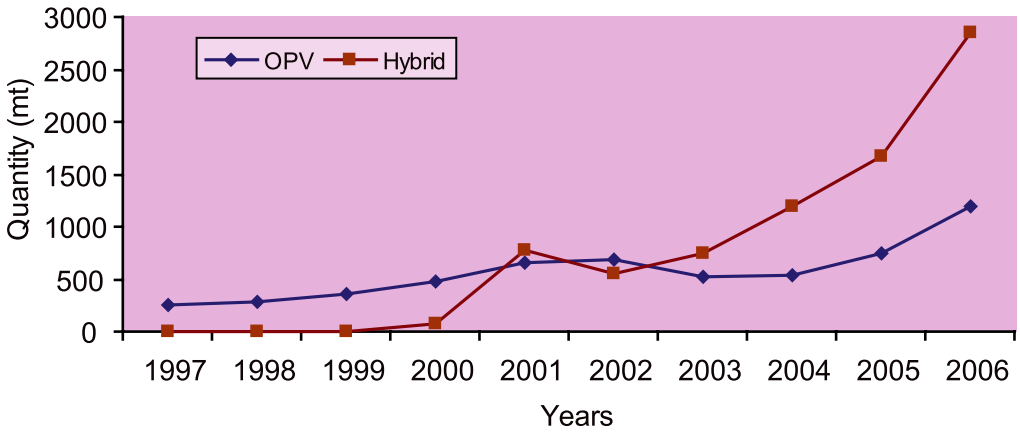

Figure 1. Maize seed production in selected countries in West Africa, 1997–2006.
Source: DTMA seed survey, 2007/2008.

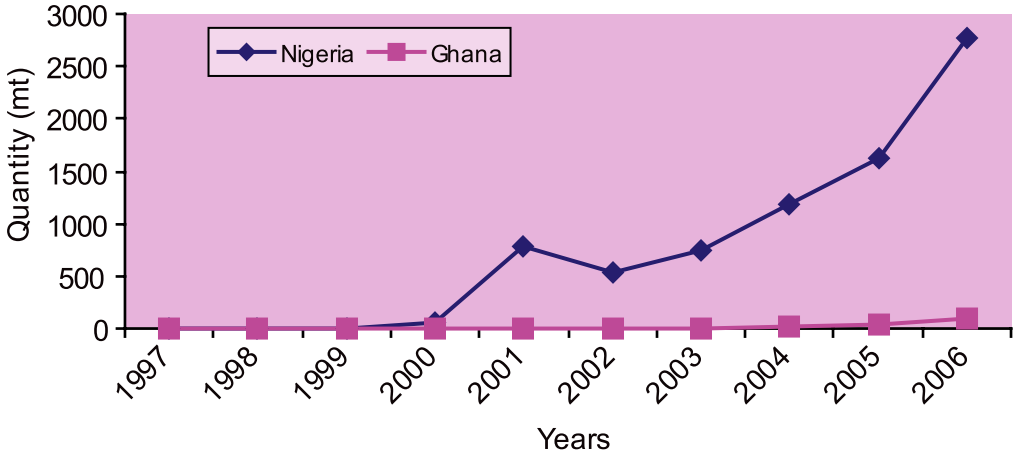

Figure 2. Hybrid seed production in Nigeria and Ghana, 1997–2006.
Source: DTMA seed survey (2007/2008).

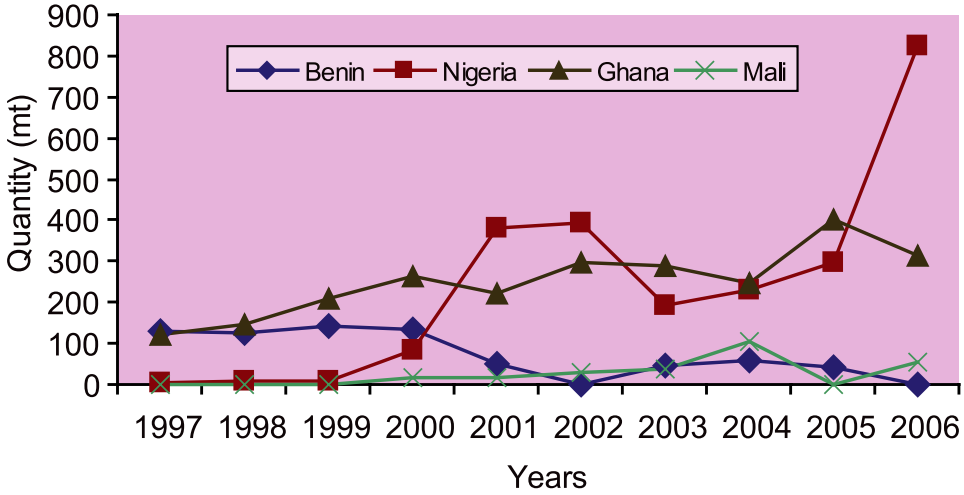

Figure 3. OPV maize seed production in selected countries in West Africa from 1997 to 2006.
Source: DTMA seed survey (2007/2008).

After a drop in production in 2002, hybrid maize seed production increased tremendously to reach a record output of about 2800t in 2006 (Fig. 2). This accounted for 77% of the total estimated maize seed production in Nigeria for that year. It is important to note that except for the apparent year of introduction of hybrid maize in Nigeria, production of hybrid seed had remained higher than the production of OPV seeds. In Ghana, hybrid maize seed production registered a steady increase from 1.5 t in 1997 to 87.4 t in 2006. However, hybrid maize seed production represented only about 1% in 1997 and 22% in 2006 of the total seed produced in Ghana for the two periods.

The four countries together showed a significant production of OPV seeds in West Africa (Fig. 3). Nigeria and Ghana were the largest producers of OPV maize seeds. Benin produced above 100 t of OPV seeds yearly from 1997 to 2000. The country's production dropped to 50 t in 2001, and has since remained below the levels of the late 1990s. The record of maize seed production in Mali covered only the period from 2000 to 2006 (Fig. 3), with very limited quantities produced.

In Nigeria, there was a steady increase in the level of OPV seed production from 1998 to 2002 before a fall in 2003 (Fig. 3). However, production recovered the following year (2004) and continued to increase to reach a high of about 826 t in 2006. The production of OPVs in that year accounted for 23% of the estimated total maize seeds produced. Production of

OPV maize seeds in Ghana also fluctuated in the 1997–2006 period. It recorded a substantial increase between 1997 and 2000 before decreasing in 2001. Since then the production trend has been irregular despite a high of 404 t in 2005. The improved maize seed sector was nascent in Bénin and Mali, with a record of low level production of OPV seeds.

In general, there were wide fluctuations in the level of yearly production of seeds of both OPV and hybrid maize varieties in the four countries. Key informants generally attributed the downward production trend in Bénin, from 2001 to date, to the monopolistic commercialization practices imposed by the seed production and marketing support organization which was established by the ministry of agriculture to help strengthen the operational capacities of the seed producers' cooperatives and improve their efficiency.

A total of 23 maize varieties was recorded in Nigeria the highest, with only eight in Bénin and Ghana (the lowest) (Table 3). In Nigeria and Ghana, the pool of marketed cultivars includes both OPVs and hybrids, while Mali and Bénin have only OPVs. From all four countries, the list includes some varieties that were released a long time ago (for example, Dorke in Ghana). This is an indicator of the slow release rates in all countries.

There are possibly other varieties imported from other regions of Africa. Despite existing laws regulating the import of crop varieties in all four countries, some of the interviewed seed companies in Nigeria have complained about illegal imports of improved maize varieties by some newly established large-scale farmers. Therefore, the list of varieties (Table 3) does not provide a complete picture of what is grown in a given country. In addition, some varieties not yet officially released are grown by farmers through adaptive research programs and community seed-production schemes.

Most Nigerian state agricultural development programs (ADPs) continue to multiply and sell seeds, and this is provoking complaints against them from seed companies. In Ghana, the combined efforts of the Ghanaian Ministry of Food and Agriculture (MoFA) with some

Table 3. Names of maize varieties marketed per country.

Bénin	Ghana	Mali	Nigeria
Dmr-esw	Obatanpa	Sotubaka	Oba super 1
Faaba/qpm	Dodzi	Dembanyuma	Acr 97
Evdt-97str	Okomasa	Tiemanties	Tzee white and yellow
Tzl	Mamaba (gh110)	Qpm (yellow)	New arewa (white and yellow)
Tzb	Dorke	Nyeleni (nieleni)	85-32-23 (farmer delight white)
Tzee	Golden jubilee	E211	86-46-32 (farmer delight yellow)
Tzbsr	Etubi	Kogoni b	Jo-1
Pisaback	Abelehi	Zanguereni	Oba super 2
		Tzeey	Qpm samaz 12
		Tzesrv	1368-9071
		Tux	Jo-f
		Diorobanna	Plateau no1
			Jo-2
			Suwan 1-sr
			Suwan-1
			Synthetic variety
			Jo-95
			Dmr-isr
			Tzpb
			Tzl comp4
			Oba98 qpm
			Oba99 qpm
			Pool-18

Source: DTMA seed survey (2007/2008).
Note: the same variety can have different names in different countries or institutions.

NGOs such as SG2000 and GTZ, have led to the establishment of a dynamic network of community seed producers who were multiplying and distributing mainly seeds of OPVs. The predominance of OPVs has continued in Ghana. Some of these producers who are still in business were interviewed during our survey. They produce seeds and take them to the seed centers for screening before selling them.

Seed sales from 1997 to 2006

Taking into account seed sales from other crops (such as rice, cowpea, sorghum, and millet), maize seed sales accounted for 20% in Bénin, about 68% in Nigeria, 77% in Ghana, 46% in Mali, and about 66% at the regional level. This suggests that except for Bénin, maize seed constituted the largest component of the total sales by seed providers in West Africa. This emphasizes the importance of maize as a major cereal and food security crop in the region where annual consumption averages 43 kg by over 650 million people (Byerlee and Heisey 1997).

Considering the higher sales figures recorded for production of OPVs in Nigeria in 1997, Ghana (in 2000–2004), Bénin (2000–2002, 2005, and 2006), and Mali (2005 and 2006), it is obvious that seeds were imported from outside the region that accounted for about 10%, and the balance of the total was seed carryover from previous seasons by seed providers.

At the country level, OPV seed sales in Nigeria had been fluctuating (Fig. 4) with a record low of 4.3 t in 1998 and a high of 653.8 t in 2006. Findings in Ghana showed an increasing trend in seed sales of OPV from 1997 to 2006. Annual sales had been above 300 t in 2001 before reaching a record high of more than 500 t in 2006. In Mali, apart from a slight drop in the quantity of OPV seeds sold in 2004, there had been a consistent increase in the quantity of sales from 2000 to 2006. Seed sales rose from a low level of 15 t in 2000 to a record high level of 142.3 t in 2006. Bénin was the only country out of the four where OPV sales had not been steadily increasing. Sales fluctuated at around 100 t from 1997 to 2001 before a sharp fall in 2002. From this time, annual OPV seed sales did not rise beyond 60 t and had a low of 10 t in 2006, following a sharp drop in seed production. The community-based seed producers were unable to sell their production of 2000 as the seed production and marketing support agency of the ministry of agriculture proposed to them a buying price substantially below the expected producer price.

Seed producers reimbursed in kind (seeds) the equivalent of the value of loans of inputs (fertilizer and other chemicals) they had contracted. They retained the remaining production, which they were later obliged to sell at the price of food grain. Consequently, the community-based seed production has been fluctuating heavily since 2001 with the lowest production levels in 2002 and 2006.

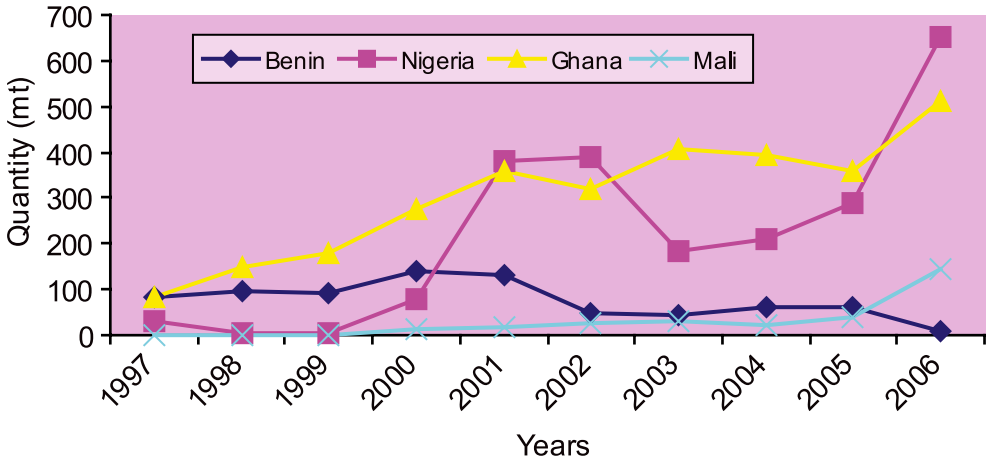

Figure 4. OPV sales in the study countries, 1997–2006.
Source: DTMA seed survey, 2007/2008.

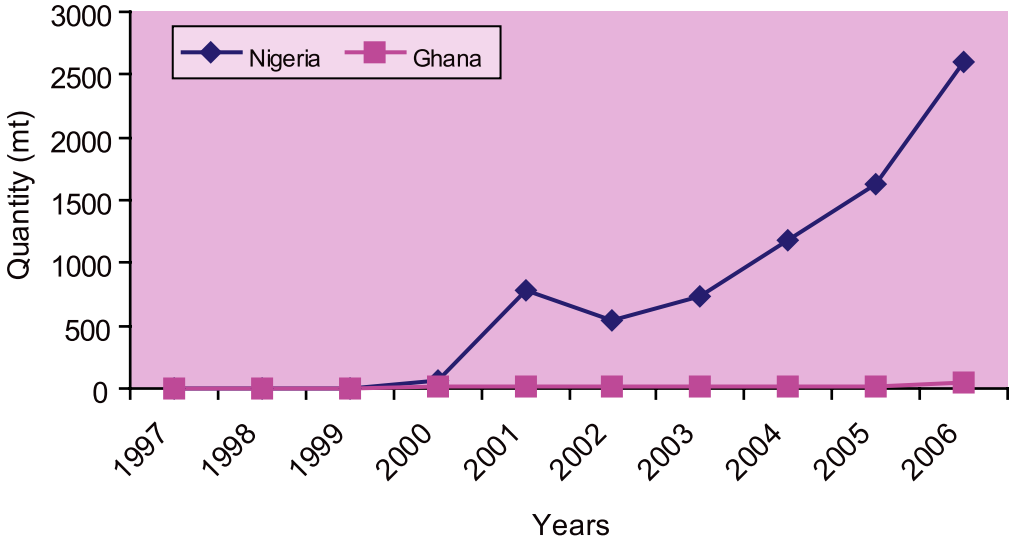

Figure 5. Hybrid sales in the study countries, 1997–2006.
Source: DTMA seed survey, 2007/2008.

Seed sales of hybrid maize were recorded only in Ghana and Nigeria. In Ghana, seed sales of hybrids represented less than 8% of total maize seed sales; in Nigeria this constituted about 80% of the total estimated maize seed sales in 2006. The relatively large sale of hybrid seeds in Nigeria may be attributed to their growing importance among farmers in recent years (NSS 2000, Minot 2008).

Evidence from the late 1990s and earlier 2000s suggests that the formal "seed industry" in the subregion was providing less than 10% of the seeds needed by the farmers (Louwaars and Marrewijk 1999, Kormawa et al. 2000). Regional bodies such as ECOWAS and the West African monetary union (WAEMU) are including seed production and seed trade as important focal points in their agricultural policy recommendations for the region. ECOWAS has published a regional seed catalog for all crops and regional testing and trading regulations are being decided. In the common agricultural policy document of the WAEMU, seed production and distribution across countries are also mentioned.

In recent times, seed providers have been striving to improve productivity but are hampered by limitations related to (i) the establishment of a seed production unit, (ii) seed production and processing, (iii) seed marketing and distribution, (iv) seed demand at the farm level, and (v) the operational environment of seed production and deployment. These limitations are discussed in section 4.

Limitations to maize seed production and deployment in selected countries

This section presents an overview of the present limitations to seed production and deployment in West Africa with a view to developing strategies that would address these problems and pave a way for development of the seed sector. At the regional level, seed production and marketing constraints and poor seed policies constitute the major obstacles to the development of the seed sector (Table 4). Production constraints are the most cited in all four countries. In Bénin and Mali, policy issues are cited second; lack of organized institutions to handle the distribution of seeds among farmers is second in Nigeria; and marketing constraints are second in Ghana.

Ranking the problems at the country level shows production, marketing, and a poor seed policy environment, in that order of importance (Table 5). In all the countries, seed production constraints ran first among the three most important. The second most important constraint is a poor seed policy environment in Bénin and Mali, marketing in Ghana, and lack of organized institutions to handle seed distribution among farmers in Nigeria. In Mali, marketing and seed demand constraints also rank second with a poor seed policy environment. Poor seed policy environment ranks third in both Nigeria and Ghana.

Although the constraints to maize seed deployment seem to vary by type of seed provider, Figure 6 suggests that production constraints are the major limitations for all the three categories of seed providers (private seed companies, NARS, and cooperative/community-based seed providers). An unfavorable seed policy environment was thought to be the second most important challenge, followed by marketing constraints. Seed retailers, on the other hand, were affected by constraints at all levels of the seed value chain. The

Table 4. Constraints to seed deployment in West Africa (%).

Constraints	West Africa (n = 39)	Bénin (n = 4)	Nigeria (n = 15)	Ghana (n = 14)	Mali (n = 6)
Production constraints	46	75	40	43	50
Lack of organized institutions	10	0	27	0	0
Seed policy environment	15	25	13	14	17
Demand side challenges	8	0	7	7	17
Marketing constraints	21	0	13	36	17

Source: DTMA seed sector survey, 2007/ 2008.

Table 5. Ranking of three most important bottlenecks to seed deployment by country.

Country	Production constraints	Seed policy environment	Marketing constraints	No organized institutions	Farm level demand
Bénin (n = 4)	1	2	–	–	–
Nigeria (n = 15)	1	3	–	2	–
Ghana (n = 14)	1	3	2	–	–
Mali (n = 6)	1	2	2	–	2
Number of times ranked 1st	4	–	–	–	–
Number of times ranked 2nd	–	2	2	1	1
Number of times ranked 3rd	–	2	–	–	–

Note: – implies ranking does not apply, and rank 1 is the most important.
Source: DTMA seed sector survey (2007/2008).

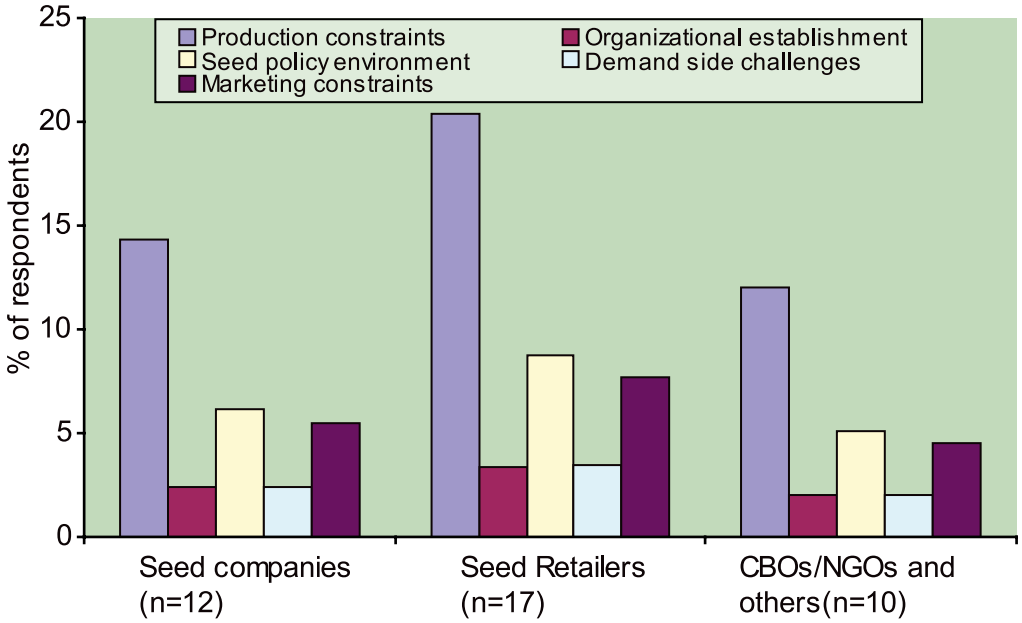

Figure 6. Limitations in seed deployment by type of seed providers in west africa
Source: DTMA seed sector survey, 2007/2008.

Table 6. Production constraints faced by seed providers in West Africa (%).

Seed production constraints	West Africa (n = 19)	Nigeria (n = 13)	Ghana (n = 2)	Mali (n = 3)
Lack of access to suitable germplasm	42	39	50	33
Production constraints	48	39	100	33
Lack of access to production credit	58	69	–	67
Unfavorable climatic conditions	27	39	–	–

Note: There was only 1 respondent from Bénin for this question (this respondent is included in the West Africa column).
Source: DTMA seed sector survey, 2007/2008.

importance of the constraints to maize seed deployment also varied according to the type of seed provider. Production constraints were reported unanimously to be the most important limitations to seed deployment by the three categories of seed providers (Fig. 6). However, seed retailers were the most affected by all five constraints. An unfavorable seed policy environment was recognized as the second most important challenge in each group, while marketing constraints ranked third among the obstacles to seed deployment.

Seed production and processing

The major limitations to seed production and processing facing seed providers include production technical constraints, production credit, and the lack of access to suitable germplasm (Table 6). In Nigeria and Mali, the lack of access to production credit was also mentioned as the major constraint. Unfavorable climatic conditions were reported to be the main production problem only in Nigeria. Similarly in Bénin, the sole respondent reported mainly production technical constraints and lack of access to appropriate varieties as the major seed production and processing problems.

Lack of access to appropriate germplasm

The ranking of breeding goals for seeds of OPV and hybrid maize was established for the seed providers in the study countries[1]. Yield improvement was the most highly ranked breeding goal for both OPVs and hybrid maize in the region (Table 7). Other important breeding goals were ability to withstand ecological and environmental factors, tolerance

[1] Note: Community seed providers in Bénin do not carry out breeding activities.

Table 7. Most important breeding goals or variety characteristics (percentage of respondents).

Breeding goals or variety characteristics	Nigeria		Ghana		Mali	
	OPVs (n = 4)	Hybrid (n = 3)	OPVs (n = 10)	Hybrid (n = 8)	OPVs (n = 1)	Hybrid (n = 1)
Yield improvement	100	100	60	25	100	100
Ecological and environmental factors	75	33	–	–	–	–
Quality/commercial value and seed attribute	75	67	–	–	–	–
Consumer preferences	50	–	10	–	–	–
Stress tolerant	75	67	–	–	–	–
Early to medium maturity	50	33	10	25	100	100
Disease tolerance	–	–	10	13	100	100
Drought tolerance	–	–	20	75		
Enhance nutrition (biofortification with minerals and vitamins etc.)	–	–	20	38	–	–
Storability	–	–	10	13	–	–
Quality protein maize	–	–	30	–	–	–
Market acceptability/high industrial demand of grains produced	–	–	70	25	–	–

Source: DTMA seed sector survey, 2007/2008.

Table 8. drought screening methods mainly used by seed companies in West Africa.

Methods	% of respondents (n = 18)
Evaluation under managed drought stress	17
Evaluation at locations with low rainfall (random drought stress)	11
Others	6
Not doing selection for drought tolerance	78

Source: DTMA seed sector survey, 2007/2008.

to stress, and the quality and commercial value of seeds in Nigeria. In Ghana, the most important breeding goal for hybrid maize was tolerance to drought. In Mali, yield improvement, early to medium maturity, and tolerance to diseases were of equal importance for OPV and hybrid maize seed providers.

Empirical findings across West Africa showed that majority of the seed providers (> 70%) did not perform any breeding or screening activity. The few providers that carried out some screening activities proceeded mostly to the evaluation of germplasm under managed drought stress or evaluations in drought-prone areas. Furthermore, the companies that carried out drought screening activities were mainly in Nigeria and Ghana (Table 8).

Breeders in the region also indicated that they obtain seeds of CIMMYT and IITA maize varieties with ease whenever available (Fig. 7). A higher percentage found IITA germplasm much easier to obtain. About 75% of the breeders claimed to have had easy access to IITA germplasm for OPVs; only about 10% encountered difficulties in obtaining the hybrid seeds. This is clearly due to the location advantage of IITA's headquarters in the region. On the other hand, only 30% of the breeders reported that they had easy access to CIMMYT germplasm for OPVs and hybrids. The seed providers in Ghana obtained OPV and hybrid germplasm of CIMMYT and IITA varieties mainly through the NARS in the country.

Seed providers identified various constraints that are generally associated with the availability of germplasm. One of these was the lack of access to suitable germplasm. A large proportion (over 80%) of the seed companies used germplasm from CIMMYT and IITA for their OPV and hybrid seeds breeding programs (Table 9). More than 50% obtained their

germplasm material from public breeding programs; very few obtained materials from other seed companies. In Nigeria and Ghana, the major sources of germplasm were CIMMYT and IITA, who provided genetic materials either directly to the seed companies and other seed providers or through the NARS. However, about 33% of seed providers surveyed identified the low quantity of seeds of improved varieties (foundation seeds) supplied to them by IITA as a major constraint. For example, in Ghana, about 67% of the survey respondents identified the insufficient quantity of foundation seeds as the major constraint in obtaining germplasm from IITA. The major difficulty in obtaining the CIMMYT germplasm was the lack of information on the materials.

In Bénin and Mali, the NARS were the only source of germplasm used in seed production. Two of the four seed providers interviewed in Bénin claimed that the main difficulties associated with obtaining germplasm were the lack of financial resources, the insufficient quantity of foundation seeds, as well as the need to travel long distances to get the improved seeds.

Table 9 presents the results of the survey on the ease of accessibility to improved maize germplasm in the region. Compared with other sources, the results showed that it was easier for breeders in the region to get seeds of OPVs from national public breeding organizations than from IITA or CIMMYT. The two international research institutions were the best sources for hybrid seeds.

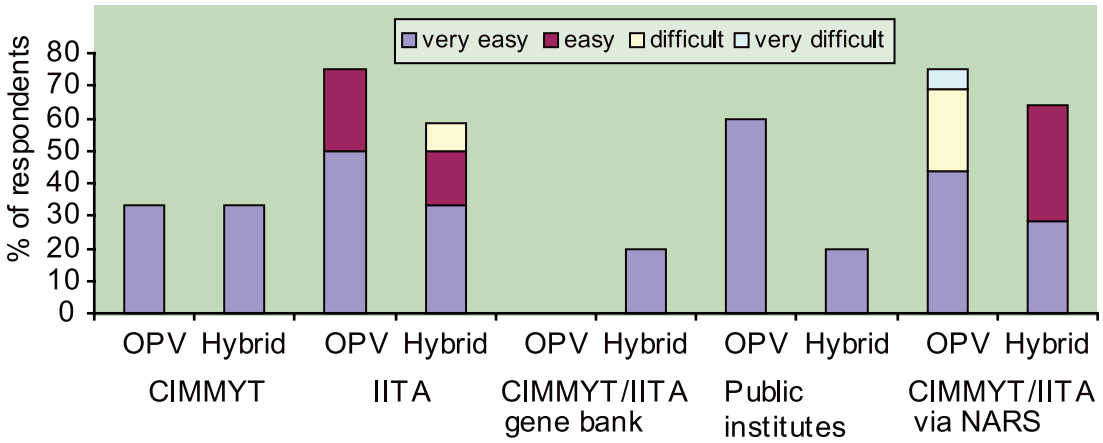

Figure 7. Ease of obtaining germplasm from CIMMYT and IITA by regional breeders.
Source: DTMA seed sector survey, 2007/2008.

Table 9. Ease of obtaining germplasm of improved maize by regional breeders.*

	Ease of obtaining OPV germplasm from the following sources						Ease of obtaining hybrid germplasm from the following sources					
	1* (n = 6)	2* (n = 12)	3* (n = 5)	4* (n = 5)	5* (n = 5)	6* (n = 16)	1* (n = 6)	2* (n= 12)	3* (n = 5)	4* (n = 5)	5* (n = 5)	6* (n = 14)
Very easy	33	50	–	60	–	44	33	33	20	20	–	29
Easy	–	25	–	–	–	–	–	17	–	–	–	–
Difficult	–	–	–	–	–	25	–	8	–	–	–	36
Very difficult	–	–	–	–	–	6	–	–	–	–	–	–
Not applicable	67	25	100	40	100	25	67	42	80	80	100	36

Note: 1*= CIMMYT's germplasm; 2*= IITA's germplasm; 3*= germplasm from CIMMYT's or IITA's gene bank (landraces held in trust); 4*= germplasm from other public breeding institutes; 5*= germplasm from seed companies; 6*= CIMMYT/IITA germplasm through NARS.
Source: DTMA seed sector survey, 2007/2008.

Table 10. Major interest in CIMMYT and IITA germplasm.

Main interest when accessing CIMMYT or IITA germplasm	% of respondents (n = 24)
High yield potential	83
Early maturity of varieties	13
Low N tolerance	4
Consumer preferences	29
Tolerance to low moisture	4
Disease resistance	17
Grain quality and utilization	21
Lodging resistance	8
Uniformity of plant height	8
Striga resistance	4
Yield stability	17
Purity of breeder stock	8
Tolerance to biotic and abiotic stresses	29
Nutritional quality (biofortification, quality protein etc.)	25

Source: DTMA seed sector survey, 2007/2008.

In general, the problems associated with obtaining public sector germplasm were common to Bénin and Nigeria. These relate to difficulties in traveling long distances within the country to obtain the foundation seeds. Any strategy aimed at locating the sources of germplasm closer to seed production organizations would promote the appropriate use of public sector germplasm. Apart from the inability of NARS to provide as much germplasm as CIMMYT/IITA to meet the requirements of seed organizations in Nigeria and Bénin, the lack of manpower and funding to obtain and test new varieties and hybrids is a major constraint. Hence, strengthening the national maize breeding programs, as well as training skilled and unskilled employees would improve the seed providers' access to germplasm through a better performing NARS. The national maize breeding programs should consider agronomic traits and consumer preference as important criteria for identifying suitable varieties and hybrids. They should also engage the extension systems, NGOs, CBOs, and farmers during extensive testing of promising varieties and hybrids.

Results from this study revealed that the seed companies in Ghana obtained germplasm through NARS only, and the major problem they faced had to do with the strict government regulations that restrict the production of foundation seed by the Ministry of Food And Agriculture (MoFA). This caused delay in obtaining delivery of orders from the MoFA that had very limited production capacity for foundation seeds. This also negatively affected the quantity of foundation seeds that could be supplied by MoFA to a single individual who requested them for immediate delivery. Similarly, the country report on Mali by the 2006 program for Africa's seed systems revealed that an inadequate supply of foundation seeds was a major obstacle to seed production in the country (Toure and Sanogo 2006).

The results of the survey further showed that seed providers in the four study countries were primarily interested in high yield potential when obtaining germplasm from CIMMYT and IITA[2]. Other important criteria in requesting germplasm from the two research institutions were consumer preferences, tolerance of the material to biotic and abiotic stresses, grain quality and utilization, and nutritional quality (Table 10).

[2] In the study countries, apart from their respective NARS, seed companies mainly interact with IITA in getting seeds.

However, despite the interest in the germplasm from CIMMYT and IITA, some weaknesses were identified to be associated with the use of the germplasm (Table 11). The weaknesses that were most often mentioned by the seeds producers included the low shelf life of seed, the limited ecological adaptability (i.e., suitability within only limited agroecologies), the yield increase associated with fertilizer use (or fertilizer requirements of the varieties), the low yield in seed multiplication, and postharvest losses in some varieties (Table 11).

Technical constraints to production

In an attempt to scale up maize seed production to various agroecologies, seed providers identified different technical constraints that hindered their plans for expanded seed sales. In Bénin, 50% of the seed providers identified inadequate technical manpower as a major obstacle, 25% adduced this to difficulty in the adoption and adaptation to new production techniques, land scarcity, lack of access to production inputs, lack of up-to-date equipment, machinery and their maintenance, and lack of drought tolerant maize materials (Table 12). In Nigeria, 40% of the seed providers identified the lack of access to production inputs, lack of up-to-date equipment, machinery and their maintenance, and inadequate skill of technicians for hybrid seed production as important technical impediments to seed production. The other problems were lack of drought tolerant maize materials and difficulty in adoption and adaptation to new production techniques. Results from Ghana showed that the lack of up-to-date equipment and machinery, inadequate skill of technicians for hybrid seed production, difficulty in the adoption and adaptation to new production techniques, as well as inadequate improved varieties and drought were critical technical challenges to expanded seed sales. The only and most crucial technical barrier to seed providers in Mali was the inadequate technical capacity of personnel in all aspects of seed production.

Table 11. Perceived weaknesses in CIMMYT and IITA germplasm by seed producers.

Weaknesses	% of respondents (n = 12)
Limited ecological adaptability of germplasm	17
Yield increase associated with fertilizer type and nutrient levels	17
Limited amount of foundation seed obtained	8
Low yield in seed multiplication	17
Low shelf life of seed (insect attacks, moisture contact)	25
Additional resources is required to produce hybrids	8
Heavy postharvest loss of some varieties if not properly handled	17

Source: DTMA seed sector survey, 2007/2008.

Table 12. Technical constraints affecting expanded seeds sales in the agro ecologies (% of respondents).

Technical factors	West Africa	Bénin	Nigeria	Ghana	Mali
N	23	4	10	7	2
Inadequate skill of technicians for hybrid seed production	39	50	30	29	100
Lack of access to production inputs	22	25	40	–	–
Difficulty in the adoption and adaptation to new production techniques	17	25	10	28	–
Land scarcity	4	25	–	–	–
Lack of drought tolerant maize materials	13	25	20	–	–
Lack of up-to-date equipment, machinery, and their maintenance	35	25	40	43	–
Inadequate improved varieties (foundation/ breeder seeds)	4	–	–	14	–
Drought (inadequate rainfall to grow seed)	4	–	–	14	–

Source: DTMA seed sector survey, 2007/2008.

The results of the study showed that the major technical-related factors that need to be supported for expanded seed sales in all agroecologies and in drought-affected areas include the following:

- Extension support for awareness creation.
- Improvement in the efficiency of grain markets.
- Support and training on seed production techniques.
- Provision of and easy accessibility to micro-credit facility for seed distributors and farmers.
- Provision of subsidies on seed supply to farmers.
- Credit for processing facilities.

In Nigeria, making available the germplasm that is suitable for various ecologies, enhancing capacity building for production and marketing personnel, improving infrastructure, and creating awareness through extension support were major support measures that could promote expanded seed sales in general and into drought affected areas in particular. In Bénin, the need to acquire the necessary equipment for seed production was considered by seed providers as the major constraint to the expansion of OPV maize seed sales. Hence, improving access to seed production equipment, such as tractors for land preparation, and technical support and training on seed production techniques would be appropriate for promoting expanded seed sales. In Ghana, the technical support necessary for the expansion of seed sales into drought affected areas included awareness creation on the DT maize varieties through extension services, technical assistance to open up sales outlets, the provision of ancillary infrastructure such as cold rooms, and facilitating access to micro-credit for seed production and distribution. In Mali, the major technical support areas that are urgently required include the provision of foundation/breeder seeds of the DT varieties and hybrids, capacity building of the local personnel on seed production and marketing, as well as the setting up of relevant institutions and mechanisms to accelerate the seed certification process.

Lack of access to production credit

The seed industry requires substantial capital investment, especially in infrastructure and machinery. Seed production is a business with large economies of scale. Therefore, it is clear that seed providers need financial support to expand production and enjoy economies of scale. The private seed companies, that import the machines, equipment, and chemicals, are often victims of macroeconomic instability (such as fluctuating exchange rates and a high level of inflation) that results in high interest rates and depreciation in the value of money, thereby generally discouraging investment. This is emphasizing the need for a general policy environment that creates incentives for investment in the seed sector.

Institutional problems limiting seed production and deployment

An examination of the typical institutional pattern for seed production and deployment systems in West Africa revealed a mixture of public and private sector activities, with various programs charged with the responsibility for ensuring effective seed production and distribution.

In Nigeria, the agricultural seed council (NASC) is the main institution regulating the seed industry. It was created in 1975 and assigned six key functions:

1. The development, certification, and quality control of seeds through varietal improvement, testing, registration, release, and multiplication of released varieties.
2. Seed technology development, technical support services, seed industry development, and co-ordination of breeder and foundation seeds.
3. Production of foundation seed, distribution, and monitoring of certified seeds.
4. Planning and monitoring of the national seed program.
5. Publication of the list of registered, released, or certified seeds varieties approved for commercialization in Nigeria.
6. Assisting in the development of the private seed industry in production, marketing, and distribution (Echekwu 1991; NSS 2000).

In Nigeria, according to the National Seed Service (NSS) (1997 and 2000), not only are investment funds reportedly inadequate, they are usually disbursed late, resulting in distortions in the various activities of the seed companies in particular, such as the breeding program. Constraints associated with the lack of appropriate varieties and hybrids, and of access to maize seed production and processing infrastructure were also common to the study countries. These may be as a result of the limited effort devoted generally to the development of germplasm and their inadequate availability. This further suggests the need for CIMMYT and IITA to intensify the efforts in developing adequate amounts and more appropriate germplasm to meet these requirements.

In Ghana, the majority of the seed providers are agrodealers who sell improved seeds along with other agricultural inputs (e.g., pesticides and fertilizers). The formal seed sector is still very small with only one private seed company in existence during the survey. The new companies emerged shortly after the survey. Alhassan (2006) estimates that only 10% of the seeds planted in the country are certified seeds provided by the formal sector and the rest is sourced from the informal seed sector. Production of hybrid seeds is assisted by NGOs and the MoFA. The creation of the seed producers association of Ghana (Seedpag) has contributed to the increase in production of certified seeds in the country (Alhassan 2006).

In Bénin, the seed production and marketing system was organized around the extensive tradition of farmers' cooperatives and the "community-based seed production" schemes introduced by the West and Central Africa Maize Network (WECAMAN) from the early 1990s. Farmers' organizations were equipped and provided with technical and financial support to help them produce improved quality maize seeds. The seeds were marketed through a dedicated technical support service of the ministry of agriculture. Since no seed company exists yet in the country, these community-based seed production schemes will continue to play an important role here. There are also opportunities for foreign seed companies from the ECOWAS or other African regions to position themselves in this market.

In Mali, until recently, seed producers and sales companies[3] were marginal, except for rice and imported horticultural seeds. Also, during the last two years, a very small group of private dealers started selling limited quantities of certified seeds to both large and small farmers. Touré and Sanogo (2006) reported two major channels of seed production and distribution in the country. The most important was the state-controlled production and distribution structure for seeds of cereal crops that was organized by the Service Semencier National (SSN) that still produced most of the foundation cereal (sorghum, maize, millet) seeds. These were mostly produced on ssn-owned seed farms by tenant farmers, but some farmers have also commenced seed production on their own land for sale to government establishments. The certified seeds are produced mostly by the Cellules Semencières Villagoises (CSV), which are village groups formed and advised by SSN to produce seeds that are marketed through SSN. However, most often, the group members retain large parts of their production on the farm or for distribution to neighbors instead of delivering them to the CSV to follow the official channel of distribution.

Evidence from Kormawa et al. (2000) revealed that the various bodies charged with the responsibilities associated with effective implementation of the seed policy have not performed credibly. Problems persist on seed production, seed marketing, quality control and farmer utilization. Hence, seeds of local varieties still dominate as a result of inadequate production, ineffective distribution, slow release of improved varieties, and an inadequate network to disseminate information on certified improved seeds. Consequently, formal seed providers are generally faced with diverse problems that have impeded effective participation and investment in the industry.

[3] New private seed companies such as Faso Kaba have since been created.

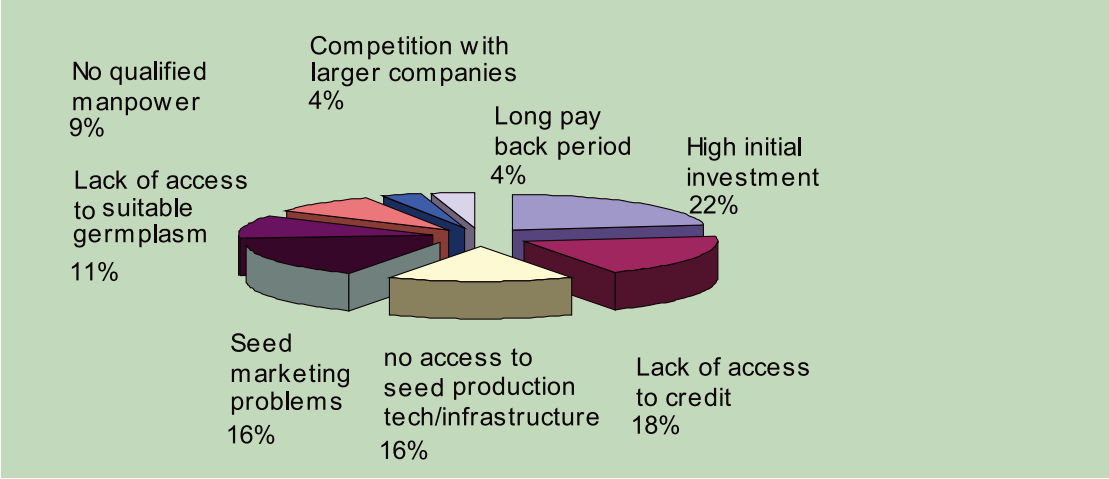

Figure 8. Institutional problems affecting the establishment of a seed company in West Africa
Source: DTMA seed sector survey, 2007/2008.

Table 13. Main barriers to new entrants into the seed business in West Africa (%).

Barriers	West Africa (n = 31)	Nigeria (n = 13)	Bénin (n = 1)	Ghana (n = 13)	Mali (n = 4)
Competition with larger companies	7	8	–	8	–
Seed marketing problems	39	62	–	23	25
Lack of access to production credit and other credit facilities	65	100	100	23	75
Unfavorable seed policy environment	58	46	100	54	100
Low adoption rate by farmers	7	15	–	–	–
Lack of access to suitable germplasm	29	39	100	15	25
Lack of qualified manpower	16	39	–	–	–
Lack of access to extension services	3	–	–	8	–
High initial investment outlay	42	46	–	54	–
Unfavorable climatic conditions	16	39	–	–	–

*only 1 respondent from Bénin
Source: DTMA seed sector survey, 2007/2008.

Major institutional obstacles in the establishment of seed companies in West Africa are caused by high initial investment costs, lack of qualified manpower, lack of credit facilities, and emerging companies' difficulty in surviving the high levels of competition with larger companies. These problems are specific to Nigeria, Ghana, and Mali that have an institutionalized seed system (Fig. 8).

Factors affecting the establishment of a seed production unit

Seed production units are usually bedeviled with various problems at set up. Major barriers to new entrants into the seed businesses in West Africa are shown (Table 13). At the regional level, lack of credit, an unfavorable seed policy environment, and the high initial investment required are cited as the main barriers to new entrants in the seed sector.

In Nigeria, the main barriers to the creation of a new seed business are reported to be the lack of credit and an unfavorable policy environment (Table 13). In Mali, all (100%) of the seed providers reported some difficulties in registering their businesses and found the licensing process requirements too difficult to satisfy. Another relatively important barrier to entry into seed business was the lack of access to production credit and other credit facilities. In Ghana, major barriers to new entrants are reported to be the unfavorable seed policy environment and the high initial investment outlay. Benin had only one respondent who focused mainly on credit issues, seed policy, and access to suitable germplasm (Table 13).

Seed marketing and distribution
Apart from seed production, proper and effective seed marketing and distribution are essential components of seed sector development. This section discusses the major factors hindering seed marketing, distributions, and delivery systems in West Africa.

Developing high yielding OPVs and hybrids alone without making them available and accessible to farmers in rural areas will not yield the intended benefits (IFDC/IITA/WARDA/FGN 2000). In Bénin and Mali, seed marketing problems were cited as a major constraint to seed sector development by seed providers. However, in Nigeria and especially in Ghana, the seed providers have fewer problems in marketing their production. Key informants revealed that farmers, cooperative societies and NGOs usually prefer to obtain their seeds through government agencies because of their perceived closeness to farmers in the rural areas. However, in all countries, funding problems have generally hindered these agricultural development agencies from achieving this role. In Nigeria, the major seed marketing problems that hinder seed distribution are the lack of market infrastructure and poor roads.

In Bénin, all the seeds produced by the community-based seed producers were often bought by a governmental agricultural development support agency for sale to individual farmers. This monopolistic seed distribution system negatively affected community-based seed producers and contributed to the subsequent failure of the community-based seed production and distribution schemes in the country. In Ghana, major problems included seed adulteration by unscrupulous businessmen, high marketing costs, and the high cost of activities to prevent sales.

Despite these challenges, 85% of the seed providers in the West African region are optimistic that they will increase the production and marketing of OPV and hybrid maize seeds in the nearest future and about 80% indicated having a reasonable chance to enlarge the scope of their seed businesses. This suggests that there is a potential for development of the seed sector, given the needed support.

Poor market infrastructure
Commercial seed trade is an essential feature of industrial agriculture (Tripp 2001), and seed marketing is a vital link between the seed producers and the farmers who ultimately use the seeds (Sasto 1969, OMaliko 1998). The present study showed that the surveyed seed companies, more often than not, suffered the problem of unsold stocks because of their weak marketing arrangements. Most rural areas are difficult to reach largely owing to the poor nature of roads that hinders movement. Furthermore, rural communities lack the appropriate extension services. One of the consequences of poor rural roads is the high cost of input delivery as the few dealers who find their way into such rural areas often exploit the farmers by charging high prices for their stock. In an attempt to address this problem, the NASC in Nigeria, for instance, has put in place the Community seed development program with the hope of diffusing improved seeds into rural communities. However, this scheme is not yet in operation nationwide. Effective seed supply requires timely delivery of appropriate varieties and support to the local seed production and farming systems (NSS 2000). There are inadequate retail outlets, however, and a lack of information on the seed markets that can ensure prompt delivery of high quality seeds to farmers at any time and in any place. The seed providers attributed this partly to a poor transportation network. Thus, effective and efficient distribution systems would require an efficient information flow, a highly effective coordination, and a state of readiness with appropriate mechanisms planned in advance. This is especially important in isolated and drought-affected areas. The seed providers in all four countries complained about the problem of inadequate extension services and the fact that many of them do not have sufficient sales outlets in the rural areas.

In Ghana, the major seed marketing problem is that the seed system is dominated by the farmers' practice of recycling seeds. Farmers do not readily buy improved seeds because most of them cannot afford to pay about US$ 1.00/kg as the price of certified seeds. A further disincentive to the purchase of improved seeds is the farmers' inability to buy the inorganic fertilizer that is needed for the improved seeds to reach the full yield potential. However, in recent years, the effort of Ghana's MoFA and Technoserve (a private sector operator) in educating farmers on the production of hybrid seeds has started to bring about a change of attitude among farmers (Alhassan and Bissi 2006).

In Mali, more than 80% of maize growers still used local varieties, and the farmer-to-farmer seed exchange system was predominant. Most seed exchanges between farmers (local and improved varieties) did not involve any exchange of money. Added to this, subsistence farmers were not accustomed to buying inputs of any sort (Toure and Sanogo 2006). Other marketing problems that emerged from this study included a lack of confidence among local maize producers in the quality of the seeds being marketed and the high cost of marketing and promotion of products (advertisements).

Seed delivery problems

The average time taken between seed development and release is about 2½ years in Nigeria. Within the 12-year period, from 1994 to 2006, the shortest time period recorded for seed release was one year; while the longest period was five years. It is expected that a shorter release time period will enhance seed sector development. This did not apply to Bénin where there were no seed companies during the survey period.

The majority of the seed companies in the four countries (> 50%) used their own retail outlets, private wholesalers (e.g., supermarkets,) and private retailers (e.g, chain stores, agrodealers, etc.) as sales outlets. Other sales outlets such as government agents and NGOs were only popular only in Ghana, and to a lesser extent, in Bénin.

Table 14. Problems of seed distribution through the various sales outlets in West Africa (% of respondents, n = 39).

	Own retail outlets		Private wholesalers		Private retailers		Government agents		NGOs	
Problems	OPVs (n = 8)	Hybrids (n = 4)	OPVs (n = 8)	Hybrids (n = 7)	OPVs (n = 9)	Hybrids (n = 5)	OPVs (n = 7)	Hybrids (n = 3)	OPV (n = 4)	Hybrids (n = 3)
Increase in overhead/ transaction costs	25	50	13	14	11	–	–	–	–	–
Use of outlet not very sustainable (some produce seed too)	25	25	13	14	–	–	29	67	–	–
Bad credit habit	–	–	75	71	56	60	43	–	25	33
Poor storage facilities	–	–	13	14	–	–	14	33	–	–
Seed adulteration/ fake seed	13	–	13	14	11	–	14	–	–	–
Unpredictable sales ordering by NGOs	–	–	–	–	–	–	–	–	75	33
Unstable government policy not promoting seed business	–	25	–	–	–	–	14	67	–	
Lack of information on the available varieties	25	25	–	–	–	–	–	–	–	–
Prices usually low	38	–	13	–	33	40	14	–	–	–
Coordination and handling problems	38	50	–	14	–	–	14	–	25	33

Source: DTMA seed sector survey, 2007/2008.

The various constraints faced by seed companies in West Africa in their use of the different sales outlets are shown in Table 14 and Annex (Tables 23a and 23b; 24a, 24b, and 24c).

For both OPVs and hybrids in the region, coordination and handling problems, high overhead costs, and the use of unsustainable sale outlets were the major difficulties faced by retail outlets owned by seed companies. A bad credit habit was specific to the outlets of private wholesalers. These discouraged most seed providers and heavily constrained seed distribution in the subregion. Seed adulteration and low seed sales were additional problems for private retail outlets, while coordination and handling problems were the only major difficulties encountered in seed sales through NGOs. This was because NGOs are fund seekers, and their inability to get appropriate funds contributed to their late placement of orders. In Bénin, seed sales were mainly through government agencies and a bad credit habit was the major constraint associated with the use of this channel.

One major limitation on the efficiency of retail agents was their apparent lack of knowledge about the characteristics of the varieties they retailed. This made it difficult for them to educate farmers on purchasing varieties suitable for the farmer's ecology. In general, the use of the existing retail outlets in the region is not sustainable as most agro-dealers in particular had inadequate operating capital. Companies, therefore, delivered the seeds to them on a consignment basis and at the end of the marketing season any unsold seeds were retrieved and restocked at high cost.

At the country level, constraints associated with the coordination and handling of OPV and hybrid retail, increased overhead and transaction costs, as well as use of unsustainable outlets were the major constraints in Nigeria (see Annex Table a5). There were no constraints to seed retailing in Bénin, but lack of information on available varieties was the main challenge in Mali. In Nigeria and Ghana, a bad credit habit was a common constraint with retailing through private retail and wholesale outlets. In addition, high transaction costs, poor storage facilities, and seed adulteration were problems in Nigeria. In Ghana, there were occasional misunderstandings between seed providers and retailers over pricing. In addition to the untimely placement of orders, sometimes some NGOs were found to be dishonest.

There were variations in the seed prices of OPVs and hybrids (Annex Table a5) from different sources and locations. The average price per kg of OPVs varied in the four West African countries in the 2006 period; 170 FCFA in Bénin, 0.725 GHC in Ghana, 300 FCFA in Mali, and ₦117 in Nigeria. Average hybrid prices per kg were 1.11GHC in Ghana and ₦134 in Nigeria in the 2006 period. Most farmers could not afford buying the seeds even at these prices, and preferred to recycle previous stock. In pricing seeds, seed companies took into consideration their direct and indirect costs, profit margin, and other marketing factors. The direct costs include the costs of seed production, processing, and distribution. Indirect costs are expenses such as management costs, taxes, insurance, building maintenance and repairs, and depreciation, which are not directly related to the volume of seeds produced or sold. These factors are taken into consideration by private seed companies in fixing seed prices, resulting in price variations between private and public seed producers. In Nigeria, private companies' purchase price for seeds produced under contract was usually negotiated between the company and the seed growers. Seed produced through the ADPs was not. Apart from the government's price subsidy for seeds produced in the public seed sector, the public seed producers also enjoy greater patronage than the private seed industries. Consequently, seed prices from public seed producers were generally lower than those of private seed companies. This development is a natural fall out of the raison d'être of the two entities. The private seed companies were established to engage in commercial production and trading in seeds to make a sufficient amount of profit to compensate investors. The government agencies exist solely for the political purposes of the welfare of the citizenry, to ensure political stability, foster equitable social and economic development, and bridge poverty gaps, etc, through several policy interventions that include the development of the agricultural sector (e.g., through the availability of agricultural inputs).

Table 15. Reasons for pricing OPV seed differently from hybrid (% of respondents).

Reasons[§]	Nigeria (*n* = 9)	Ghana (*n* = 9)
Hybrids are more expensive to produce compared to OPVs	89	100
Hybrids have stable and uniform yield	22	–
Hybrids have a higher yield than OPVs	33	33
Packaging differences between the hybrids and OPVs	11	–
Hybrid needs more attention in processing stage than OPVs	11	22
Location of purchase	11	–
Demand for hybrids is higher (high demand attracts higher prices)		11
Hybrid is drought tolerant	–	22

[§]Hybrid seeds were not available in Bénin and Mali.
Source: DTMA seed sector survey, 2007/2008.

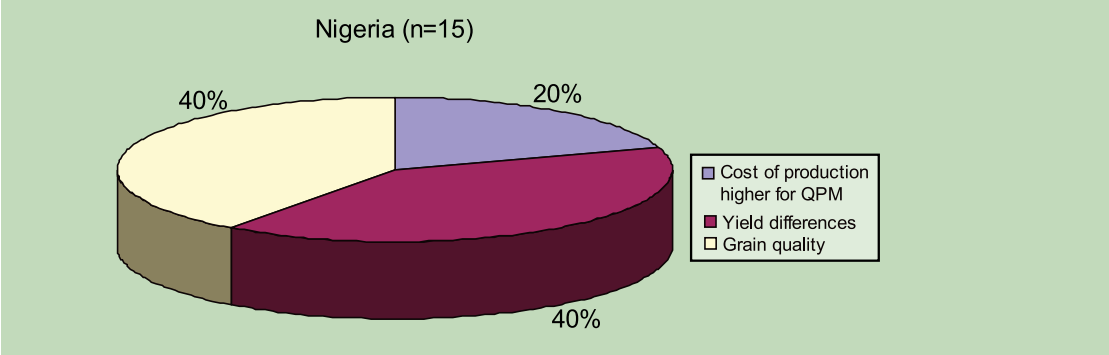

Figure 9. Reasons for differences in seed price of OPVs.
Source: DTMA seed sector survey, 2007/2008.

Furthermore, there were various reasons for price variations between OPVs and hybrids (Tables 15).

In Nigeria, yield differences, grain quality, and the high cost of production of quality protein maize (QPM) were the three most important reasons for pricing OPVs differently (Fig. 9). However, in Ghana, the only reason why there was a price differential between OPVs was because of the bio-fortification of some of the varieties (e.g., golden jubilee variety). In Mali, it was due to grain utilization (human consumption versus use as livestock feed). Furthermore, the seed companies in Nigeria and Ghana (no hybrids in Bénin and Mali) indicated that high cost of production, high yields, as well as more stable and uniform yield were the reasons for pricing OPV seed grains differently from hybrids.

Constraints limiting seed demand at the farm level

The demand for improved seeds is relatively low, due mainly to various constraints, such as poor promotion and marketing efforts, high prices, and the inability of farmers to purchase complementary inputs, especially fertilizer. The major limiting factors as perceived by the seed providers in the four study countries are presented in this section.

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

The lack of awareness about new maize varieties, due mainly to an ineffective and poor extension system, was a major cause of the low level of adoption of improved maize varieties in Bénin and Nigeria. Constraints to the rapid adoption of new maize varieties by farmers in

Table 16a. Constraints to the rapid adoption of new maize varieties in West Africa.

Constraints	% of respondents (n = 36)
Some new varieties have high inputs requirement	8
Inadaptability of some new varieties to the environment	11
Ineffective and poor extension system	50
Lack of access to credit	39
Small land holdings and land tenure problems	8
Marketing difficulties (problems)	20
Non-availability of complementary inputs	14
Risk aversion (fear of consumer/market acceptance of new technology)	33
Farmers and seed value chain actors are not well organized	14
Substantial change in varietal characteristics (e.g., taste)	3

Source: DTMA seed sector survey, 2007/2008.

Table 16b. Possible solutions to the constraints to rapid adoption of new maize varieties in West Africa

Possible solutions	% of respondents (n = 36)
Promote varieties with little input requirement	8
Provide appropriate technology	31
Establish an appropriate extension system	69
Improve grain marketing system	11
Government to provide total support for new technology (e.g., mop gluts)	61
Organize actors along seed value chain	3
Government intervention to improve infrastructure	6
Creating confidence in farmers through quality seed delivery	3
Promote hybrid maize seed to forestall OPVs seed saving culture	6

Source: DTMA seed sector survey, 2007/2008.

Nigeria, however, included the lack of access to credit and non-availability of complementary inputs. In Bénin, similar problems existed in addition to the poor adaptation of some of the new varieties to the environment (Table 16).

The respondents suggested possible solutions to the constraints enumerated in Table 16a. In particular, respondents recommended the use of participatory approaches in technology testing and demonstrations (through appropriate extension system), government's support to improve farmers' access to new and appropriate production technologies, and the provision of subsidy on other farm inputs such as fertilizers and pesticides. Furthermore, the improvement of grain marketing systems and establishment/funding of effective and efficient extension systems were among other possible ways of solving the problems associated with the rapid adoption of maize varieties in the region (see Tables A3b (i–iv) in Annex III for country-specific details).

Seed providers' perception of farm-level demand

The main reasons for the low farm-level demand for improved seeds were the low rate of adoption by farmers in Nigeria and Ghana, poor extension support to new technology dissemination in Bénin and Nigeria as well as farmers lack of confidence in the quality of seed sold in Mali. High seed prices were also notable in Nigeria (Fig. 10). Seed providers attributed the problems in farm level demand to poor promotion and marketing efforts, high prices, and the inability of farmers to purchase complementary inputs, especially fertilizer. Increasing the demand for improved seeds by farmers through effective extension and seed promotional activities could be the right approach to addressing these problems.

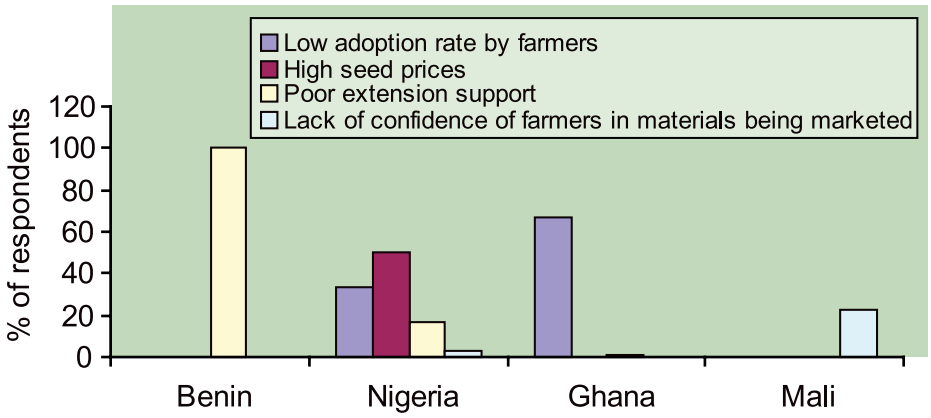

Figure 10. Seed companies perceptions of factors influencing farm-level demand.
Source: DTMA seed sector survey, 2007/2008.

Table 17a. Policy constraints to expanding sales of maize seed into drought affected areas (% of respondents).

Policy constraints	West Africa (n = 25)	Bénin (n = 3)	Nigeria (n = 9)	Ghana (n = 11)	Mali (n = 2)
Government bureaucratic inefficiency	8		22	–	–
Lack of awareness of policy makers on DTM	8		22	–	–
Lack of agricultural input subsidy	20		33	18	–
Late release of inputs by government	4		11	–	–
Lack of research support from government	20		56	–	–
Weak/no enforcement of seed laws (e.g., on quality, etc.)	20		11	18	100
Unstable government (seed) policies	12		33	–	–
Lack of capacity in advocacy	4	33		–	–
Difficult collaboration with intermediary institution (in seed value chain)	8	67		–	–
Policy that encourage seed importation into the country	12	–	–	27	–
Too many regulations of seed sector on foundation/breeder seed prod	12	–	–	28	–
Lack of access to agricultural credit	4	–	–	9	–
Poor extension support	4	–	–	9	–

Source: DTMA seed sector survey, 2007/2008.

Table 17b. Possible policy solutions to expanding sales of maize seed into drought-affected areas (% of respondents).

Policy solutions to constraints	West Africa (n = 24)	Bénin (n = 3)	Nigeria (n = 8)	Ghana (n = 11)	Mali (n = 2)
Improve research support/funding	13	–	38	–	–
Capacity of building for policy makers in DTM related issues	8	–	25	–	–
Early release of inputs at subsidized rates	13	–	38	–	–
Stable government policies	17	–	50	–	–
Harmonize/strengthen seed regulations and laws	21	–	13	18	100
National policy to have a focus on cooperative organization	4	33		–	–
Collaboration amongst supporting institutions	13	67	13	–	–
Government to subsidize cost of seed to farmers	8	–	–	18	–
Introduce policy to stop seed importation into the country	13	–	–	27	–
Make law on production of foundation seed flexible	13	–	–	27	–
Government to provide access to agricultural credit	4	–	–	9	–
Government to fund and equip extension services	4	–	–	9	–

Source: DTMA seed sector survey, 2007/2008.

Policy-related challenges to seed production and deployment

There were distinct country variations in policy factors limiting expanded seed sales by seed companies, particularly in drought-affected areas. The various policy constraints and issues for consideration are presented [Table 17a and b, Fig. 11].

The policy interventions required varied across the four study countries. The private seed sectors in Nigeria and Ghana are relatively better developed than those in Bénin and Mali. Consequently, Bénin and Mali require more policy interventions to get the private seed sector started[4]. Major policy factors in Nigeria included a lack of research support from government, lack of agricultural input subsidy, and unstable government policies (seed). In addition, policy-makers' lack of awareness of DT maize and government bureaucratic inefficiency also constituted barriers to scaling-out seed sales to drought affected areas in the country. Addressing these problems could have great impact in improving Nigeria's seed sector. In Ghana, other areas that required interventions included the lack of agricultural input subsidy, weak or outright non-enforcement of seed regulatory laws, promoting seed importation into the country, and the inflexibility of the law that seeks to regulate the production and distribution of foundation/breeder seeds.

In Bénin, the difficulty in collaborating with intermediary institutions in the seed market chain and the lack of capacity in advocacy, accounted for the largest component of policy issues affecting expanded seed sales. In Mali, the major policy thrust was on the weak or outright non-enforcement of seed regulatory laws. Results showed that the policy support options required by the seed providers in Bénin included the need for a national policy that focuses on cooperative organizations for small seed producers and ultimately on the creation of private seed companies. Strengthening seed regulations and laws in Mali and Ghana will improve seed sector development. In Ghana, an additional policy measure to advance the seed sector is to remove the restrictions on the production and distribution of foundation/breeder seeds.

At the regional level, West Africa is improving seed distribution policy through ECOWAS but more needs to be done to promote awareness among stakeholders about these policies and to implement them. Nigerian seed companies are already selling seeds in neighboring countries. However, due to lack of enforcement of ECOWAS rules and good integration, markets in northern Bénin are not being supplied with seeds. Therefore, the major strategies that could be used by seed companies to expand seed sales included credit provision to producers for seed production and processing to deal with the liquidity constraint of seed providers. This will allow the existing companies to expand operations and take advantage of ECOWAS' trade rules.

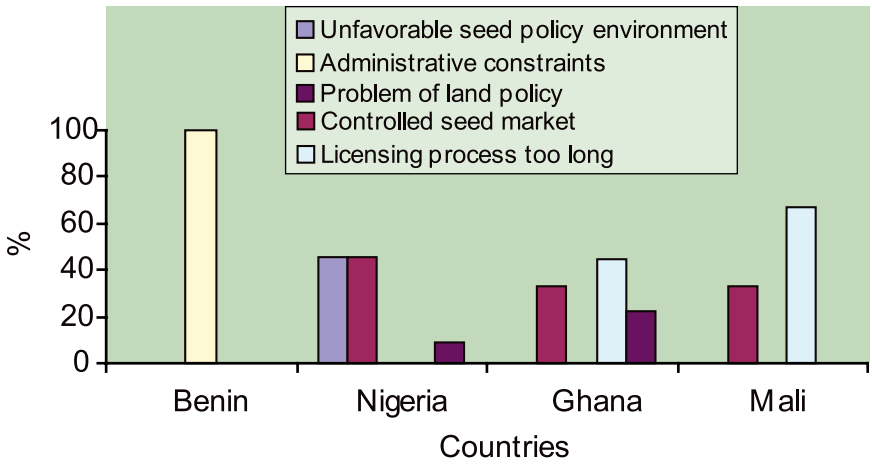

Figure 11. Major seed policy related problems hindering the production and distribution of seeds in West Africa.
Source: DTMA seed sector survey, 2007/2008.

[4] This has since become more important for Bénin. In Mali, the private seed system has since our survey made big strides with the help of the AGRA seed program.

Factors constraining the deployment of newly released varieties

The various limitations to the rapid dissemination of new maize varieties and hybrids by seed providers in the study countries are discussed in this section under three scenarios: (i) constraints to the rapid dissemination of maize varieties to farmers, (ii) constraints to the rapid diffusion of maize varieties to farmers, and (iii) factors limiting seed dissemination to different ecologies.

Constraints to the rapid dissemination of new maize varieties to farmers

In the four study countries, the major challenges to the rapid dissemination of newly released maize varieties to farmers were the unavailability of seed in commercial quantities, lack of awareness of available varieties and hybrids, lack of access to credit facilities by farmers, and the high relative price of seeds (Table 18). This implies that setting up training programs to provide adequate information about a new variety, as well as actions to ensure the availability of seeds in large quantities would help to improve the activities of the seed industry and get maize varieties rapidly to the farmers. This would in turn increase sales outlets and provide readily available information (as a database) about various maize buyers in different locations, and thus help to promote seed dissemination in these areas. Developing varieties with broad adaptation to different agroecological zones, as well as providing effective extension delivery services to seed providers would further help in rapidly disseminating the new maize varieties and hybrids.

Constraints to the rapid dissemination of new maize varieties to many farmers

The limitations in getting new maize varieties to many farmers in terms of scale and scope of marketing varied for each country, as shown in Table 19.

In Bénin, monopolistic distribution of seeds through a single intermediary, slow reimbursement of seed sales on credit, difficulty in having access to other maize seed buyers, and the low demand resulting from farmers' lack of awareness were the four main problems identified. The demand for improved seed was also relatively low, mainly because of poor promotion and marketing efforts, high prices, and the inability of farmers to purchase complementary inputs, especially fertilizer. These constraints are similar to those affecting rapid dissemination of the new maize varieties to farmers, and therefore suggest that any policy strategy designed to remove them would greatly help in the development of the seed industry.

Table 18. Factors impeding the rapid deployment of new varieties to farmers in West Africa (% of respondents).

Factors	West Africa (n = 34)	Nigeria (n = 13)	Bénin (n = 4)	Ghana (n = 12)	Mali (n = 5)
Unavailability of foundation seed in commercial quantity	35	62	–	33	–
Lack of awareness (through demos/adverts) about the variety	44	62	25	25	60
Fake merchants who repackage low quality seeds with company bag	12	8	50	8	–
Lack of access to credit facilities by farmers	41	54	–	42	40
High cost of seed distribution	24	23	50	17	20
High relative price of seed	9	23	–	–	–
Slow certification process for new seed varieties	18	–	25	17	60
Poor adaptability of varieties to different ecologies	12	15	25	8	–
Difficult to change old habits and cultures	6	8	–	8	–
Slow reimbursement of seed credit sales	9	8	50	–	–

Source: DTMA seed sector survey, 2007/2008.

Table 19. Main constraints in getting new maize varieties to many farmers (% of respondents).

Constraints	West Africa (n = 31)	Nigeria (n = 12)	Bénin (n = 4)	Ghana (n = 10)	Mali (n = 5)
Lack of finance for expanded seed production	55	67	–	70	40
Government regulatory agencies create unfair competitive environment for seed production	29	42	50	–	40
Retrieval of unsold seeds expensive	10	8	50	–	–
Lack of techniques by distributors in handling seed	10	8	50	–	–
Unsuitability of germplasm for different ecologies	10	17	–	10	–
Non availability of fertilizer and other farm inputs	7	17	–	–	–
Lack of extension services support	29	25	25	40	20
Lack of infrastructure to distribute seeds	16	33	–	10	–
Slow certification process for new seed variety	3	–	–	–	20
Lack of confidence in materials being marketed	10	–	–	10	40

Source: DTMA seed sector survey, 2007/2008.

In Nigeria, the lack of infrastructure to distribute seeds, government input subsidies programs (especially seed prices), and poor extension support were the critical impediments to spreading new seed varieties to many farmers. Most rural areas are difficult to reach, due largely to poor roads, that prevent extension staff from contacting the rural communities. Supply of improved seed varieties to such rural communities is also affected. Hence, many farmers in such communities are denied the benefits of improved technology (e.g., storage facilities) while input delivery comes at high cost. Providing good roads and transport facilities, uninterrupted power supply for proper storage, as well as effective extension advice on appropriate agronomic practices to be followed by farmers, would generally promote the seed dissemination process. Other limitations in Nigeria included lack of finance for expanded seed production, an unfair competitive environment for seed production created by the NASC/government, an inadequate supply of breeder seeds, the non-availability of fertilizers and other farm inputs, and the unsuitability of germplasm/varieties for different ecologies.

In Ghana, production constraints, such as inadequate access to breeder/foundation seeds and limited production capacity, such as the scarcity of farmland and other kinds of production infrastructure were the major potential sources of delay. Other potential problems included marketing constraints such as the lack of infrastructure for seed distribution and the low level of demand as farmers were not aware of the benefits of new technologies.

In Mali, major sources of delay were gross lack of confidence in the seeds being marketed, policy constraints such as taxation on seeds, ineffective seed law, and the slow certification process for new seed varieties. Other limitations in Mali included a lack of extension support and the lack of access to micro-credit for large-scale seed production.

Factors limiting seed dissemination to different ecologies

The difficulties in disseminating maize seed to different ecologies that are affected by various levels of drought are shown in Table 20 (a–c) and Annex, Tables A6 (a–d).

Table 20a. Barriers in getting new varieties to farmers in high potential areas, rarely affected by drought.[1]

Barriers	Nigeria (n = 15)	Bénin (n = 4)	Mali (n = 6)
Lack of confidence in materials being marketed	20.0	–	–
Competition with other seed producers	20.0	–	–
Poor grain market for farmers	30.0	–	–
Lack of awareness of varieties	20.0	–	50.0
Expensive retrieval of unsold seeds	10.0	–	–
Limited financial resources to produce and market seed	–	50.0	–
Lack of modern equipment for seed processing	–	50.0	–
Recycling of OPV seed by farmers	–	–	50.0

Source: DTMA seed sector survey, 2007/2008.
[1] Low occurrence of drought: drought occurs only in 0 to 1 years out of every five years.

Table 20b. Barriers in getting new varieties to farmers in high potential areas sometimes affected by drought.[1]

Barriers	Nigeria (n = 15)	Bénin (n = 4)	Mali (n = 6)
Lack of confidence in materials being marketed	12.5	–	–
Farmers' resistance to change	12.5	–	–
Poor grain market for farmers	12.5	–	–
Lack of drought tolerance maize seed varieties	12.5	–	–
Lack of awareness of varieties	25.0	–	–
Poor road infrastructure	12.5	–	–
Limited financial resources to produce and market seed	12.5	–	–
Slow seed certification process	–	100.0	–
Subsistence farmers are resource poor	–	–	100.0

Source: DTMA seed sector survey, 2007/2008.
[1] Medium occurrence of drought: drought occurs in about 2 to 3 years out of every 5 years.

Table 20c. Bottlenecks in getting new varieties to farmers in drought-prone, low potential areas.[1]

Bottlenecks	Nigeria (n = 15)	Mali (n = 6)
Lack of confidence in materials being marketed	8.3	–
Farmers resistance to change	8.3	–
Lack of drought tolerance maize seed varieties	8.3	–
Lack of awareness of varieties	17	–
Poor road infrastructure	8.3	–
Limited financial resources to produce and market seed	42	–
Lack of modern equipment for seed processing	8.3	100

Source: DTMA seed sector survey, 2007/2008.
[1] High occurrence of drought: drought occurs in about 4 to 5 years out of every 5 years.

In Bénin, the existing seed providers indicated that limited financial resources to produce and market seeds as well as a lack of modern equipment for their processing were the two major barriers to the dissemination of new varieties to areas of high potential that are rarely affected by drought. Adequate credit provision through various channels such as microfinance organizations would therefore help to promote seed production and marketing to farmers in this area. In the areas of high potential sometimes affected by drought, the only constraint identified was the slow procedure for seed certification. Thus, a prompt and effective seed certification process is capable of addressing this problem.

In Nigeria, lack of awareness of varieties, lack of confidence in materials being marketed, and the poor grain market impeded new variety dissemination. This suggests the need for

effective tools (such as advertisements, radio, and television announcements) for promoting new varieties. The development of good quality and high yielding varieties would promote the marketing of these varieties, and policies that promote and increase profitability of agriculture would also stimulate farmers' interest in improved seeds. Strict enforcement of seed laws is important so that the activities of unscrupulous seed providers who mix seeds of various qualities or standards together for sale to farmers will be checked and punished. A poor grain market for farmers, competition with other seed producers, and the costly retrieval of his unsold seeds from sales points were other obstacles to the dissemination of new maize varieties to areas of high potential rarely affected by drought. Strategies aimed at developing the grains market and the promotion of good quality seeds make dissemination of new maize varieties possible in the face of competition with other seed producers. On the other hand, creation of awareness with extension support would lead to increased demand and might reduce the severity of the problem of unsold seed stock.

In Mali, seed providers pointed out that the current practice of seed saving and recycling of old seed by farmers and the lack of awareness of the potential economic benefits of new varieties were the major difficulties in getting new varieties to farmers in areas of high potential rarely affected by drought. This situation suggests a need for more education and information (training programs) for farmers and extension support for new varieties that are to be released.

In the areas of high yield potential sometimes affected by drought[13], lack of confidence in the quality of materials being marketed, farmers' resistance to change, lack of DT varieties, and limited financial resources to produce and market seeds were identified as constraints in getting new varieties to farmers. This further shows the importance of providing good quality seeds and the need to change farmers' attitude by practical demonstration of the benefits of the varieties on their farms. There is also a need to invest in the development of DT varieties to ensure continuous production in this area. Microfinance institutions should provide credit opportunities to seed providers.

According to the seed providers in drought-prone, low potential areas of Nigeria, getting new varieties to farmers was hindered by poor road infrastructure, in addition to the constraints listed for areas with high potential. Hence, any developmental program or strategy targeted at getting new varieties to farmers in this area should aim at improving rural infrastructural facilities and providing incentives to seed companies to move into these regions. Results from Mali showed that the major difficulties in getting new varieties to farmers in drought-prone, low potential areas was the lack of modern equipment for seed processing. There is therefore the need for microcredit facilities to enable local seed processors to facilitate expanded seed sales to drought-prone areas.

Concluding remarks and policy implications of the results

This study on the maize seed sector has covered four West African countries (Bénin, Ghana, Mali, and Nigeria) that are part of the DTMA project. From the results, the level of development of the seed sector can be summarized as follows. First, the study found that Bénin had no formal seed delivery system at all at the time of the study. There is no private seed company operating in that country. Second, there are emerging private seed companies in Mali and Ghana, but with different levels of success. Third, Nigeria has the most developed seed system but it is also facing many challenges related to seed production, delivery, and policy.

Hybrids have played a very important role in the development of private seed industries in countries all over the world. However, in the maize seed sector of West Africa, only Nigeria and Ghana have recorded sales of hybrid varieties during the surveyed period. Nigerian seed companies have clearly expressed their preference for producing and distributing hybrid seeds. However, despite a rapid increase in hybrid seed sales (especially in Nigeria), the current levels of availability and sales are still quite low for the promotion of a sustainable seed system. Nonetheless, most of the seed providers (85%) in the West African subregion have plans to increase production and marketing of OPV and hybrid maize seeds, and about 80% have a good chance to scale-up their seed businesses.

Major findings and potential areas of intervention for improving the seed sector can be summarized as follows for each country. In Nigeria, the provision of demonstration and extension support ranked highest, followed by the government support to emerging seed companies. In Bénin, until seed companies are created, production schemes to strengthen existing community-based seed production is required. In addition, more seed retail outlets in target areas, providing the opportunity to negotiate and sign contracts directly with other farmers, and technical support for information dissemination were the major approaches identified, particularly for areas of high potential sometimes affected by drought, and drought-prone areas of low potential. Furthermore, efforts to increase effective demand for improved maize seeds by farmers should be intensified through effective extension and seed promotional activities. This will also require fair prices for the seeds and farmers' output so that they are adequately empowered to purchase good quality seeds. In Ghana, crucial intervention areas will be improvement in access to foundation seeds and regulation of the import of seeds to help the newly established companies. Also, as in all countries, adequate demonstrations of new technologies and extension support to increase farmers' awareness of the potential of new technologies will be required. In Mali, the important areas of intervention included increasing seed processors and marketers access to microcredit, educating farmers, and increasing the awareness of the potentials of new technologies as well as of new varieties more quickly.

Based on the findings of the study, the conclusions and policy inferences for enhanced seed sector development for the four countries in the West Africa sub-egion are presented as follows:

Need for more seed companies

A number of factors are responsible for the low level of development of the seed sector in SSA. Although seed companies are critical for a viable seed sector, a total of only 11 seed companies were interviewed in the four countries studied. The number of seed companies varied by country during the study period; eight in Nigeria, two in Mali, one in Ghana, and none in Bénin. Therefore, except for Nigeria that had eight seed companies, there are too few seed companies in West Africa to drive a viable seed sector. It is almost impossible to

develop the seed sector without seed companies (indeed it has not been done anywhere in the world). Therefore, efforts should be directed towards promoting and sustaining seed companies in West Africa. In this study, technical and institutional causes of delay in the creation and sustenance of seed companies were identified. These represent a policy axis where investment is required in order to improve the production and delivery of improved seeds to farmers.

It is clear to us that the starting point in West Africa should be the facilitation of the creation and establishment of more seed companies. The existing community-based seed production schemes, which currently play critical roles in multiplying improved seeds and in increasing awareness about improved varieties within communities, should be assisted to become sustainable enterprises. They will, however, need to go through vitally required reforms to become more independent and financially viable organizations. This can start by encouraging and supporting them towards having strong linkages with seed companies where they exist, and/or instituting and following private enterprise rules in these organizations.

Increasing the adoption of improved maize

Dissemination and diffusion of improved varieties largely determine the extent of the demand for quality seeds. Efforts to increase farmers' awareness and adoption of improved varieties will increase demand and provide more incentives for the establishment of new seed companies. Currently, adoption rates in some areas of West Africa are still too low to motivate seed companies. Accelerating seed dissemination in all the different agro ecologies of the four study countries through participatory breeding, strengthening of extension services and increasing seed retail outlets using input stockists to make seed readily available to the majority of maize growers will be an essential process. Existing seed companies are greatly interested in the development and deployment of hybrids for the obvious reasons of increased profitability resulting in less recycling of seeds and more annual purchases. Therefore, increasing the development of hybrids will meet the interest of seed companies and provide them with additional incentives to invest more.

Improving varietal release process and related policies

Although most West African countries currently have varietal release committees, these are less effective primarily because of the lack of operating funds that result in their infrequent meetings to discuss the release of new varieties. This affects the period of time before new varieties are released. Farmers often start exchanging and distributing seeds of improved varieties before their official release. However, before a variety is officially released, seed companies cannot multiply and distribute seeds in a country, thus the incentive to produce large quantities is reduced.

Our study shows that new entrants into the seed business complained about high initial financial investment and the lack of qualified manpower. Additionally, the seed business requires substantial funds, making access to financing (credit) an essential requirement.

Within countries, facilitating the emergence of new seed companies and recognizing the special nature of the seed business should be a priority. It is our belief that the seed business needs government support while various seed providers' schemes seek to grow to a level where they are able to take advantage of economies of scale. This is an essential condition for the expansion of the seed sector.

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Annexes

Table A1: Institutions interviewed in the surveyed countries.

Bénin	Ghana	Mali	Nigeria
Association Des Producteurs Et Distributeurs	AGLOW Seed	Comptoir 2000	Alheri Seeds Nig. Ltd.
Seed Provider Associations	Alpha Seeds Enterprise	Faso Kaba	Champion Seed
Nonka Nera	Ababio Farm	Agri-Tech	The Seed Project Co. Ltd
Seed Providers Association, Pade	Asuoyeboa Cooperative Society	SOSEM Ltd	Savannah Seeds & Livestock
Seed Providers Association Of Angoradebou	Bawre Farms	Seed Cooperative Of Bamako	Manoma, Funtua
	Chinese Women Agrochemicals	Seed Farm	Maslaha Seeds Ltd
	Daba Farms		Nagari Seed Nig. Ltd
	Ejura Farms		Premier Seed Nig. Ltd
	K.Badu Agrochemicals Co. Ltd.		IAR-ABU
	Martha Bruckner Farms		Sasakawa Cooperative Society
	NACO Farms		UNDP Farmers' Group
	Obek Agro-Services		Farmers' Union
	Pangabu Farms		Women Farmers' Group
	Sefa And Jane		Commercial Seed Producer
			Farmer's Association Of Nigeria, Kano

Source: DTMA Seed Sector Survey, 2007/2008.

Table A2a. Maize recorded seed production in project countries, 1997–2006 (t)

Year	West Africa		Bénin		Nigeria		Ghana		Mali	
	OPV	Hybrid	OPV	Hybrid	OPV	Hybrid	OPV	Hybrid	OPV	Hybrid
1997	257.3	1.5	131.2	0.0	5.9	0.0	120.2	1.5	0.0	0.0
1998	278.8	1.5	125.0	0.0	7.5	0.0	146.3	1.5	0.0	0.0
1999	359.0	1.5	142.7	0.0	8.0	0.0	208.3	1.5	0.0	0.0
2000	479.5	70.1	133.6	0.0	83.0	61.5	262.9	8.6	15.2	0.0
2001	655.8	781.1	50.0	0.0	382.7	775.2	223.1	5.9	15.7	0.0
2002	692.4	545.1	0.0	0.0	395.4	539.2	297.0	5.9	27.6	0.0
2003	525.0	748.3	45.0	0.0	192.6	742.4	287.4	5.9	35.6	0.0
2004	538.0	1189.5	60.0	0.0	231.3	1179.2	246.7	10.3	104.2	0.0
2005	741.5	1666.9	40.0	0.0	297.6	1626.4	403.9	40.5	0.0	0.0
2006	1196.3	2856.4	2.0	0.0	825.5	2769	312.8	87.4	56.0	0.0

Source: DTMA Seed Sector Survey, 2007/2008.

Table A2b. Maize recorded seed sales in project countries, 1997–2006 (t)

Year	West Africa		Bénin		Nigeria		Ghana		Mali	
	OPV	Hybrid	OPV	Hybrid	OPV	Hybrid	OPV	Hybrid	OPV	Hybrid
1997	195.8	0.0	83.8	0.0	30.0	0.0	82.0	0.0	0.0	0.0
1998	251.6	1.2	98.2	0.0	4.3	0.0	149.1	1.2	0.0	0.0
1999	277.8	1.2	91.5	0.0	6.3	0.0	180.0	1.2	0.0	0.0
2000	493.9	74.0	139.2	0.0	80.1	61.5	274.6	12.5	15.2	0.0
2001	868.2	797.0	130.0	0.0	379.0	775.2	359.2	21.8	15.7	0.0
2002	757.7	551.6	50.0	0.0	388.3	539.2	319.4	12.4	27.6	0.0
2003	634.9	749.4	45.0	0.0	184.6	738.4	405.3	11.0	32.5	0.0
2004	686.9	1184.4	60.0	0.0	210.2	1175.2	393.7	9.2	23.0	0.0
2005	744.4	1636.5	60.0	0.0	287.0	1624.4	357.4	12.1	40.0	0.0
2006	1318.9	2637.5	10.0	0.0	653.8	2596.5	512.8	41.0	142.3	0.0

Source: DTMA Seed Sector Survey, 2007/2008.

Table A3a. Seed retailing through own retail outlets in West Africa (% of respondents).

Constraints	Nigeria		Mali	
	OPV (n = 7)	Hybrids (n = 4)	OPV (n = 1)	Hybrids
Increase in overhead/transaction costs	29	50	–	–
Use of outlet not very sustainable (some produce seed too)	29	25	–	–
Seed adulteration/fake seeds	14	–	–	–
Lack of information on the available varieties	14	25	100	–
OPV sales is poor through this channel	14	–	–	–
Coordination and handling problems	43	50	–	–
Coupon system not available to all	–	25	–	–
Seed prices are usually low	29	–	–	–

Source: DTMA Seed Sector Survey, 2007/2008.

Table A3b. Seed retailing through outlets of private wholesalers in West Africa (% of respondents).

Constraints	Nigeria		Ghana	
	OPV (n = 6)	Hybrids (n = 5)	OPV (n = 2)	Hybrids (n = 2)
Increase in overhead/transaction costs	17	20		
Use Of Outlet Not Very Sustainable (some produce seeds too)	–	–	50	50
Bad credit habits	83	80	50	50
Poor storage facilities	17	20	–	–
Seed adulteration/fake seed	17	20	–	–
OPV sales are poor through this channel	17	–	–	–
Coordination and handling problems	–	20	–	–

Source: DTMA Seed Sector Survey, 2007/2008.

Table A4a. Seed retailing through private retailing outlets in West Africa (% of respondents).

Obstacles	Nigeria		Bénin		Ghana		Mali	
	OPV (n = 3)	Hybrids (n = 2)	OPV (n = 2)	Hybrids	OPV (n = 3)	Hybrids (n = 3)	OPV (n = 1)	Hybrids
Increase in overhead/transaction costs	–	–	_	_	–	–	100	–
Bad credit habit	33	100.0	100	_	33	33	100	–
Poor storage facilities	_	–	–	–	–	–	–	–
Seed adulteration/ fake seeds	33	_	–	–	–	–	–	–
OPV sales are poor through this channel	33	–	_	_	–	–	–	–
Occasional misun-derstanding (e.g., on pricing etc.)	–	–		_	67	67	–	–

Source: DTMA Seed Sector Survey, 2007/2008.

Table A4b. Seed retailing through outlets of NGOs in West Africa (% of respondents).

Problems	Nigeria		Ghana	
	OPV (n = 3)	Hybrids (n = 2)	OPV (n = 1)	Hybrids (n = 1)
Bad credit habit	–	–	100.0	100.0
Poor storage facilities	–	–	–	–
Seed adulteration/fake seed	–	–	–	–
Few credible NGOs buying seeds	33	–	–	–
Untimely placement of request by NGOs	67	50.0	–	–
Coordination and handling problems	33	50.0	–	–

Source: DTMA Seed Sector Survey, 2007/2008.

Table A4c. Seed retailing through outlets of government agents in Nigeria (% of respondents).

Problems	Nigeria		Bénin	
	OPV (n = 4)	Hybrids (n = 3)	OPV (n = 3)	Hybrids
Increase in overhead/transaction costs	–	–	_	_
Bad Credit Habits	_	_	100	_
Use of outlet not very sustainable (some produce seeds too)	50	67	_	_
Poor storage facilities	25	33	_	_
Seed adulteration/fake seeds	25		_	_
Unethical business behavior of government officials (e.g., over invoicing)	25	33	_	_
Unstable government policy not promoting seed business	25	33	_	_
OPV sales are poor through this channel	25	–	_	_
coordination and handling problems	25	–	_	_

Source: DTMA Seed Sector Survey, 2007/2008.

Table A5. Average prices per kg of OPV and hybrid seeds in 2006

Country	Producer Price	
	OPV	Hybrid
Bénin, FCFA	170.0	–
Ghana, GHC	0.725	1.11
Mali, FCFA	300.0	–
Nigeria, Naira	117	134

Source: DTMA Seed Sector Survey, 2007/2008.

Table A6a. Accelerating seed dissemination to farmers with different drought effects (% of respondents).

Possible Solutions	Accelerate the speed of getting new maize varieties to farmers in high potential areas				Accelerate the speed of getting new maize varieties to farmers in high potential/drought affected areas				Accelerate The speed of getting new maize varieties to farmers in drought-prone low potential areas			
	Nigeria	Bénin	Ghana	Mali	Nigeria	Bénin	Ghana	Mali	Nigeria	Bénin	Ghana	Mali
N	7	1	11	6	5	2	12	6	12	1	11	5
Produce seed closer to the areas and increase retail outlets	29	–	9	–	–	–	8	_	_	_	9	_
Target large-scale farmers who will be used as model farmers	14	–	9	–	–	–	_	–	–	–	_	–
Participatory breeding and technology development	14	–	46	–	20	–	33		8	-	27	-
Compulsory certification of seeds	14	–	–		–	–	–	–	–	–	–	–
Government buying back excess grain in the market	43	–	9	–	–	–	–	–	–	–	–	–
Provision of demos and extension support	71	–	55	17	80	—	58	_	42	–	46	40
Stabilizing seed prices	14	–	–	–	–	–	_	_	–	_	–	–
Provision of stress tolerant varieties	14	–		–	–	–	–	–		–	–	
timely seed certification	–	100	–	17	–	–	–	17	–	–	–	20
Help to acquire more equipment	–	100	–	–	–	–	–	–	–	–	–	
Provision of storage facilities	–	100	–	–	–	–	–	–	–	–	–	–
Strengthening community/cooperative- based seed production	–	–		–	–	–	_	–	17	–	_	–
Improve infrastructure	–	–	–	–	–	–	–	–	25	–	–	–
Increase availability of resources (e.g., sales outlets etc.)	–	–		17		–	–	_	42	_	_	–

Source: DTMA seed sector survey, 2007/2008.

Table A6b. Accelerating seed dissemination to farmers with different drought effects, contd (% of respondents).

Possible Solutions	Accelerate the speed of getting new maize varieties to farmers in areas of high potential				Accelerate the speed of getting new maize varieties to farmers in drought affected areas of high potential				Accelerate the speed of getting new maize varieties to farmers in drought-prone areas of low potential			
	Nigeria	Bénin	Ghana	Mali	Nigeria	Bénin	Ghana	Mali	Nigeria	Bénin	Ghana	Mali
Develop technology that satisfies consumers' preferences	–	–	18	–	–	–	17	–	–	–	9	–
Make new technology affordable to farmers	–	–	9	–	–	–	8	–	–	–	9	–
Increase networking among seed companies	–	–	18	–	–	–	17	–	–	–	18	–
Educate farmers/increase their awareness of new technology	–	–	18	33	–	–	17	17	–	–	18	20
Work with opinion leaders and policy makers to scale up	–	–	9	–	–	–	17	–	–	–	9	–
Increase access to micro-credit	–	–	–	33	20	50	_	17	8	100	–	–
Provide labels/relevant technical information on marketed seeds	–	–	–	17	–	–	–	–	–	–	–	–
Provide equipment/work materials to extension service	–	–	–	17	–	–	–	–	–	–	–	–

Source: DTMA seed sector survey, 2007/2008.

Table A6c. Accelerating seed dissemination to farmers with different drought effects, contd (% of respondents).

Possible solutions	Accelerate the speed of getting new maize varieties to farmers in areas of high potential				Accelerate the speed of getting new maize varieties to farmers in drought affected areas of high potential				Accelerate the speed of getting new maize varieties to farmers in drought-prone areas of low potential			
	Nigeria	Bénin	Ghana	Mali	Nigeria	Bénin	Ghana	Mali	Nigeria	Bénin	Ghana	Mali
Establish village -level seed distribution system	–	–	–	10.0	–	–	–	17	–	–	–	–
Release of DT varieties	–	–	–	–	40	–	–	–	25	–	–	20
Reliable weather forecasts	–	–	–	–	20	–	–	–	8	–	–	
Release of extra- early varieties	–	–	–	–	20	–	–	–	33	–	–	40
Varieties released must be superior to existing varieties	–	–	–	–	20	–	–	–	8	–	–	–
Increase retail outlets in target areas to make seeds available	–	–	–	–	20	50	8	–	42	100	9	–
Provision of opportunities to negotiate contract directly with farmers	–	–	–	–	–	50	–	–	–	100	–	–
Technical support for information dissemination	–	–	–	–	–	50	8	–	–	–	9	–
Provide systemic support (e.g., funding for relevant agencies)	–	–	–	–	–	–	17	–	–	–	18	–

Source: DTMA seed sector survey, 2007/2008.

Table A6d. Accelerating seed dissemination to farmers with different drought effects, contd (% of respondents).

Possible solutions	Accelerate the speed of getting new maize varieties to farmers in drought affected areas of high potential Mali	accelerate the speed of getting new maize varieties to farmers in drought-prone areas of low potential Mali
Avoid conflict between extension services and marketing companies	17	20
Commercial promotion by seed companies	17	20
Sales promotion in drought affected areas	33	_
Subsidize seeds and other inputs for initial period of time	17	_
Supply other complementary inputs, e.g., fertilizer		_

Source: DTMA seed sector survey, 2007/2008.