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## **Mali Seed Sector Development Plan**

### **Initiative to End Hunger in Africa: Agricultural Policy Development Program**

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# Executive Summary

## Introduction and context

The objective of this study is to identify interventions that are likely to be productive components of a possible USAID seed-sector intervention in Mali.

Despite a good history of varietal development of millet, sorghum, maize, rice and cowpeas, most Malian farmers retain their own seed or exchange with nearby farmers: few use improved, high-yielding varieties or certified seed. This is especially true of those growing traditional crops: millet, sorghum, cowpeas, groundnut and upland rice. The low fraction using improved seed undoubtedly leads to significantly lower agricultural production, and thus lower farm incomes than would otherwise be possible.

However, several efforts are underway to improve crop varieties, and make them more available to Mali's farmers. Breeding done in the international private sector, at the international centers of the Consultative Group for International Agricultural Research (CGIAR), in Mali's national programs, and by private companies and individuals is expected to provide a steady pace of improvements in crop varieties for the foreseeable future. The challenges will be to effectively develop these scientific and technological advances within the Malian context and to ensure their adoption by the country's farmers.

The *Institut d'Economie Rurale* (IER) provides new varieties for a range of crops. Recently it has taken the role of producing and selling foundation or basic seed to the National Seed Service (NSS). In turn, NSS organizes production of first generation seed (R1) of improved varieties and uses trained farmers to further multiply, attempting national coverage. NSS oversees the operation and buys R1 seed. The independent National Seed Laboratory certifies the seed before it is sold. NSS sells R1 seed to village seed production associations who produce second-generation seed (R2). The National Seed Laboratory also certifies R2 seed. In the past, the volume and diversity of improved seed made available to farmers through this mechanism has fallen far short of demand. However, NSS has completely changed in the last three years. From a pure government operation with its own farms, staff and equipment, but with almost no operating money, it has become a coordinating agency for village seed production associations (VSPAs), leading them to produce for national needs through the Seed Sector Support Project (SSSP), financed by the African Development Bank (ABD). SSSP plans to produce a large volume of seed and keep production costs low. It remains to be seen if the proposed 7,150 tonnes of certified seed proposed for sale in 2009 can be realized.

## Some problems

SSSP is described as a privatization plan, but the VSPAs are poorly placed to fill a commercial role, with each association privately producing and distributing seed and without involvement by large-scale Malian businessmen. Under SSSP, the supply chain for improved seed will need an orchestrated combination of efforts by farmers, farmers' groups, VSPAs, IER, ICRISAT, NGOs, DNAMR (the Rural Support Directorate of the Ministry of Agriculture, Livestock and Fisheries

(MALF)) and the private sector to ensure that farmers continue to receive improved seed and the necessary accompanying information. In some cases, farmers' associations may eventually find seed distribution a profit-making operation but experience in other parts of Africa indicates that this outcome will not be frequent.

The generation and flow of information about the performance of different varieties remains a government function, with the flow of information back and forth between the farmers and the IER forced to pass through divisions of MALF.

In the absence of plant variety protection (PVP, intellectual property laws for new plant varieties) or varietal exclusivity, private companies have little incentive to collect information about the performance of new varieties. Local vegetable seed breeders need PVP laws if a private sector is to develop. In addition, cotton is important in Mali and the possibility of international cooperation with commercial cotton-seed companies should generate substantial benefits. While a great deal of inertia is expected to slow the adoption of PVP laws, the World Trade Organization's requirement for a PVP law provides a motivating factor.

DNAMR is responsible for testing varieties at its 52 local branches and feeding information to and from IER. Within DNAMR, two divisions are involved with seed. One is responsible for extension and supports the information exchange with IER; the other is responsible for support of agricultural input supply and works with the NSS.

Contradictory laws governing seed have been drafted with little input from farmer groups, professional associations, private seed growers or the recently formed seed-importer associations. Neither of the two organizations set up to co-ordinate the National Seed Plan – the National Seed Council and the National Seed Variety Committee – has farmer or private-sector representation. The National Seed Council meets too infrequently to fulfill its role of planning the level of R1 seed needed to meet a recommended seed-variety renewal period of three years. The National Seed Variety Committee meets, but has not kept the national seed variety catalogue up to date. The seed laws do not provide for "truth in labeling" except through certification, so seed information is not available in informal village-level seed trade.

Vegetable farmers and those growing maize and irrigated rice use more improved seed than those growing traditional crops. Traders import vegetable seeds, usually from Europe but there is also seed production in Senegal and some in Côte d'Ivoire. In addition, traders import some seed from other countries in West Africa. Imported seed is subject to sanitary and phytosanitary control as it enters Mali. There is a lack of information on private-sector participation – by importers, producers and distributors – in the seed industry. However, Malian farmers can benefit from imported high-quality, internationally certified seed, sometimes immediately or, more usually, after local testing and adaptive trials. In addition, some French seed companies in joint ventures with Malian partners carry out adaptive trials of seeds in Mali to develop commercial vegetable seed tailored to the West African market. Such collaboration benefits Malian farmers, as well as other farmers throughout West Africa. These companies are usually representatives of the major global US and French vegetable seed companies. Malian farmers could also benefit from improved availability of public-sector vegetable varieties, created by IER, and the African Vegetable Network coordinated by ICRISAT and AVRDC.

Traditional farmers know little about the range of seed available. The National Seed Service plans to use the *Observatoire des marchés agricoles* to add a seed-market information report to its current service. A nexus of private-sector promotion would benefit from contributions from an agricultural input suppliers association, chambers of agriculture, trading networks and NGOs. The resulting seed market network should have links to operators in neighboring countries that already produce seed for peanuts, maize, beans and forage crops.

It is possible that SSSP will organize sufficient support for seed multiplication by producer groups, including those organized by NGOs. There exists scope for productive donor support and NGO support for on-farm testing activities oriented to the design of appropriate packages of seed, fertilizer and water-retention technologies, for the whole range of cereal, legume and vegetable crops.

The progress in varietal selection in the last 30 years has not been as great as it might have been. One major reason for the relatively slow progress has been weak linkage between research and the farmer-customer. Much has been done to improve the responsiveness of research organizations to the needs of the small scale farmer, but some inherent difficulties remain. The private sector does not currently find seed multiplication for these crops profitable, and when it does start, it will not generally be oriented to the job of varietal selection and on-farm testing until exclusive varieties become both possible and available.

There is a need for a sustainable means to distribute new varieties. The village seed production associations, even lead by the NSS, will find it difficult to commercialize large volumes of seed because profit margins are small, and yet the improved seeds offer significant yield gains – of the order of 15 to 25 percent – particularly in combination with other inputs. However, it is likely that currently existing agricultural input traders will enter into the seed business with some success. As production volumes organized by the SSSP increase, a major opportunity should occur to assist in the development of companies with marketing and distribution capabilities that may be more able to aid in the planning and creation of demand than the VSPAs.

A core challenge to the design of effective interventions in the seed sector in Mali stems from the differences in the approaches that are appropriate for the cash economy and those that are appropriate for the subsistence economy. The corresponding opportunity is that effective use of improved seed may shift the dividing line between the cash and subsistence economies, and improve the productivity and stability of both.

Where farmers can produce varietal seed, there is also a division between markets where the economic asymmetries will keep seed markets from operating effectively and those where quality factors can induce farmers to purchase seed.

For the purposes of discussion, the seed market can be divided into the following sub-sectors:

- High-value crops with seeds that are difficult to reproduce: vegetables, hybrid maize, hybrid sorghum and hybrid millet.
- Crops that are used in the cash economy and which have seeds for which quality is difficult to achieve or maintain: varietal cotton and varietal peanuts.
- Crops that are used by those in the cash economy and have seeds that are relatively easy to reproduce: varietal maize.

- Crops that are used by those outside the cash economy and which are relatively easy to reproduce: millet and sorghum.
- Disaster relief.

Different approaches are proposed for different categories.

## **Potential interventions in the Malian seed sector**

### **Regulatory environment**

Three regulatory elements to promote are the development of truthfully-labeled seed, PVP law and variety registration.

To broaden the market for quality seed, government should encourage “truthfully-labeled seed”, in addition to formally certified seed. In the absence of certification, truthfully-labeled seed would carry a label providing basic information, such as the name of the producer, the weight of seed, the germination rate, when the seed was tested, physical purity, etc., with serious penalties for fraudulent labeling. Truthfully-labeled seed would encourage trade in improved varieties of seed beyond the cash economy and where the certification system cost would be a restriction to the distribution of seed through informal channels.

The benefits of exclusivity in variety development and variety testing need to be communicated frequently and with conviction. In addition, some positive impact might be made through the creative use of existing law.

While the National Variety Committee (CNV) is accelerating approvals, they should take steps to make sure that news and information about varietal performance and registration is widely distributed. In addition, linkages to the corresponding regional catalogue must also be assured. Those conducting registration trials should be rewarded for the quality of their work and the number of good varieties that are used by farmers, regardless of origin.

### **Public goods (IER and DNMR)**

In the absence of PVP laws and a varietal exclusivity policy in the distribution of new varieties from publicly-funded research, there will be a need for public support of on-farm testing and of the distribution of the information acquired to researchers, seed distributors and to farmers to reduce transaction costs in the acquisition and refinement of new technology. This can be achieved through development of a variety information database to synthesize available information and subsidies for on-farm testing by private seed-supply companies as they come into existence.

Given the long-term planning horizon for investments in research and limits to government resources, foreign assistance will continue to be both productive and necessary in the area of public plant-breeding. Potential means of support include building linkages with existing plant-breeding programs (such as those of ICRISAT and ILRI), evaluation of research performance, and the development of facilities and equipment to support efficient and adequate production of foundation seed.

On-farm testing systems need public support and DNAMR does not have adequate resources to do the job of linking IER with farmers and assuring adequate communication in both directions. Support is needed for the cost of local testing, transportation, communication, convening meetings and the preparation of documents. The seed activities of two of DNAMR's divisions could be combined to feed VSPAs with better information on new varieties to allow them to anticipate demand. Alternatively, DNAMR could move its variety testing and seed-related activities to NSS, thereby bringing all of the seed activities together under a single management structure, thus feeding demand and performance information could be back to IER, and allowing performance information to be used in new production plans. At village level, if seed laws change to allow for quality-declared seed, it becomes worthwhile to train VSPAs in the production of higher-quality, labeled seed. This type of support would help spread new varieties faster and potentially improve the quality of the seed of traditional varieties available in the villages.

## **Support business development**

SSSP should result in a significantly developed seed supply over the next few years. One sign of success will be supply-demand imbalances. The moment will then have arrived to support the development of commercial seed businesses that will sustainably develop the sector. Support would likely take the form of technical training, business training, forging links to international organizations, linking to sources of equipment and technology, financing operating funds and investment, and developing a seed price information system. From among the traditional field crops, it is likely that rice, maize, peanuts, and cowpeas will make the transition to commercial status, in that order. Hybrid varieties of sorghum and millet may eventually become commercial, but are expected to remain of modest importance for some time. This study identifies specific likely entrants into the seed business. The large vegetable seed companies would not require support for vegetable seed trade operations but potential interventions might support the development of commercial businesses for non-vegetable crops (including forage crops), as well as the entry of small local private seed companies in the vegetable seed business. In addition, there is already a need to build a local seed trade association, affiliated with the African Seed Trade Association, to promote changes in government legislation and regulations that respond to commercial needs.

Some village seed production associations can be transformed into private seed companies. Those that emerge with market orientation and good organizational skills, they should be given the same opportunity for training and support that may be available to new commercial companies under the potential interventions listed above. In addition, the interest shown by the Association of Professional Farmers' Organizations in on-farm testing and support for village level seed production should be encouraged.

## **Introduction of new varieties**

Launches of new varieties will involve on-farm testing and demonstrations performed by the research organizations and MALF's local agricultural development agents. NGOs will also be involved, but the ability of these organizations to adequately cover the launch of a new variety requires support.

For sorghum and millet seed, even though tradition and economics work against the development of significant markets, there is an advantage in introducing new varieties. Free market approaches will

not maximize the potential value of the varieties to Malian society, so three different kinds of subsidized programs should be considered: small-packet programs, coupon systems and lending programs. Small packet programs allow farmers to try new varieties at low cost. A coupon program would follow a small packet program. It would allow organizations promoting new varieties to sell subsidized coupons for the purchase of seed from a range of certified seed sellers, public and private. Certain seed would be promoted but farmers would be free to redeem the coupons for any seed from any dealer acceptable to the managing agency, thus encouraging the development of seed trade in areas where it would not otherwise exist. A coupon system could be used to promote truth-in-labeling or quality declared seed, which would help spread varieties by allowing local farmers to sell to neighboring villages without violating seed laws. Publicity thus accomplished, existing local microfinance associations could receive funds to make loans specifically for seed and only seed. Promotion of demand for forage seed is likely to follow the same pattern.

In contrast, while vegetable seed will generally move through the private sector, the commercial sector will not want to promote some species, such as cassava and potatoes. For these crops, producer associations may need help in finding customers for their starts, tubers or cuttings. Support should focus on crops where commercial involvement is least likely.

The coupon system can also function as an effective emergency seed-delivery mechanism. Coupons would be free; recipients would be chosen based on need. In emergency situations outside the normal cash economy, a coupon system could be combined with seed fairs. Further, microfinance seed-loan programs can operate in emergency situations without dramatically changing program administration. (The need for interchange of seed in emergencies is another reason for relaxation of the seed laws.)

### **Strengthening demand for new varieties**

Direct and long-term support for the use of new sorghum and millet varieties and other species where commercial success is unlikely can increase the public good through more efficient grain production and wider adoption of new varieties. It has a favorable environmental impact by increasing the amount of land that can be left fallow. This in turn can decrease the pressure on fragile ecosystems and biodiversity.

Opportunities for synergies to boost returns from the SSSP program include support for: compliance with PVP principles through payment of royalties of developers of varieties, even before the passage of a PVP; judicious selection of VSPAs; NSS pricing that reflects market realities in order to encourage private participation in the market for seed; training of farmer-growers in the areas where those companies wish to produce; existing seed-production companies and individuals; sufficient floating-rice seed-production capacity; and development of fruit-tree reproductive stock.

### **Biotechnology**

There exist opportunities to put biotechnology to work to increase productivity in Mali's agricultural sector. The development of the capability to use biotechnology at IER should be supported, particularly the development of staff familiar with the potential of the technology and the safety issues, as well as regulatory capacity within the MALF and the Ministry of Health. Beyond regulatory approval, there are issues of technology ownership that can usefully be addressed for existing

biotechnology. In some cases the owners may have decided that they have no interest in the Malian market and may be willing to donate their interest. When that is the case and a Malian or regional research organization has already identified the technology as of significant, facilitation of approval for its introduction to Mali would be useful, as would the regulatory evaluation of selected biotechnology.

In addition, Bt cotton can be expected to reduce the amount of insecticide treatment necessary in Mali. Given the labor-intensive nature of Malian cotton production, a reduction in insecticide use would likely represent a major improvement in farmer safety, as well as environmental safety. Mali should be willing to negotiate a royalty with Monsanto, the owner of Bt cotton technology. In order to start the process, the government will require support in order to approve and undertake field trials that will establish the added value. The fiber products are not eaten and should be of minimal concern to the Ministry of Health, where food safety might be evaluated. Almost no Bt protein or DNA appears in the oil after it has been refined, so the oil would also be of minimal concern. Significant amounts of the Bt protein and DNA do appear in cotton seed cake, and have been found to be substantially equivalent to normal cotton seed cake for use in animal feed.

## **West African regional context**

Regional seed movement can stabilize supplies, reduce cost and increase the range of varieties available to the customer. Regionalization of the seed industry will allow for higher returns to research investment, lower costs of production, lower costs of holding inventory, stable supply, better variety testing, and a reduction in the phytosanitary and treatment restrictions to trade. Regionalization of seed trade is already happening in the vegetable seed sector. Although current regulations may not be entirely favorable, support of regional information about seed prices, demand and availability can help the sector become more efficient.

Harmonization of seed laws is proceeding with respect to phytosanitary, certification and registration regulations. A CILSS-INSAH initiative is relatively advanced: they have drafted regional compromise standards for certification, phytosanitary laws and for registration, as well as a combined catalogue of registered varieties. There is mutual agreement that there is no need for phytosanitary restrictions for shipment of seeds among the CILSS countries. A separate ECOWAS initiative should receive continued support to enable full regional harmonization. However, regional harmonization is ignoring uncertified, quality-declared seed and PVP law. These are important omissions, which should be rectified. Success in some of the regional harmonization issues might make West Africa more attractive to outside seed businesses. Mali could offer such firms incentives to target the West African market.

Accumulation of information about donor-funded projects similar to Mali's SSSP program, sharing information on best practices, and generating contacts for seed sales to resolve shortages and surpluses all hold out hope for productive information exchange.

The proposals for harmonization have not addressed biotechnology, though it can be best addressed at a regional level if there is a West African consensus. If there is general support for biotechnology in the region a regional approval mechanism for the evaluation of agricultural biotechnology would be very efficient.

## Recommendations

Detailed discussion in chapter 8 leads to specific recommendations for the actions that USAID Mali could effectively take to promote the seed sector:

- 1) Encouragement to NSS to change its seed pricing policy to reflect market realities at planting time and thus allow a clear profit for commercial seed production.
- 2) Support of the expansion of the commercial seed sector with loans for equipment and operation, and training for technical and business staff.
- 3) Support for the distribution of new sorghum and millet varieties and the expansion of commercial seed business into sorghum and millet areas.
- 4) Distribution of very small packets of new varieties in specific sorghum and millet-growing areas to which they are adapted and sold in local stores, at the rate of one year per new variety.
- 5) Sponsorship and subsidies for a coupon system allowing farmers to purchase subsidized coupons and redeem them for seed, encouraging commercial seed companies to expand into the area.
- 6) Financing seed loans through local micro-finance organizations (*caisses villageoises*).
- 7) Support for miscellaneous projects at NSS:
  - a) women's associations producing vegetable seed
  - b) upgrading the 60 ha floating-rice seed-production facility at Mopti (at an approximate cost of \$400,000), if USAID proceeds with significant number of controlled flooding irrigation projects requiring floating rice.
- 8) Funding the purchase of cold-room facilities, foundation-seed operations and foundation-seed equipment at IER.
- 9) Financing an on-farm testing program either at DNAMR or AOPP.
- 10) Support to Malian regulatory changes favoring quality-declared seed, PVP, and evaluation of biotechnology, possibly accompanied by appropriate training.
- 11) Building forage seed needs into livestock development programs with forage research, including winter crops.
- 12) Donor coordination and coordination with the owners of biotechnology for freedom to operate.

The following table summarizes the relative benefits, costs and risks of these actions:

Project cost	Level of Benefits		
	Low	Medium	High
Low	7a. Women's vegetable seed (L)	4. Small packet distribution (L)	1. Change NSS pricing (H)
Medium		10. Regulatory changes (M) 11. Forage seed (M)	8. IER foundation seed (L) 12. Donor coordination (M)
High		7b Floating rice (M)	2 & 3. Commercial support (H) 5. Coupon program (L) 6. <i>Caisse villageoise</i> funds (H) 9. On-farm testing (L)

Note: Associated risk level: low (L), medium (M), high (H)

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## List of Abbreviations

ADB	African Development Bank
AOPP	Association of Professional Farmers' Organizations
ASTA	African Seed Trade Association
ATRIP	African Trade and Investment Policy Program
AVRDC	Asian Vegetable Research and Development Center
BNDA	<i>Banque Nationale de Développement Agricole</i>
CGIAR	Consultative Group for International Agricultural Research
CILSS	Comité Inter-état pour la Lutte contre la Sechèresse au Sahel
CMDT	Malian Textile Development Company
CNV	<i>Comité National des Variétés</i>
DGRC	MALF's <i>Direction Générale de la Réglementation et du Contrôle</i>
DNAMR	MALF's Rural Support Directorate
fCFA	CFA franc(s)
ha	hectare(s)
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IER	<i>Institut d'Economie Rurale</i>
IITA	International Institute for Tropical Agriculture
ILRI	International Livestock Research Institute
INSAH	Institut du Sahel, CILSS
IP	intellectual property
kg	kilogramme(s)
MALF	Ministry of Agriculture, Livestock and Fisheries
NGO	non-governmental organization
NSS	National Seed Service
ODI	Overseas Development Institute (London)
OECD	Organization for Economic Cooperation and Development
OHVN	<i>Office des Hautes Vallées du Niger</i>
ON	<i>Office du Niger</i>
OPAM	<i>Office des Produits Agricoles du Mali</i>
PVP	plant variety protection
R1	first-generation commercial seed
R2	second-generation commercial seed
SAFGRAD	Semi Arid Food Grains Research and Development
SLACER	<i>Service Local d'Appui, Conseil et Equipement Rural</i>
SSSP	Seed Sector Support Project of the NSS
USAID	United States Agency for International Development
WARP	USAID's West African Regional Program

# Foreword

This paper was commissioned by the U.S. Agency for International Development, West Africa Regional Program to develop a broader understanding of the Malian seed sector and the potential for interventions in that sector that could have a positive impact on agricultural growth in Mali. This paper is a component of USAID/WARP's Action Plan process under the Initiative to End Hunger in Africa.

The Initiative to End Hunger in Africa (IEHA) was announced as a Presidential Initiative by USAID Administrator Natsios in August 2002 at the World Summit on Sustainable Development. IEHA is one of USAID's programs for helping to fulfill the USG commitment to the Millennium Development Goals. At the Millennium Summit held in September 2000, donor countries agreed to join forces in order to halve, between 1990 and 2015, the proportion of people whose income is less than one dollar a day and also the proportion of people who suffer from hunger.

IEHA's specific objective, which is to "rapidly and sustainably increase agricultural growth and rural incomes in sub-Saharan Africa", is based on the well-supported premise that accelerated growth in real per capita agricultural GDP is the most effective means of reducing poverty and alleviating hunger. In order to achieve such growth, IEHA will focus on six core themes: (1) science and technology; (2) agricultural trade and market systems; (3) strengthening community-based producer organizations; (4) building human capital, institutions and infrastructure; (5) ensuring vulnerable groups and countries in transition are not left out; and (6) sustainable environmental management. During the initial plan period (FY2003-FY2008) about 70% of available resources will be concentrated on the first two themes.

Following an initial survey of issues in Mali's agricultural sector, it was determined that there were several analytical gaps preventing a thorough evaluation of the country's seed sector. This paper seeks to fill in those gaps, discuss the importance of the Malian seed sector within the context of the six core IEHA themes, and to propose potential interventions to be considered for inclusion into USAID/WARP's IEHA Action Plan during the initial plan period.

## Preface and Acknowledgements

This study of development on the seed sector in Mali was conducted at the request of USAID/Mali. Without the help of Dr. Gaoussou Traore and Dr. Mamadou Camara of USAID/Mali in helping me make contacts, this study would have been much less thorough.

I would like to thank Dr. Andy Cook, Abt Associates' IEHA Team Leader, and Mr. Dennis McCarthy of USAID/Mali and his staff for acquainting me with Bamako. Dr. Cook also deserves considerable credit for offering comments on the first drafts of this report.

I must thank Dr. Robert Tripp of the Overseas Development Institute in London for providing me with contacts and documents relating to the recent history of seed production in East Africa. These studies point out the notable long-term lack of success of African village-level seed production associations.

I would like to thank Dr. Eva Rattunde of ICRISAT's research station in Mali for her comments on participatory plant breeding, and on the potential for the use of village associations in seed production. I would also like to thank her for the useful list of potential contacts that she provided. Concerns raised about the long-term sustainability of village-level seed production associations in national seed supply should not be interpreted to question the role of village level associations in participatory plant breeding.

While I was not able to speak with Mr. Mahama Adamou of the African Development Bank (ADB), I found the document that he developed to justify the recent ADB loan to Mali's National Seed Service to be very useful. I suggest that anyone doing further studies on the Malian seed sector consult the document and Mr. Adamou. Although village-level seed production has its limitations, this project could usefully serve as a model for seed production projects in other West African Nations.

I would like to thank Dr. William Masters for his succinct reminders of the asymmetries that influence seed markets.

Frank Chabert, Mike Mailloux, Gebrile Bah and Tiécoura Traoré introduced me to the private agricultural input sector, and provided me with the background information that allowed me to propose a commercial approach to seed distribution in Mali.

Finally, I would like to thank the members of the village association at Kondogola near Cinzana for their time and concrete comments about the local prospects for seed production and commerce. Their willingness to plan for a better future will undoubtedly be rewarded.

The author was privileged have the opportunity to apply his experience in the global seed industry and from the USAID-funded SAFGRAD (Semi Arid Food Grains Research and Development) to the specific problems limiting seed-sector development in Mali. I have received input from many sources but take full responsibility for any errors.

# 1. Major Players in Mali's Seed Sector

## 1.1. Research Institutions

Mali has two primary research institutions that play a role in the development of seed: (i) the *Service Semencier National* and (ii) the *Institut d'Economie Rural*.

### 1.1.1. Service Semencier National

The *Service Semencier National* (NSS), or National Seed Service, was previously a state monopoly seed-production organization that operated its own farms and facilities and has traditionally focused on rice. Throughout the 1980s, NSS was supported by donor financing and produced sizable amounts of seed, especially for government parastatal organizations. In the 1990s, the Government of the Republic of Mali (GRM) assumed responsibility for financing NSS, and operations became rather limited, especially when development projects ceased placing firm orders in the mid 1990s. In recent years, NSS has been much improved by the policy changes and restructuring that occurred. The state-owned farmland has been distributed to individual growers and all responsibility for production has been passed to individual growers and grower associations.

A loan to the NSS from the African Development Bank for the Seed Sector Support Project (SSSP) will fund major operations through 2006. The current work plan under this loan is ambitious, but workable from the standpoint of organizing seed production. It is likely that the SSSP plan will permit much larger production of seed than the NSS is currently producing, but that due to weaknesses in the plan, provisions for marketing and commercializing that seed will be lacking. On the production side, as more of the basic field crops are spun off, the SSSP provides for adding NSS efforts in vegetable crops and fruit trees, new areas that may be in need of support.

Several current or ongoing NSS initiatives are not funded through the SSSP loan, including renovations needed to continue NSS production of floating rice in an old irrigated area at Mopti, under partial-control flooding. Floating rice has to float to produce seed, and it is unclear if some of the projects which have been converted to full water control could be used to grow floating rice. The NSS director believes that upgrading the Mopti project is justifiable, but additional funding would be necessary.

In addition, the previous NSS location at Samé for dryland cereals is not included in SSSP funding. This location has average rainfall of under 500mm per year. In a brief evaluation of options, there appear to be numerous possible production areas for sorghum and millet seed production, and the decision to drop the Samé station from inclusion in the SSSP project appears justifiable.

Finally, the SSSP loan fails to cover several projects that support women's associations. The associations have organized to produce seed of vegetable crops, principally onions and shallots. The NSS has expressed an interest in helping these associations finance their seed production activities.

### 1.1.2. Institut d'Economie Rural

Production of basic seed for all crops was transferred from NSS to the *Institut d'Economie Rural* (IER), or Rural Economy Institute. IER now produces all breeder seed<sup>1</sup> and is better able to maintain quality control since NSS has moved to exclusive use of farmer growers for all production. The two organizations work in concert, and NSS is able to provide IER with firm orders for foundation seed, and in the future may even be able to make some advance payments using the SSSP loan.

As a result of this organizational relationship, IER's production capacity for foundation seed directly affects NSS's operations. IER has been able to provide enough seed of rice, maize, sorghum and millet, but has not been successful in delivering enough foundation seed of cowpeas and peanuts, likely due to losses resulting from inadequate storage facilities. While generally reliable in meeting NSS needs, in a situation of crop failure or natural disaster, IER might not be able to produce sufficient foundation seed to sustain the following year's activities.

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<sup>1</sup> Annex 1 provides definitions of technical terms specific to the seed sector.

## 2. Extension Agencies and Programs

Mali has several government extension programs that connect to research and introduce the farmer to new varieties, using on-farm trials and providing information flow in both directions. These organizations and programs include the two extension divisions of the *Directorat d'Appui au Monde Rural*, the *Assemblée Permanente des Chambres de l'Agriculture du Mali* and its Association of Professional Farmers' Organizations, the Malian Textile Development Company, and the Office du Niger.

Mali needs better linkage between agricultural research and the farmer. Public-sector extension programs are discussed below, but it is noteworthy that the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) is becoming increasingly involved in projects for West Africa that help in income generation for Sahel farmers, including a program for the selection of vegetable seed varieties. Both ICRISAT and ILRI (the CGIAR International Livestock Research Institute) have programs in livestock forage production that will produce new varieties. Under current policy, both will be more aggressive in forming on-farm testing linkages than they have been in past decades.

### 2.1. *Directorat d'Appui au Monde Rural*

The *Directorat d'Appui au Monde Rural* (DNAMR) is the most important organization in disseminating seed research and technology in Mali. DNAMR has two divisions that are involved with seed: (i) the *Division Conseil Rural et Vulgarisation Agricole*, and (ii) the *Division Promotion de Filières Agricoles*. At the local level, DNAMR activities of both divisions are implemented by a local *Service Local d'Appuis, Conseil et Equipement Rural*, of which there is one for each of Mali's *cercles*, for a total of 52. DNAMR has experienced problems with the efficacy of its activities in recent years due to problems that may go beyond funding issues.

The *Division Conseil Rural et Vulgarisation Agricole*, DNAMR's extension division, works with research institutions to disseminate new technology and to assist research with on-farm testing. It is responsible for the back-and-forth flows of information between research and farmers via the on-farm testing system.

This division is under-funded and can not do enough testing to keep research closely connected with market needs and support the generation of demand for new hybrids. Prior to 1997, USAID funded an OUA/SAFGRAD program that was relatively effective at providing a link between research and farmers, which might present a model for improving the efficacy of the *Division Conseil Rural et Vulgarisation Agricole*. The organization could benefit by incorporating individuals trained under the previous project into its operations. However, to do so, funding for salaries, trial expenses, transport, and communications capability will be necessary.

The *Division Promotion de Filières Agricoles*, or Agricultural Value-chain Promotion Division, is DNAMR's division responsible for seed supply and dissemination, focused primarily on identifying which farmer associations will work with NSS in seed production. The organization has taken an approach of surveying and evaluating all existing farmer associations in terms of their seed production capacity and experience. The resulting inventory is to be maintained permanently and will serve as a guide to seed production in Mali. Eventually, the inventory will serve to facilitate the search for seed sources by farmers' associations looking for seed to buy.

The *Division Promotion de Filières Agricoles* is also responsible for the organization of seed marketing, which it achieves largely by identifying key stakeholders in the seed trade on both the supply and demand sides and by convening biannual meetings, which take place before planting and after harvest. Meetings held before planting present forward demand for producer use in planning their planting, while post-harvest meetings present supply information to potential buyers of crops. There is some hope that these meetings will evolve into a seed exchange (*bourse*) whereby supply and demand will be able to set prices.

While the development of an inventory of seed producers is a useful starting point, the list will probably contain many organizations that are not seriously involved with seed, and is unlikely to be a very effective means of finding sources of seed. The existing distribution chains of the input-supply companies are better equipped to equate demand with supply. Likewise, holding biannual meetings for the seed industry is a good idea, and may improve seed distribution, but is unlikely to create enough demand for the products of the production associations. Such meetings are likely to be more popular with suppliers. Both of these activities are to be fully functional in 2003.

## **2.2. Assemblée Permanente des Chambres de l'Agriculture du Mali**

The *Assemblée Permanente des Chambres de l'Agricultures du Mali* is a farmers' and agricultural traders's organization organized to promote commercial agriculture. With the emphasis that the government is currently placing on village-level associations, this body has an important role to play in the support of the seed production associations that will be serviced and coordinated by the NSS. Currently, most of the organization's activity in this area is run by a new subsidiary body, the Association of Professional Farmers' Organizations (AOPP), which has taken an interest in collaborating with the NSS and NGOs on seed supply. The organization is also involved in training farmers to perform on-farm testing. Certain advantages may be presented by this new organization due to its interest in both variety performance and seed supply issues, and it may prove more flexible in its approach to seed support activities than DNAMR-sponsored support.

## **2.3. Malian Textile Development Company**

The Malian Textile Development Company (CMDT) is a parastatal cotton company with Malian Government and French ownership. Historically, it promoted the production of crops other than cotton in its southern Mali where it operates. During recent drops in cotton prices, CMDT experienced severe financial pressures, and for two years was temporarily out of the seed business altogether with the exception of cotton seed, as it did not have the resources to make seed purchases for non-cotton crops. CMDT has experienced a financial recovery and had resumed the production of non-cotton seed, but has now made an agreement with the Ministry of Agriculture to cease its extension and seed production activities for crops that are not used in cotton rotations.

This agreement has created an opportunity for other parties to enter into the commercial seed business in this favorable zone for crops such as rice. Seed production for the crops that have been spun off will be organized by NSS and DNAMR. If the existing growers can continue to manage these crops, problems with seed production problems may not be large, however, there will remain a need for marketing these crops, now that CMDT plays no role. Financing for these crops will also become an issue, as the *Banque*

*Nationale de Développement Agricole* (BNDA) and CMDT had previously jointly managed all lending in this area. BNDA must now adapt to address lending for the other crops independently of CMDT.

CMDT will continue seed production and extension for the crops in the cotton rotation. However, both marketing and the amount of seed that is produced is limited, as CMDT storekeepers are unwilling to risk large orders a year in advance. Nonetheless, there is room for additional commercial seed activity within CMDT. In addition, it should be noted that the creation of a new cotton promotion organization similar to CMDT has been announced for southwestern Mali. However, during the course of this study, no information regarding the new organization's involvement in the seed sector was available.

## **2.4. Office du Niger**

*Office du Niger* (ON), a parastatal overseeing irrigated agriculture in the inland Niger delta, has a well-defined seed production structure<sup>2</sup>. The area is divided in five zones, and there are five seed-production villages within each zone. Each village has a village seed committee and a village seed producers' association, which is able to borrow to cover operating expenses. Previously, the associations were not permitted to borrow to cover capital expenses. However, under SSSP, financing for capital expenses will presumably become possible. A higher-level pilot committee attempts to guide pricing across ON's zones, but local villages are free to negotiate prices.

ON helps with certification, facilitating inspection and delivery of samples. Each village association has its own brand and tries to develop an image of quality. Associations sell seed with a label inside the bag. They sell some uncertified seed, notably of unregistered varieties. When interviewed, ON's program coordinator indicated that ON had considered selling quality declared seed and were not opposed to the idea, and that due to the compact ON area, certification is not a major hurdle. ON does purchase basic seed directly from IER, particularly unregistered varieties.

Of the challenges faced by ON, wild rice presents a major quality problem. Producers also find difficulties producing R2 seed within the standards set by the National Seed Laboratory. Additionally, many canals in ON are closed for service in the winter, limiting off-season production opportunities.

## **2.5. Village Seed Producers Associations**

Village seed producer associations are playing a growing role in the Malian seed sector, and the government is strongly promoting them and farmer-growers to enter the seed industry, particularly through NSS. Support to these associations consists largely of assistance for seed production: technical support and financial support for the purchase of inputs and equipment and, in some cases, loans until planting time when the seed producer expects to sell his seed.

For the individual farmer, one of the major advantages of membership of a producer association is a certain amount of mitigation of the risk associated with not selling his product. Association members share in the sales in proportion to the seed that they have delivered to the association, and thereby avoid the risk of being left with an entire unsold crop.

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<sup>2</sup> USAID has conducted several studies that contain further background information on ON agricultural activity.

Associations of seed growers can provide certified seed and seed of new varieties, but they have a great deal of difficulty assessing the demand for their product outside their own area: there is usually either too much or too little demand for their seed. Both DNAMR and NGOs offer significant support to these associations in the form of technical assistance in production, access to new varieties, and arrangement of production financing. Unfortunately, this kind of assistance does not address some of the more fundamental problems faced by these associations, which include weak management skills, lack of access to demand information, and lack of access to distribution networks. In summary, the village seed producer associations are not sufficiently market-oriented.

One of the institutional problems with the use of farmer associations as the basis for seed production is that the legal status of these associations is not clear. MALF would like to move the associations toward cooperative status. However, at the time of this study, they had no concrete plans for this. It does not appear that the current status of these associations will allow for mergers leading to the economies of scale that might make the best use of the nascent entrepreneurial talent in these associations.

## **3. Current Structure of Mali's Seed Sector**

### **3.1. Seed Production**

First generation seed is referred to as R1 in Mali, grown from foundation or basic seed and used to plant second generation seed. Second generation seed, or R2, is intended for general use by farmers.

#### **3.1.1. Foundation Seed Production**

IER is primarily responsible for the production of foundation seed in Mali. Under existing seed law, which views both IER and NSS as state agencies, IER is required to provide foundation seed to NSS without payment. There is a need to change the law to reflect IER's new semi-autonomous legal status, but IER is proceeding as if the change had been made. NSS will pay for seed purchased from IER. In its new status, IER is supplying basic seed to all those that it considers qualified buyers.

Demand for foundation seed is expected to grow, and IER should provide foundation seed to all purchasers who are willing to pay for it and are technically and financially able to make good use of it. Production of foundation seed is a new role for IER, one that the current financial plan does not adequately support. The institute does not have adequate storage facilities or any special equipment for the processing of foundation seed, and budgets have not been changed to reflect the new role.

As the private sector becomes more active in Mali, it will look for ways to increase seed prices, largely by producing better seed than is produced by the NSS system. One of the most direct ways to achieve this is to produce more R1 seed. To do so, the private sector will need more foundation seed. It is expected that increasing activity in Mali's seed sector will place further strain on IER's foundation seed production capacity.

#### **3.1.2. First Generation Seed Production**

NSS has retained direct control of R1 seed, but production has been transferred to producers associations and to farmer growers. R1 seed production areas are concentrated and certification costs are lower than for R2 seed. All R1 seed is certified.

Since the price of R1 seed is higher, and the margin narrow or non-existent, there will be increasing pressure for private companies evolving out of the producer associations to provide it. With early access to foundation seed, private companies have the ability to get to the market early with new varieties allowing for price leverage and creating an incentive for rapid sales of new varieties.

#### **3.1.3. Second Generation Seed Production of Field Crops**

NSS previously also controlled the production of R2 seed. However, the bulk of second generation commercial seed production was transferred to farmers and farmers' associations about two years ago. There are several advantages to private production, as the government is no longer directly involved in production, and private producers are better able to focus attention and deliver in a timely manner.

The farmers associations that produce the R2 seed are to be identified by DNAMR, or by other extension agencies with the help of NGOs. The role of these organizations in identifying farmers' associations is especially important in areas that are remote from NSS operations. DNAMR's approach is to select a group from among the existing farmers' associations. The major weakness of this approach is that it does not require that a group be focused on seed production, and individuals who joined the association with other objectives they may not be enthusiastic about seed as a business. In general, DNAMR does not have a good reputation in identifying seed-production associations. However, some locally-based extension agencies have been successful in the organization of producers association, particularly in the ON zone.

In some locations, NGOs have stepped in to provide coordination for R2 seed production. These efforts have been more successful, but supporting them costs more. While producer associations for R2 seed are to be spread all over the country, production areas do not exactly match the distribution of the demand, and some seed will have to be transported significant distances.

Once NSSS selects new associations and association members, it continues to provide support for them, including training. The SSSP loan to NSS provides BNDA-administered funds that will allow associations to have access to financing for production and marketing costs. However, the definition of marketing costs in this case may not be very broad. The terms of the loan may permit BNDA financing the farmer to hold the seed and sell locally, but does not provide for market surveys or advertising costs. On the other hand, financing for both storage facilities and processing equipment is being made available to village seed producers associations, in a marked expansion over the resources that were available to associations in the past.

The SSSP loan is expected to allow the NSS to expand R2 seed activities into the production of fruit trees and garden crops where it has not been active in the past. There are also several crops for which local quality production in the public sector will be needed, such as onion starts, cassava and potatoes.

Limited opportunities exist for private-sector or commercial development of seed production because start-up costs are substantial, especially the capital for the purchase of raw, unprocessed seed. New entrants into the seed sector in Mali will likely need to make production arrangements with NSS-sponsored village seed production associations that have been trained by the SSSP. In general, private, commercial enterprises entering the sector will have a great interest in reinforcing quality-control mechanisms, as they will be competing on quality. The focus on quality presents opportunity for marked improvements.

### **3.2. Development of New Varieties**

Public plant breeding will be the primary source of new variety technology for Mali. For crops with weak connections to the cash economy, there is an even greater justification for public research. More importantly, in the absence of Plant Variety Protection (PVP) laws in Mali (see *Regulatory Environment* below), public plant breeding must be supported by government and donors. Once PVP laws have been established, it will become possible to channel support to basic crops and those with the weakest connections to the cash economy.

Beyond vegetable crops, most of the new varieties being developed in Mali will come from IER or international research institutions such as ICRISAT or IITA. This will almost certainly continue to be the case until a PVP law is passed and agricultural productivity rises. With PVP, seed companies can expect to retain one third of the added value that they create (Tripp, 2000). However, without PVP, the returns to the varietal component of seed performance drop, with the exception of hybrid crops and new varieties with limited supply.

Theoretically, there are alternatives to non-exclusive release by public plant-breeding organizations, including the allocation of some varieties exclusively to the private sector on a rolling lottery basis. Another potential solution that is more likely to be politically acceptable, would be to encourage all public programs to release unfinished bulked lines to allow private-sector operators to finish them and sell their own versions exclusively. However, both these solutions presuppose the existence of a private sector, and are unlikely to be applied in Mali in the near future.

### **3.3. Biotechnology Development**

Currently, the Malian public sector does not operate any biotechnology research programs. Tentative efforts are underway to establish a biotechnology program at IER, which held a meeting on the subject in 2002 and has laid out preliminary plans for regulations that will enable them to conduct research. These regulations will require an act of parliament. The expertise for regulatory evaluation is likely to develop first among those trained to use the technology and, even though the short-term goal may be the development of a regulatory system, support of biotechnology research may be the quickest means to that end.

While IER may have a role to play in stewardship of public biotechnology in Mali, it is likely that much of the good biotechnology will be privately developed. Biotechnology development in Mali is most likely to involve the major global technology companies (although their role in the conventional seed industry in Mali is likely to be limited). There are several additional factors which would affect their likely role in the transgenic seed industry, discussed in the following paragraphs.

Most transgenic products are not patented in Africa, and multinational companies will usually refrain from commercially using each others' traits developed through the use of biotechnology in order to avoid conflicts in other parts of the world. In some cases, multinational companies may possess trade secrets and other proprietary information that allow them to protect their intellectual property. However, in other cases, the technology may be sufficiently easy to deploy that local, private, independent companies that might not be subject to those constraints will have an advantage due to their cost structure.

The regulatory cost of transgenic varieties is sometimes the major cost. While creation of a trait through biotechnology may only cost \$100,000 for easy projects, the cost of the staff to pursue regulatory applications and required testing can run into tens of millions of US dollars for a trait to be used globally. This is especially the case if the regulatory agency has some interest in delay. The attractiveness of Africa for the commercial use of transgenic crops will to a large extent be determined by the cost of the regulatory procedures that are put in place. Structures that parallel US regulatory structures may keep costs low.

Some multinational companies may choose to get involved in biotechnology development in Mali for reasons associated with their global public relations strategies. Agreements with local research

organizations, extension organizations and seed businesses, can sometimes be partially justified by the public-relations value for multinational creators of biotechnology even if it is a money-losing operation. Syngenta has a long history of involvement in Mali, both in the commercial sector and in the public sector through the Syngenta Foundation. Monsanto will likely be interested in the development of Bt cotton. Mali may also benefit from possible applications of the work of international public research institutions that are developing biotechnology.

### **3.4. Varietal non-exclusivity**

The potential for the development of a commercial seed business in Mali is highly dependent on the establishment of PVP laws and a regulatory environment that allows for exclusivity. When laws that allow for exclusivity are in place, incentives will arise to concatenate testing, production planning and sales in a single commercial organization to assure that varietal performance will be taken into account in setting production plans. Exclusivity increases the value of advertising, and can lead to the customer getting better information on how to use the variety. Frequently, it also leads to the involvement of distributors in testing which also increases the information that the customer receives.

The policy of non-exclusivity of varietal access associated with IER and the international centers limits not only the incentive for private variety development but also the incentive for private businesses to invest in acquiring information about variety performance and communicating that information. There is little incentive to test because others will benefit from the information.

Given the likelihood that public varietal releases in Mali will remain non-exclusive, the first generation of seed companies in most crops are not likely to do a lot of testing. Without varietal testing seed will be traded like a commodity, and there will be limited incentive for private business to acquire and communicate information about the variety. Currently, commercial entities engaged in on-farm testing include at least two vegetable companies that operate their own testing in Mali. The vegetable seed market is in a concentrated zone around Bamako.

### **3.5. On-Farm Testing**

Extension programs play an important role in situations where PVP and varietal exclusivity are not available. However, where the extension service is not effective, it may be useful for the research organizations to take on a certain amount of extension activity, especially in the form of on-farm testing.

The use of on-farm testing in variety introduction is the key to increasing the demand for seed. It is through on-farm testing that new varieties can best be introduced. On-farm “participatory” testing gives farmers an opportunity to observe the characteristics of varieties and to contribute their feedback about a variety’s strengths and weakness. Field trials serve as a focal point for discussions about varietal selection. Researchers are thus able to learn in detail farmers’ needs, and this understanding in turn can be translated into a new generation of improved varieties, if it can be passed to the plant breeders at IER. Good research systems make ample use of feedback from users to define research priorities, and farmer participation in variety evaluation is a valuable tool in learning their product needs. While requirements change over time as customer needs evolve, they do not change so rapidly that researchers can not use the same set of objectives over several crop cycles.

The major player in on-farm testing should be DNAMR's extension division, particularly once seed has been registered. However, inadequate funding means that DNAMR has not been very effective in this activity, even though it does receive assistance from NGOs and international centers. Compounding the effect of the absence of a functional extension system, NSS does not have an extensive program of on-farm varietal testing. While NSS has produced seed of experimental varieties for distribution in small packets and is generally willing to help, it does not view on-farm testing as its central role. This role is partially played by IER, which provides data for variety registration in part through on-farm testing. Mali's Association of Professional Farmers Organizations (AOPP) has also expressed an interest in conducting on-farm testing. ICRISAT has worked together with AOPP and found it both receptive and effective. However, AOPP is a new organization and it is not clear if it has the capacity to effectively coordinate on-farm testing for the entire country.

### **3.6. Seed Conditioning and Storage**

In most seed industries around the world, farmers grow raw seed that is then sent to a central plant for processing. However, the absence of significant economies of scale in Malian drying conditions make on-farm and village processing possible and thus opportunities exist for substantial amounts of seed processing at the farm-level. Benefiting from this possibility requires that plant and equipment should be sized correctly for the planned harvest schedules. However, there may be greater economies of scale in storage, which could more profitably take place at central warehouses, depending on the cost of transport. Local-level seed conditioning and storage can have an advantage if the seed is to be sold in the area. However, if centralization offers economies in quality control and training or distribution, then it generally becomes more efficient to process the seed at the same location. In Mali, economies of scale may be least important in rice where demand is concentrated in small areas, favoring smaller enterprises, while demand for the other crops is more dispersed and centralization of processing is more likely to be favorable.

Mali's R1 and R2 seed are processed differently. Although its operating policy does not require it, NSS purchases all R1 seed, conditions it in its facilities, stores it and sells it for use by R2 producer associations throughout Mali. In theory, producers associations might market their own R1 seed, however, NSS's decision to provide this service relates directly to the difficulties that all producers have in finding markets for their seed. NSS already knows who the customers are, and has a decidedly easier task in making the sales.

The proposed NSS system of support for village seed producers associations of R2 seed is capable of producing large amounts of seed. However, quality control becomes a serious challenge in a system where so many people are involved, and proper training and record keeping will be essential. For the time being, treatment of R2 seed has generally been abandoned due to a lack of equipment capable of doing a good job at the village level. However, this may change as the SSSP loan makes financing available through BNDA for village seed production associations to obtain loans for the procurement of conditioning equipment, storage facilities, and carts for local transport.

Current procurement options are somewhat limited. A village-sized rice seed cleaner of Malian manufacture costs roughly 1,000,000 FCFA (about US\$17,000), and small rice cleaners are available from other sources. However, the design and manufacture of seed cleaners is an art requiring some

experience, and local machinery should be evaluated carefully in comparison to imported equipment to verify that its output for unit cost is competitive.

A substantial amount of large-scale seed-conditioning equipment that was purchased by donors in the 1990s for development projects is currently under the control of the Ministry of Finance. For instance, the *Office du Niger* had four large seed cleaners, but during the decentralization process they were deemed surplus and turned back to the Ministry of Finance. If these cleaners still exist, they may be of some value to a commercial seed company, but they would certainly need repair as they will not have been used for a long period. The ministry could auction this equipment to larger-scale commercial enterprises, which may be able to put it back to use.

There is very little modern storage in operation in Mali and, for some crops, establishing modern storage facilities may present an untapped opportunity. Legumes, including peanuts, cowpeas and soybeans – as well as some vegetable crops, such as potatoes – are susceptible to deterioration in storage. While cooler storage is better, refrigerated storage is probably not a profitable option in Mali. Systems making use of cool night air to cool insulated warehouses that are then sealed during the day may have potential for Mali and could make major differences in the germination of these crops.

Private businesses are not currently engaged in storage operations, but would be able to organize better storage than that planned for the village seed producer associations producing R2 seed. The private sector can achieve a performance advantage because of access to capital for construction of this kind of storage and, for this group of crops, fertilizer, grain and agricultural input supply companies would be the most likely commercial entrants. However, given current and foreseeable low margins and the size of investment required for facilities and equipment, commercial enterprises are not likely to enter the Malian market for seed conditioning and storage in the near future. The exception may be in areas where particular quality-driven opportunities might exist, like storage that limits maximum temperatures for legumes. Another potential opportunity may be found in offering corn-seed sizing equipment.

### **3.7. Emergency Seed Programs**

The SSSP loan provides for an emergency stock of at least 500 tonnes of R1 and R2 seed for dryland cereals. This seed to be stored by *Office des Produits Agricoles du Mali* (OPAM). OPAM is jointly financed by the government and foreign partners involved with the *Programme de Restauration du Marché Céréalière du Mali* (PRMC), which has been in place for 20 years. It assures the management of the national security stock of about 35,000 tonnes of millet and sorghum grain. The emergency seed stock will be made up of seed that remains unsold at the end of the sales season. The stocks can be used as seed the following year, if necessary and, when such measures are not necessary, sold as grain before the harvest. In any case, the security stock is not held for more than one year and, since it is year-old seed at the time of sale, it would not compete directly with the private seed sector. However, the amount of seed stored roughly equals annual sales projections for sorghum and millet seed. If there comes a year when this seed is put on the market, it would undoubtedly have an impact on private-sector demand.

The existence of this stock is desirable, but it puts an up-side cap on sorghum and millet seed prices in a year of short supply, and presents yet another reason why subsidized programs will be necessary if commercial seed activity is to occur in sorghum and millet seed.

## 4. Regulatory Environment for Seed

Regulations and certification for seed fall under the purview of the *Direction Générale de la Réglementation et du Contrôle* (DGRC), and are managed by its *Division de Contrôle Phytosanitaire et du Conditionnement*. Much of the current seed legislation is not applicable to local trade in seed because that law applies only to certified seed<sup>3</sup>.

Only registered varieties are produced by NSS, while IER releases some good varieties that are not registered. Village seed producer associations produce these varieties, but the seed can not be certified. In general, failure to register the right varieties can be a constraint to the effectiveness of NSS and may create a tendency to produce out-of-date varieties.

Overly restrictive government registration regulations impose a substantial cost in the product development cycle, as evidenced by the current situation of variety registration in Mali, where there is a need for transparent, efficient evaluation systems. During the course of this study, several informed parties were interviewed with respect to current registration practices<sup>4</sup>. They made various observations regarding standards for registration and the *Comité National des Variétés* (CNV), or National Variety Committee.

One party reported that the standard for registration was that any new variety be equal to existing varieties with some identifiable benefit. If this indeed is the standard, it would be quite adequate. However, some additional inquiry would be necessary to confirm that the amount of testing required is not excessive. There must be recognition that the final evaluation in on-farm trials should be made at the local level, and that observations from commercial use should also be accepted, while the registration of varieties based on limited official data can be made conditional on the results of on-farm testing. Another party observed that CNV has been rather inactive due to a lack of funding, and that it is unable to conduct meetings or print the list of registered varieties, both of which represent relatively small investments. CNV must be revitalized and pushed to rapidly work through the current backlog of pending varieties.

### 4.1. Certification of Seed

All R1 seed is currently certified, and all R2 seed is to be certified in the near future. With R2 production areas dispersed throughout the country, the cost of certification may limit the attractiveness to farmers of establishing NSS-supported production associations, particularly for sorghum and millet crops. Cases of corruption result in even higher costs in the certification process.

As noted above, production areas are dispersed, yet there is currently only one station for certification, near Bamako, and the cost of getting samples to that station can be substantial. However, the SSSP loan supports the establishment of four new locations for certification laboratories, which should help reduce certification transaction costs for village seed producers associations. The economies of scale in

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<sup>3</sup> Though several interviews were conducted with informed parties, a copy of Mali's seed regulations could not be obtained during the course of this study, so the information presented here requires further verification.

<sup>4</sup> Ouefa Diallo of the National Seed Laboratory at Sotuba was not available for interview during the period of this study.

germination testing in this case may not be large and small labs should be able to operate efficiently, if the total volume of seed production is sufficient.

## **4.2. Alternatives to Certification**

Among those interviewed for this study, those in government positions were likely to be supporters of the universal use of certification for all seed sold. Farmers using seed of the commercial crops tend to appreciate certification more than farmers purchasing seed of sorghum and millet. Those most closely involved with sorghum and millet research and production do not generally support universal certification, as they perceive certification as too costly, note that registration too slow, and find that village seed trade is usually honest. Very few in private industry support universal certification, as they find variety registration to be a difficult process. Most farmers, particularly those who operate outside the monetary economy, find that seed certification is too costly an option. In general, the more commercial the environment, the greater the support expressed for alternatives to certification.

One major alternative to certification is truth-in-labeling or quality declared seed (Quality Declared Seed, FAO, 1993). Law enabling this would require that a certain amount of information be presented and would impose penalties in cases of false information. A change to this type of seed law might prove very useful. However, it is unpopular among those who would be called upon to draft the revised legislation.

Another approach to reducing the cost of certification is self-certification. A self-certification system would require that the government certify the quality system of a private company, and then authorize such company to issue its own seed-certification tags. While this type of system often provides gains in efficiency, it would be premature to enact a self-regulation system in Mali, given the near absence of private seed businesses.

## **4.3. Plant Variety Protection**

Mali's seed laws do not fully support private institutions in the sector, with its current lack of Plant Variety Protection (PVP), or patent protection, being the most notable omission.

Although PVP is not available, public research organizations should take on the responsibility of explaining how plant variety protection operates in an economy with commercial testing and breeding activity. It should be made clear to all involved that PVP rights are temporary – typically 17 to 20 years – and efforts should be made to ensure that protected germplasm is not lost, or released for general public use.<sup>5</sup>

The implications of the current absence of PVP laws will be further discussed within the context of private-sector development of the seed industry.

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<sup>5</sup> The centers must be careful to explain the reason for their public role in terms of the asymmetries in the markets for open-pollinated and self-replicating varieties, and to remove themselves from involvement in anti-globalization political arguments that undervalue the positive role of private plant breeding.

## 4.4. Regulation of Biotechnology

Mali has no regulations governing the use of biotechnology, and while Bt maize and cotton would be of use in Mali, the potential of biotechnology can not be achieved without a means for product evaluation and clear pathways for the approval of testing and use of the products. No current plan has been made for training in biotechnology regulatory work in the current General Directorate of Regulation and Control (DGRC) Training Plan (*Plan de Formation, Rapport Provisoire*, DGRC, 3 October, 2002), and the biosafety plans that have been made within the IER have not yet been translated into a permanent regulatory structure.

Around the world customer acceptance of biotechnology has been frequently manipulated by local political forces. While biotechnology does have the potential to produce dangerous products, as do many other technologies, the plant biotechnologies that have been promoted for plant agriculture are generally safe<sup>6</sup>. The quality of the regulatory structures put in place for this safe category of biotechnology may depend on local political forces. Without political consensus to use safe biotechnology, reasonable and efficient regulatory structures are unlikely.

## 4.5. Harmonization with West African Regional Regulations

Regional seed trade is important to the future of West Africa because of the potential interchange of varieties along the narrow east-west rainfall bands. Inter-country trade will facilitate the development of commercial seed enterprises where there are economies of scale, such as in hybrid corn production, and will help to stabilize weather-related variation in seed supplies. Delays at the borders for seed transit are currently substantial, due in large part to phytosanitary laws.

Both ECOWAS and CILSS-INSAH have harmonization plans in process. The objectives of both organizations are the same — harmonization of certification, phytosanitary and registration procedures for seed within West Africa. The ECOWAS agreement is more preliminary and, at this stage, has simply defined the issues for which harmonization will be sought. INSAH is more advanced and has drafted certification regulations that currently appear acceptable to all member countries. The proposed regulations specify an agreement that no phytosanitary issues should apply to the transit of seed through regional inter-country trade, and provide a uniform position on seed imports from outside the CILSS region. In addition, INSAH has prepared a draft catalogue of all of the registered varieties in the region and a proposed mechanism to maintain the catalogue.

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<sup>6</sup> This paper refers to traits produced by biotechnology that are substantially equivalent to their conventional counterparts, but does not refer to traits that are not substantially equivalent, for example plants designed to produce pharmaceuticals or industrial chemicals.

## 5. Estimating Current and Future Seed Demand

Mali, and West and Central Africa in general, have the least developed commercial seed markets in the world (author's experience). Demand for fresh seed and improved varieties in Mali is dampened by a range of issues that also restrict access to other agricultural inputs, including a lack of financing, the high cost of delivering inputs, and limited access to markets.

Demand for R1 seed is generally good, but demand for R2 seed of crops other than sorghum and millet is unknown, with sales dispersed among the many village seed producer associations. The maximum price for R2 seed sold by the producer associations is somewhat limited by the price that the NSS fixes for R1 seed; even though the associations are free to sell at what ever price they chose, the NSS prices tend to fix an upper limit on prices in the market. In the commercial crops, the difference in price between R1 and R2 seed is usually not large. R1 seed is usually of better quality and, when available, especially at low government prices, it may take sales from producers of R2 seed. The fragmentation of information about supply of and demand for R2 makes it more difficult to manage inventories. However, NSS plans to include seed price, demand and supply information in the *Observatoire des Marches Agricoles*, and DNAMR plans to help organize seed markets.

Demand for seed of new varieties is generally low, and is limited by the farmers' lack of information about the new variety and the degree of trust that he has in the supplier or the source of the new variety. Risk aversion dictates that farmers generally prefer to get a small quantity of a new variety and compare it with varieties used previously. To a certain extent, the farmer's risk aversion can be overcome with demonstration trials, information from trusted sources and advertising. In a small number of countries, the registration of new varieties provides a degree of confidence in their performance and farmers are willing to buy on the basis of performance in registration trials. Most Malian farmers are rarely made aware of the results of the registration trials and have no reason to trust reports of trial outcomes of which they may hear. An alternative to promoting new varieties might be found in the use of seed fairs, which IER have used as a promotional tool in the North in low rainfall millet area.<sup>7</sup>

The emergence of a commercial seed trade assumes a stable demand for the crops. The main crops for which seed demand will be discussed are millet and sorghum seed, rice seed, maize seed, vegetable seed. Demand for cowpea and peanut seed, and forage crop seed will also be discussed.

### 5.1. Millet and Sorghum Seed

Demand for millet and sorghum seed is small and stagnant. This is partially due to performance issues with the "improved" varieties that have been released, partially due to low yields of sorghum and millet,

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<sup>7</sup> Siaka Bourema reported on IER's use of seed fairs, which are a variant of the normal field day. Demonstrations are planted with local and improved varieties. Farmers are invited to bring their seed for sale; public organizations bring seed of new and improved varieties for sale; and private seed companies can be included where they exist. Fairs work best at the margins of the cash economy where risk aversion may be high. In Uganda and Sudan, seed fairs have been used in emergency relief (Getting Off the "Seeds & Tools" Treadmill with CRS Seed Vouchers and Fairs, Tom Remington, Jeremiah Maroko, Stephen Walsh, Paul Omanga, and Edward Charles, June 7, 2002).

partially due to grain-market access problems, and partially due to issues associated with the incidence of poverty among sorghum and millet growers.

The current policy of NSS only promoting certified seed of all crops may be a serious drawback to the promotion of new sorghum and millet varieties. The direct costs of certification, logistical costs, geographic dispersion and general complexity all work against certified seed in this market. Demand for new peanut, cowpea, millet and sorghum varieties is already generally weak due to low expectations, and millet and sorghum farmers are especially driven by risk aversion.

In many parts of Mali there is no sorghum and millet package of technological improvements that will produce large returns for the small farmer at an acceptable risk. This situation is not expected to change in the short-term. Future development of livestock production in Mali using maize, sorghum and millet as feed grains should help to put a floor under crop prices and reduce the risk to the producer in good production years. In years where there is surplus grain in the market, traders will be willing to purchase and store grain if they know that there will be good future demand for grain for livestock finishing, thus limiting the downward trend in prices in times of surplus over food needs.

## 5.2. Rice Seed

There is good demand for R2 rice seed, and also for R1 rice seed, based on the demand for R2 seed. Demand for new varieties is also high because farmers are accustomed to seed improvements. Use is particularly well established in *Office du Niger* where totally controlled irrigation generates yields that are high enough to make performance differences easy to observe. The presence of wild rice also provides a rapid index of genetic purity that is visually evident when buying seed.

Generally for rice, seed is sold in 80 kg bags. While the size is not customer-friendly, bag sizes for other crops are also large. A more customer-oriented business would adopt the use of smaller packages, as in other countries with small farmers where four 5 kg bags packaged in a box of 20 kg are often sold. Currently 30 percent of Malian rice farmers replace seed every three years. The SSSP loan document projects that this will reach 85 percent in areas with full irrigation control by the end of the SSSP program in 2006.

## 5.3. Maize Seed

Demand for both R1 and R2 maize seed is growing. The internal market for maize as food in Mali is relatively small, and the increasing demand for R2 maize seed is due to the increase in demand for maize for use as animal feed in Mali and Côte d'Ivoire. In the early 1990s, CMDT over-promoted maize and drove the price down 25-30 fCFA/kg. Recent markets for maize as feed have developed since that time.

In Mali, the potential profitability of maize seed in the immediate future results from the possibility of the growth of demand for maize as a cash commodity for poultry feeding, coupled with the availability of consistently good improved varieties, based on work done by the International Institute for Tropical Agriculture (IITA) and the International Maize and Wheat Improvement Center (CIMMYT). In the long-term, there is the possibility of the development of a hybrid maize market if it becomes profitable to fertilize maize to the point where farmers can consistently attain yields of more than 3.0 tonnes/ha. This

opportunity would be even greater if seed exports to Burkina and Côte d'Ivoire became possible on a consistent basis and irrigated areas became available for seed production in Mali.

#### **5.4. Vegetable Seed**

A commercial sector based on imports of seed from the world's two largest vegetable seed companies already exists in Mali, and one estimate puts the amount of imported vegetable seed at roughly 50 percent of total demand. At the present time, these foreign seed companies are unwilling to invest in local seed production due to the lack of PVP laws. Their varieties do have some protection due to the inherent difficulties in cleaning vegetable seed. If PVP laws were put in effect, however, these same companies have shown interest in using Mali as a potential supplier of vegetable seed for other locations in West Africa, based on the assumption that costs of production could be low and access to irrigation could make seed production stable. The quickest way for Mali to increase its vegetable seed production might be to pass a PVP law. The current situation has led to an artificial image of a shortage of locally produced seed in the market.

NSS is expanding its activities in vegetable seed production and establishing new village seed producer associations as it has done for field crops. These producer associations will be in direct competition with both existing local vegetable seed companies and international seed companies. Local production of quality vegetable seed would be a desirable change because of the income that it generates, but NSS's promotion of varieties that belong to other players in the market is less desirable. The interest of NSS in increasing Malian skills in vegetable seed production should be seen a positive step. Local seed production may make a contribution to import substitution, and NSS support can raise the quality of locally-produced vegetable seed. Any commercial spin-offs will likely depend on the availability of local markets for the crops and varieties selected and the level of quality achieved. A few examples of success in this area do exist, including a commercial market for onion sets that has been successfully explored by an NGO, Enterprise Works. ICRISAT Niamey is actively looking for public-sector varieties of many species that IER can evaluate.

#### **5.5. Cowpea and Peanut Seed**

NSS has gathered no information about the market for seed of cowpeas and peanuts because of the limitations on foundation seed supply. Demand for improved varieties of cowpea and peanut seed is generally weak due to low expectations on the part of farmers.

#### **5.6. Forage Crop Seed**

Demand for seed of forage crops is low, due in large part to distortions in the market for forage. Land is publicly owned in Mali and, although farmers' rights to land are being strengthened, they do not have the right to deny access to herders wanting to graze fields after harvest. Most grazing land is public and subject to the "Tragedy of the Commons" and, as in many cases, a public good can be used to the point of destruction if management for a sustainable yield is not enforced externally. Where herders have rights to free forage, it is difficult for farmers to justify expenses incurred in producing forage crops or spending money on forage crop seed.

Only towards the end of the dry season does the market value of forage become significant, and there is better opportunity for commercial development of crops that will produce forage at this time. Irrigation projects, particularly those overseen by the *Office du Niger* which maintain complete control of water can be used for forage production during the hot, dry season. Increases in forage crop production in this area have not happened, as “total” control over irrigation in this case is not really total, and the quality of the water distribution system does not permit large areas of winter irrigation. The continuous presence of crops in the fields can also create problems of insect pests, ground water levels and soil management. Solving these problems could have a significant impact on Mali’s livestock production capacity and thereby increase demand for forage crop seed.

## 5.7. Cotton Seed

CMDT distributes cotton seed for free to participating farmers as part of its operation and expects to recover the value of the seed through the price it pays farmers for cotton and in the integrated marketing of its agricultural products. There is a significant advantage in the association of its cotton seed and ginning operations. Cotton seed has to be ginned and usually there is not enough of it to justify special ginning equipment for seed. It is convenient for other cotton seed processing to be done at the same location. This policy has preserved a tendency to undervalue seed in CMDT-zone markets, and other cotton development organizations can be expected to adopt the same policy. CMDT should be encouraged to begin charging for cotton seed. For these reasons cotton seed is excluded from this discussion. (Sugar cane starts are excluded for the same reason.)

## 5.8. Wheat Seed

Recent USAID information on irrigation points out the tenuous status of wheat production in northern Mali. The irrigation systems for wheat require a high level of maintenance and transportation is difficult. The government does not seem to be giving its full support to wheat production. Given the problems with the economy of wheat production, no special consideration has been given to wheat seed production in this document.

## 5.9. Summary

Table 1 provides a rough summary of the improved seed use that is possible. It is based on NSS numbers from 2000, but includes a few different assumptions, chiefly lowered rates of coverage for seed for the sorghum and millet markets, higher areas for maize, and lower areas for peanuts.<sup>8</sup> It is uncertain whether there is demand for this amount of seed.

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<sup>8</sup> Sorghum and millet penetration will be low because of the risks perceived by the farmers who cultivate them.

Maize areas are increasing due to demand for maize in cattle feed. Peanut areas have decreased by difficulties in selling to Europe, based both on European oil surpluses and high aflatoxin levels in Malian peanuts.

**Table 1**  
**Mali's projected seed use**

Crop	Area	Yield	Grain price at harvest	Total crop production	Value of total production	Seeding rate	Total seed	Seed price	Replacement rate	Coverage	Total seed weight	Market value of seed
	ha	kg/ha	fCFA/kg	1000s of tonnes	billions of fCFA	kg/ha	tonnes	fCFA/kg		%	tonnes	million fCFA
Cotton	400,000	1.0	360	400	144							
Vegetables	21,000	12.0		252			980				5	
Maize	250,000	2.0	70	508	36	25	6,250	120	0.33	30	619	74
Rice, paddy	250,000	2.3	100	575	58	100	25,000	190	0.33	75	6,187	1,176
Peanuts	100,000	1.1	175	110	19	160	16,000	250	0.33	30	1,586	397
Cowpeas	75,000	1.7	200	129	26	25	1,875	210	0.33	30	186	39
Sorghum	693,000	0.8	75	554	42	8	5,544	120	0.33	15	274	33
Millet	919,000	0.7	75	643	48	6	5514	120	0.33	15	273	33
<b>Total</b>	<b>2,287,000</b>			<b>2,518</b>	<b>451</b>						<b>9,125</b>	<b>1,752</b>

## 6. Opportunities and Constraints to Private Sector Development

The returns to seed research and production in Africa are low in comparison to other areas, and as a result multinational seed players can not justify involvement, especially in the absence of PVP laws and lack of varietal exclusivity. Since the only current commercial seed activity in Mali is in vegetable seeds, the discussion of other commercial seed activity is entirely speculative.

Without varietal exclusivity all players in the market will have an incentive to place a lot of emphasis on brand, germination and physical quality. The interest of general agricultural development would be better served by more emphasis on variety, but that has to be largely done in the public sector for the reasons mentioned above. Private enterprises will only have an incentive to promote varieties when they are in a position of having supply when others do not. This does offer some private-sector opportunity to focus promotion on newer products and some incentive to test in order to determine which variety is likely to be in demand next.

New local companies may be able to operate within cost structures that multi-national companies would find difficult. Local companies would have several advantages over large commercial enterprises, including the fact that they would be able to:

- Subcontract most production activities to seed producer associations
- Focus on specific local markets
- Use contacts with public research to avoid high cost of varietal development and at the same time gather information on new varieties
- Affiliate with other seed companies inside or outside Africa, and potentially negotiate licenses from some of the major international companies.

While opportunities exist in many market niches for local private seed business in Mali, most of these opportunities are indeed based on production advantages. Typically, local discussion of the seed sector focuses on production and neglects the longer-term varietal and marketing aspects of the business. The fundamental driving force behind the development of a private seed industry is the development of new varieties. If the flow of new varieties from public research can be assured, information about them is available from on-farm trials, and NSS can modify their price policy, a local seed industry can develop based on the ability to deliver newer varieties faster than NSS, deliver higher quality, and find and sell to the markets that need the seed.

The opportunities of, and constraints to, the development of private-sector businesses in several market niches based on the current environment are described below. For a local private sector to achieve sustainable success in the longer term, it must develop capacity in the fundamental components of the seed business, including the following:

- Securing sources of new varieties
- Securing information on the performance of the varieties
- Communicating variety information to potential customers and generating demand
- Forecasting demand for the variety
- Securing a supply of seed to satisfy the demand
- Supplying information about the quality of the seed
- Making sales and getting paid.

## 6.1. Opportunities for Village Seed Producer Associations

One possibility for Mali is that a private seed sector would evolve out of the village seed producer associations being established with NSS support. In a market without varietal exclusivity, it is to the advantage of the seller to emphasize the general quality characteristics: germination and purity.

In the case of rice producer associations in ON, producer organizations were encouraged to seek out this type of advantage by adopting and developing brands and by including certification tags in the bags to differentiate themselves in their local markets. To a certain extent, market forces are working and customers have become increasingly aware of the quality differences by virtue of the fact that varietal and seed quality differences are evident in high-yield situations, such as rice. The associations are also buoyed by the fact that irrigation projects are relatively compact, and seed demand is easier to estimate and commercialization is easier to organize. Rice seed businesses will remain local in the absence of PVP laws, and in the continued absence of such laws, some of these rice production associations have an opportunity to develop into true seed business, if they can absorb the required management lessons and if laws facilitate the evolution of the associations into true cooperatives with the appropriate legal status.

The success of ON rice producer associations may have unduly influenced the design of the SSSP loan and NSS's approach to village seed producer associations in general. Although these government programs have made an assumption that the producer associations will be able to learn the commercial skills necessary to market their product, NSS, DNAMR and ON staff all recognize the inherent difficulty in developing the marketing capabilities of the associations. Experience indicates that most of the village seed producer associations being established will not make the transition to true seed businesses.

Village seed producer organizations face several constraints, including competition from various sectors including the informal sector, NSS distribution, and competition from agricultural input companies and commercial seed companies.

The informal sector has traditionally played a large role in seed distribution in Mali. The current seed laws do not explicitly allow for village trade in seed, and this seed would not normally be certified, but for many it is entrenched practice. Farmers traditionally select heads of grain crops and save seed for their own supply and to trade with their families and neighbors. Demand for a particular farmer's seed might depend somewhat on his skill at selection, but he would have had little opportunity to profit from his skill. Seed was often loaned until after harvest, and it was generally not considered polite to refuse a request for seed if the person who received the request had enough available. Cash rarely changed hands, as new varieties were sometimes traded for a larger quantity of other seed or grain. Since each farmer would normally adjust the amount of seed that he would save so he would have extra seed, there is traditionally excess seed in the local market, driving the cost of seed down to that of its alternate use as grain. This reinforces the local tendency to undervalue seed.

There are exceptions to the tendency for seed to be traded within the village, particularly for seed that is difficult to store such as that for peanuts and potatoes, and in certain areas of the country such as ON. However, in many cases, these traditions persist and present an impediment to the successful development of a private seed market led by village seed producer associations. In some places in

West Africa, the tradition of saving seed is so strong that farmers do not consider purchasing. The case of vegetables along the northern bend of the Niger is especially striking. Farmers save seed even when purchase is possible. Productivity and quality suffer severely.<sup>9</sup> This is a remote location that could benefit from additional communication about seed quality. Where communication is good, as in the vegetable-producing area around Bamako, there is less tendency to save seed inappropriately.

Village seed producer associations will also be affected by NSS practices and resulting price constraints. NSS is a government service, and its staff reports that it is prohibited from making a profit on seed sales. Generally, sells R1 seed at a price determined by the cost of production, plus the cost of conditioning, storage and transport, plus 25 to 30 percent. Administrative costs are not included in the price. These prices are even sometimes lower than those of the grain at planting time, and some of the seed sold by NSS is thus undoubtedly used as grain. The administrative subsidy presents a disincentive to the development of a free market and private sector competition in seed.

Existing agricultural input companies will have an advantage over producer associations in access to retail distribution systems. The SSSP loan that is supporting the development of the village seed producer associations does not allow for the provision of financing to its association customers, while financing for the purchase of agricultural inputs is made available through BNDR and through the *caisse villageoise*, the nearly universal local micro-finance organizations.

Outside Africa, there are some examples of farmers' cooperatives that have evolved into viable commercial seed companies, but nearly all of them acquired competent, focused management early in their histories. Concentration of entrepreneurial management in cooperatives is the exception rather than the rule, and there are no examples in Africa of small farmer associations that have evolved into commercial seed companies.<sup>10</sup> It is unlikely that Malian farmer associations will acquire the marketing and variety skills necessary for success in a future broad seed market.

## **6.2. Opportunities for Local Agricultural Input Supply Companies**

The viability of linkages between variety development and seed production and marketing in a single commercial organization depends on whether sufficient returns to variety development are available. The values of the increases in performance in West Africa are low because of the low base yield levels. Without PVP laws they are even lower. This creates niches for local independent, agricultural supply and grain trade organizations in parts of the seed market, but with low profits.

### **6.2.1. Marketing Fertilizer and Seed Packages**

Mali's soils are relatively poor. Past strategies of long-fallow rotations, low inputs and shifting cultivation are being replaced by fertilizer use and soil improvement as markets develop and allow farmers to sell products and purchase fertilizer. The interactions of seed with other technologies become important in such an environment.

Combining inputs into a single sales package can help assure favorable input interactions. If fertilizer companies get into the seed business, there will be a large opportunity to package seed and fertilizer

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<sup>9</sup> Source: D. Pasternak, ICRISAT, Niamey. Personal communication.

<sup>10</sup> Strategies for Seed System Development in sub-Saharan Africa, R. Trip, ICRISAT, 2000

together. This would be of the greatest value in areas where fertilizer use may not currently be high, including sorghum, millet, and cowpeas, but would require that packages be adjusted to local needs. Packaging seed and fertilizer together may make it easier to sell seed to farmers associations who do not now purchase seed. Private companies will want to generate return business, and thus have an incentive to explain interactions of seed with other technology to customers, and possibly to provide some limited demonstration and extension work. If those involved with fertilizer can explain that good varieties can increase the return to fertilizer use, it would present an opportunity to sell seed and fertilizer in packages that plan the right ratio between seed and fertilizer for specific ecological zones.

Where intensification drives demand, more customers will be buying seed with other inputs. Agricultural input suppliers will be able to increase seed sales to customers that they have already been identified for other products, and promote seed demand in that group. Since the effects of using phosphorous fertilizer are partially cumulative over the years, farmers have an incentive to go back to the same fields as phosphorous accumulates to try to get more from the same land. In time, average yield levels should rise and varietal selection will make more difference. Minor improvement in seed quality will become more evident, as will the differences in varieties. The long-term effect will be to generate moderate demand for purchased seed.

Demand needs to be increased in order to make the seed industry sustainable. Larger organizations are better placed to help generate demand and improve pricing power. Commercial seed enterprises will need to focus on advertising and on attractive, informative and convenient packaging in order to differentiate themselves from the seed associations organized by NSS.

Agricultural input supply companies will face several constraints, as farmers may be unwilling to invest in improved varieties if they can not see the benefit in doing so, or have experienced little success with improved varieties in the past. Poor physical response of improved varieties in Mali may be a result of low soil fertility, which is in part due to weak land tenure rights that restrict incentives for investing long-term improvements in soil fertility. Low soil fertility makes it difficult to measure improvements in performance, even though they may be significant in percentage terms when there is enough information.<sup>11</sup> The incentive to pay close attention to varieties and seed quality has been small in many cases, especially for sorghum and millet.

The interactions among technologies are central to raising yields high enough that returns to all inputs are positive. It would significantly raise the cost of the minimum investment per hectare to achieve optimum use of inputs and technologies. For example, a new variety alone may increase yield by ten percent, and be hard to observe. Likewise, the use of an appropriate fertilizer alone may increase yield by ten percent and not be profitable. However, the use of both the new variety and the fertilizer together may increase yield by 30 percent and be quite profitable but the customer may not believe it until he has seen it. Major investments in education are likely required to bring about a substantive change in attitudes.

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<sup>11</sup> In yield trials in areas of increasing climatic stress, variances of trial yields do not fall as rapidly as their averages. Whether you are a scientist or a farmer it is difficult to measure yield differences in stress environments.

## 6.2.2. Marketing Hybrid Maize

To date the commercial sector for maize seed in Mali, like that in the rest of West Africa, has suffered because maize is not its primary crop. The profitability of the hybrid maize seed business has driven the profitability of the commercial seed market development in East Africa, where even in the absence of PVP, exclusivity can be maintained. Hybrids make varieties proprietary because inbreds can be kept as “industrial secrets” even without plant variety protection and, even in the case where the inbreds come from public institutions like IER and IITA, it is possible to make proprietary hybrid combinations of those inbreds, thus circumventing problems created by the absence of PVP laws.

Large amounts of seed are sold since hybrid maize generally is not replanted by the farmer, and sales of hybrid maize seed are possible in situations where farmer involvement in the cash economy allows for use of products with higher costs. While hybrid maize increases the income stream for the seed company, it does pose some significant genetic quality control issues.<sup>12</sup> In properly controlled production conditions, the cost of double crosses may not be markedly higher than those of varieties, because the female can be a single cross with full yield potential.

IER indicates about a 25 percent advantage of known hybrids over current varieties, thus demonstrating some potential for a hybrid market in Mali. The development of a hybrid maize market in Mali will hinge on the ability to effectively communicate information about these returns to farmers. Making the optimistic assumption that hybrid maize seed may cost 18,000 fCFA/ha and assuming a price of maize of 100 fCFA/kg at harvest, the farmer would break even at a very low base yield (720 kg/ha). The problem is not the return for farmers with above average yields. It is that the farmer cannot measure a difference of 144 kg/ha with any certainty. If his base yield is 3,000 kg per hectare, the 25 percent yield increase would be 750 kg/ha, which would be more perceptible to the farmer.

The capital necessary for the production of hybrid seed can be made arbitrarily small, but the human capital involved in the organization of seed production and quality control can be substantial, and can present a barrier to entry into the market even where production systems avoid the use of expensive equipment. There are sizable returns to scale in maize seed production where a substantial portion of the users have mechanical planters. Planters work much better where seed is sorted by size. The sizing equipment is relatively expensive and can justify centralization of processing and storage. Seed sizing for the significant numbers of animal-drawn mechanical planters used in Mali would both improve their function and play a role in quality control (as the germination levels of different sizes are frequently different).

If margins allow, fertilizer, grain and agricultural input supply companies will be the most likely successors in the commercial side of the Malian seed sector. The producer associations are likely to survive as producers for companies who identify demand, and who condition and sell seed. All of the major government players in the Malian seed sector would welcome the stabilization and broadening of demand that participation of commercial seed companies would offer, especially for sales over longer distances.

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<sup>12</sup> Hybrid corn production requires good isolation so that only the pollen from the male pollinates the female. Pollen control in a village setting requires that seed production be concentrated in an area and that no other corn be allowed within 200 m.

### 6.3. Opportunities and Constraints for West African and International Trade

For most crops other than vegetables, the limited international trade that has taken place has been opportunistic, based on transient surpluses and shortages. NSS has made some international sales of its certified rice seed to Guinea. Another one of the few cases of regional trade observed during the study involved NGOs seeking sources of white sesame seed from Burkina Faso to meet the needs of the European market. Frequent regional seed trade is an important, but as yet unrealized opportunity.

In some instances, there is a need for regional trade to improve performance. Private seed businesses are more likely to take advantage of inter-country trading needs than SSSP-sponsored activities. For example, rice varieties adapted to southern Mali are more likely to come from Ghana, the West African Rice Development Association in Cote d'Ivoire and other higher rainfall areas than from ON, which has worked in a lower-rainfall zone. NSS has not given these foreign varieties proper attention in the past.

Regional harmonization of seed laws could permit regional trade in hybrid maize seed. This might interest the major international maize seed companies. Their interest in involvement is likely to increase with the emergence of a single market of about 2,000 - 3,000 MT of seed selling at \$1.50/kg. A combined market in Mali, Burkina Faso, and Côte d'Ivoire would have a chance of reaching this level. The speed at which this occurs will depend greatly on the emergence of maize as a feed grain. Seed would have to be produced locally and the international involvement would likely take the form of a licensing agreement with a local seed company.<sup>13</sup>

Commercial businesses have an opportunity to develop international trade based on comparative advantage. For example, performance and quality differences for vegetable seeds have given imported commercial seed an advantage over local saved seed, and some of the vegetable seed imported to Mali is produced in Senegal by firms with French ownership. International trade based on comparative advantage could be encouraged by promoting the dissemination of information about prices, costs and inventories relevant to the West African seed market. Information about seed should be included in regional agricultural market information support programs.

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<sup>13</sup> The author does not see a special role for USAID in the establishment of activity in hybrid maize seed in Mali at this time.

## 7. Context for IEHA

At a fundamental level, the goal of development assistance in Africa is poverty alleviation. The primary goal of the USA's presidential *Initiative to end hunger in Africa* (IEHA) is to fight poverty and hunger by rapidly and sustainably increasing agricultural growth and rural incomes in sub-Saharan Africa. The agricultural sector is especially important because agriculture is the primary source of employment for an estimated 70 percent of the African population and low per capita incomes are closely correlated with both poverty and hunger. Seed availability contributes to alleviation of poverty by increasing productivity, but the development of sustainable commercial seed distribution systems also depends on poverty reduction and crop market access for success.

This section will discuss seed sector issues within the context of the six core IEHA themes:

- Science and Technology
- Agricultural Markets and Trade
- Community-based Producer Organizations
- Human and Institutional Capacity and Infrastructure
- Vulnerable Groups and Transitional Economies
- Environmental Sustainability

### 7.1. Science and Technology

Mali's seed system would benefit dramatically from significant improvements in science and technological applications. Support is necessary to increase the benefits from previous and on-going investments in varietal development. The primary goal is to make the delivery of new research to the farmer, whether he is inside the cash economy or outside it, faster and more efficient. In addition to investments in the development of new varieties, technical improvements in seed handling and conditioning are important to increase yields and stability of the varieties.

The private sector should also be expected to play a role in science and technology generation and dissemination. However, Mali will first require a strengthened regulatory environment for seed to support private-sector advances in science and technology. Without PVP laws, varietal exclusivity, and biotechnology patents, it will be difficult to increase private-sector investment in agricultural research and improve the focus and quality of the research output by maintaining better linkages between the farmer-customers, on the one hand, and private plant breeders and seed businesses, on the other.

#### 7.1.1. Support for Private-Sector in Science and Technological Inputs

Returns to seed investments in Mali are low fundamentally because agricultural productivity is low. Productivity breakthroughs will not only require improved seed, but also other innovations such as increased fertilizer use and the means to use it more efficiently. In the absence of those other innovations, expectations for profits in the seed sector are low and uncertain. Especially in the absence of PVP law, the benefits to society are larger than the potential private profits.

In this situation, some public subsidy to private-sector activity is justified. The form of the subsidies can be:

- Low interest loans for investment in plant and equipment
- Facilitation of contacts with outside suppliers of seed equipment
- Facilitation of access to the use of public facilities on a rental basis
- Low-interest loans for operating capital (largely purchase of seed from farmer producers and village seed producer associations)
- Training of technical and managerial staff
- Assistance in on-farm variety testing
- Facilitation of the formation of regional and other international affiliations
- Provision of vouchers for seed purchase to potential customers to develop the outer edges of the commercial seed market
- Financing village-level micro-credit for the purchase of seed
- Support for market price, supply and demand information systems

### **7.1.2. Support for Biotechnology Development**

IER is just beginning to discuss a national biotechnology agenda. The institute anticipates launching into biotechnology development for the first time in Mali in the near future. The development and application of biotechnology the seed sector is an important step in improving science and technology, and has the potential to offer substantial long-term benefits to Malian farmers. There are many ways in which U.S. support and guidance could be provided at this critical juncture.

Despite some support for biotechnological development, IER may need assistance in coordinating interaction to the maximum degree with the USAID biotechnology support programs: the Agricultural Biotechnology Support Program II at Cornell and the regulatory support program at Michigan State University and ISNAR. These programs and other U.S. government biotechnology outreach programs can offer direction and technical assistance in the development of local Malian programs in biotechnology.

Ownership of biotechnologies provides the possibility of the same linkage with the customer that is provided by PVP laws and varietal exclusivity. This implies rights, such as the opportunity to manage it to maximize its value, and responsibilities, such as management to minimize the chance of negative environmental impact, e.g. pest resistance. Support for the regulation and patentability of biotechnology would therefore likely be the most important component of any U.S. support for biotechnology in Mali.

There is much to be gained from providing support for the regulatory approval of biotechnology developed in the public sector outside Mali, which is appropriate for use in Mali, and which is not restricted by patents on the technology used in its development. For example, golden high-vitamin-A rice may have substantial benefits in Mali. CGIAR centers and other public research institutions, such as the Danforth Center in St. Louis, are in the process of developing biotechnology that will have applications in improving Malian crop productivity. The actual cost of developing these technologies may be less than the cost of their regulatory approval.

In general, the U.S. government assumes a position in support of changes in the intellectual property laws that will allow patenting of the innovations of modern biotechnology in Mali. In the absence of such laws, Malians are not legally restricted from using technology that was developed by companies in the U.S. or elsewhere. Regulatory requirements may provide the some developers of technology

with *de facto* exclusivity in Mali, but is it more likely that there will be little applicable intellectual property protection.

Support might also be provided to assist Mali to sidestep the component intellectual property rights issues that may be associated with biotechnology developed in both the public and private sectors. U.S. support programs might act as an intermediary to ask for the donation of rights to use public-sector technology in Mali or negotiate favorable terms for its use. There may be organisations willing to undertake the contacts necessary to clarify biotechnology use if all of the components of the technology are indeed in the public domain and available for use without restrictions. ISNAR is one such organization that may be willing to help. In the private sector, support could be provided in the form of encouraging some developers to pursue, or allow use of, the technology in Mali without patent protection. The principle motivation for doing so may be the potential for favorable publicity, but developers may agree to introduce biotechnology into Mali in the absence of exclusivity and without a potential for return, if they know that there is dedicated U.S. support for Malian regulatory requirements. A final option for jumpstarting biotechnology development in Mali, in the absence of a regulatory environment, would be to explore the use in Mali of biotechnology for which patents have already expired and provide regulatory support for their use in Mali.

## 7.2. Agricultural Markets and Trade

While information systems to assist seed producers in assessing market demand are vital to the development of seed markets in Mali, support for this activity will not be discussed within the IEHA context, since the SSSP loan already plans to contribute to the development of the seed market by collecting and distributing market supply demand and price information.

Generally, USAID actively supports market-based approaches to agricultural input supply. Such support is complicated by the fact that acceptance of the role of private industry has made it more difficult for governments to justify public seed sector activities. Seed value can be categorized by three characteristics: varietal content, germination, and physical purity. While the private sector may be able to find competitive advantages based on these characteristics, there are three asymmetries in the seed market that make public-sector approaches attractive:

1. Inter-temporal asymmetry. For many crops, a farmer can buy new seed this year, increase it and next year avoid paying the person who developed the variety.
2. Interpersonal asymmetry. A farmer can supply seed to his neighbor and the neighbor can avoid paying the person who developed the variety.
3. Informational asymmetry. The farmer frequently lacks information about the characteristics of a variety that justify its purchase.

The first two asymmetries make it difficult to capture returns to private plant breeding for varietal content. They also inhibit investment in on-farm testing to accumulate information about variety performance. These two market problems are used to justify continued funding of public plant breeding. When PVP laws do not exist or are not enforceable, these two asymmetries will cause the private sector to under-invest in varietal development and drive the need for public-sector support.

The third market problem applies to the introduction of all new varieties, public or private, and to the introduction of seed with improved germination and purity. New varieties and new seed brands are by definition unknown to the customer. There are two fundamentally different approaches to the lack

of information. The big-government approach is to create variety registration systems to test for better varieties and certification systems to assure other aspects of quality. The free-market approach is for the seller to establish trust with the customer through the use of a brand and a trust worthy distribution system. The problem with the former is that the government does not always prioritize performance and quality in the same ways that performance and quality are prioritized by the customer, and may not have the trust of the customer. The problem with the latter is that it assumes a long-term relationship between seller and buyer in which the seller is adjusting to the buyer's needs. That relationship cannot exist in new markets, and can not be functional where there is no market.

The fundamental asymmetries in the seed market are part of the justification for continued support of USAID and other donors for public plant breeding in the region. CGIAR has a policy of non-exclusive release of finished varieties, and the Government of Mali has a similar policy for its new varieties. These non-exclusivity policies will make it difficult to build varietal stewardship into the intermediate future Malian seed sector. In the absence of varietal exclusivity or ownership, the private seed sector can only be a provider of the physical and germination characteristics of the seed, and can not justify either breeding or the investment required to test and characterize new products.

Any commercial non-exclusive system will under-invest in the generation of varietal performance information. In a cash economy with commercial involvement, the desire to "help" the poor by providing free access to finished varieties will result in inadequate on-farm testing, since no party can be assured of getting a return for their investment in on-farm testing. In the long-term good, commercial delivery systems need exclusive varieties.

Development of viable seed businesses requires access to breeder and foundation seed by private seed companies. Such access can be provided by IER. It is expected that the first seed businesses will work with public varieties on a non-exclusive basis. In Mali for the foreseeable future, public investment in on-farm testing will be needed. Seed registration and certification contributes to the development of seed markets by adding to the customer's trust in the performance and quality of the product when he does not know the producer.

### **7.2.1. Importance of Regional Trade**

Varietal adaptation in West Africa is frequently determined by latitude, moisture availability and to some degree by quality preferences. Varieties are adapted to narrow bands running east-west across the entire Sahel. If they are to succeed, varietal selection and commercial seed systems need to operate regionally across the bands. Regional harmonization of seed laws is central to the long-term productivity of the future West African seed sector. Commercial seed needs to be able to move east and west along the bands of adaptation to be able to fill needs created by local variation in seed production conditions. This movement is essential to supply stability and inventory control. Regional harmonization has started but is not finished, and support should be provided to harmonize Mali's regulatory and trade environment as necessary.

## **7.3. Community-based Producer Organizations**

Community-based producer organizations are so central to Mali's agricultural development policy that they can not be under-emphasized. The challenge in supporting their development will be to find and encourage more productive roles. Producer associations can play a role in varietal selection and

seed supply outside the cash economy. They can simultaneously play an important role in contributing to the empowerment of poor communities and ensuring their voice in Malian society.

The Cooperative League of the USA (CLUSA) reports that the first objective of the producer associations that have been established in Mali has been to provide financing for farmers in the commercialization of their production. The most effective of these organizations have been established by NGOs, largely as a means to access the banking sector and address its lack of information about potential small customers. Producer associations typically move into input supply once they have established sources of financing for product marketing. In Mali, most of the current input supply activity involves fertilizer and agricultural chemicals. While there are a few examples of seed purchase, they are infrequent.

Producer associations can form an important link in the commercial seed-distribution chain by helping evaluate and promote new varieties and playing a role in establishing standards of seed labeling. For locations and crops that are outside the cash economy, the associations offer an opportunity to test, introduce, and maintain new varieties. Producer associations may facilitate access to outside assistance either from government institutions or NGOs. Assistance may take the form of training, free seed, or free or financed community seed equipment. ICRISAT is currently working with producer associations in participatory varietal selection.

Associations of seed producers can make a contribution in production of seed for the cash economy. In an environment where land-holdings are small, they can help spread information about quality production techniques, and play an important role in the organization of seed production. They can help organize the grassroots level in commercial seed production. This is the role that NSS is supporting through the SSSP loan in its development of village seed producer associations.

Effective seed companies most frequently grow from large producer organizations that are active in trade of agricultural inputs or agricultural research. Mali's agricultural sector is comprised almost entirely of smallholders, with essentially no large farmers. It is expected that new seed businesses will grow either from parties already possessing entrepreneurial skills and who learn about the product, or from parties that already know the product and develop entrepreneurial skills. Future seed businesses are likely to purchase seed from the village seed production associations and market it, but the village seed producer associations being established are not likely to become the dominant seed distributors in Mali.

## **7.4. Human and Institutional Capacity and Infrastructure**

The essence of an effective seed supply organization is to be able to study the characteristics of a variety, communicate those characteristics so as to create demand for the variety, plan production to satisfy that demand, plan the distribution and sale of the seed that is produced and collect the payments. It is difficult to integrate these activities without creation of a seed business. While parastatal businesses such as CMDT can integrate all these functions, other government structures have a great deal of difficulty in doing so. Though many previous agricultural support programs have provided support for developing human and institutional capacity by training scientific and technical staff, there has been almost no support for developing Malian management capacity. Training in the business skills that are required to fulfill these activities is central to the success of any seed organization, public or private.

Efficient science-based regulatory structures will be key to the commercialization of the products of modern varieties and biotechnology in Mali. Plant variety protection is a key to the long-term integration of plant breeding into the emerging commercial seed sector in high value crops. While the Malian government has an understanding of the institutional desirability of PVP law, it lacks the capacity to implement regulatory change. Support of the training for implementation of a PVP law may make such legislation more attractive and speed acceptance.

As previously discussed, biotechnology offers the potential for large increases in crop productivity, however, the development of a biotechnology sector also requires regulatory change for which there is little institutional capacity. Training and technical assistance will be necessary to support policy and legislation in this area. Regional harmonization of biotechnology regulatory requirements could speed the approval of appropriate technology. Given the shortage of trained biotechnologists, a regional approval process may be the shortest path to approval for use in Mali. Regional regulatory structures have the potential of reducing regulatory cost and improving the quality of the review process. Training and capacity building at the regional level may thus be key.

Finally, although Mali has an established registration and certification system, it is overly restrictive, costly for universal application, and encourages corruption. Institutional capacity-building activities could make it possible to extend the benefits of registration and truthful labeling of seed to a larger group. The benefits to the customer are great when commercial seed is labeled with the name of the seller, the germination, the variety name and perhaps with the physical purity. However, government certification of this information need not be universal, and additional technical assistance and training in policy development would allow Mali's regulatory officers to design a more flexible system that adds value to a larger quantity of seed.<sup>14</sup>

## **7.5. Vulnerable Groups and Transitional Economies**

Mali is an especially vulnerable country. The population is poor, dependent on rainfed agriculture and the climate is variable. Seed interventions have the potential to raise the productivity of the Malian agricultural sector in general and improve Mali's ability to export to surrounding countries and to export high value crops to Europe (vegetables and fruit). Forage seed and dual purpose crop interventions have the potential for reducing and stabilizing the cost of animal production in Mali and improving Mali's ability to export animal products. These interventions have the potential to hugely reduce poverty.

Some improved varieties have the potential of increased yield stability under stress and can directly reduce vulnerability to variable rainfall. Biotechnological approaches to yield stability have not yet left the laboratory, but they will come. Good seed systems will reduce the time that it takes to deliver these innovations to the people that need them most. They must be accompanied by biotechnology regulatory approval systems

Seed interventions have the potential to reach poor and hungry people who are outside of the normal cash economy. There can be a short-term conflict between support for vulnerable groups and

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<sup>14</sup> Regional harmonization of Seed Laws should fall within USAID/WARP's activities. Rapid progress is already being made through CILSS and ECOWAS. Promotion of this goal will likely involve training of seed regulatory officials from Mali and other countries in the region, especially if regional harmonization is to extend to PVP, the regulation of biotechnology, and the reform of seed laws.

supporting the development of effective markets. Until the poor are integrated into the cash economy, both the creation and the delivery of this technology is not sustainable, but depends on sources of public funding. Many assistance programs provide goods and assistance through the public sector. Such support, particularly in the form of free seed, may directly compete with the development of private sector business. Disaster assistance is an extreme case where subsidies that are aimed at alleviation of poverty.

Even where public plant research is subsidized there is a need to deliver new varieties to the farmer in a sustainable way. Usually that means that the farmer should have enough cash income to pay for some seed, a position that is not possible for all Malian farmers. Good policy must treat the farmers in the cash economy differently from those outside it. While subsidies may risk forcing farmers to remain in unfavorable situations when they would be better served by a move, the productivity gains associated with new varieties justify subsidies for those outside the cash economy.

While, within the context of IEHA, interventions must be considered in terms of their potential impact – positive or negative – on vulnerable groups, this study has largely focused on interventions that support the development of a private seed sector in Mali.

## **7.6. Environmental Sustainability**

Well-managed, high-yield agriculture reduces the pressure on delicate environments. When farmers can improve their livelihood by improving the yields on the land that they currently farm, there is less need for those farmers to cultivate new marginal land. The cultivation of this new land will usually cause the loss of habitat needed by species in need of protection and lead to the loss of biodiversity.<sup>15</sup> New varieties make the intensification of agriculture possible. While broad intensification of sorghum and millet production is not likely to occur in the foreseeable future, intensification of the more commercial crops can be favored in the near-term. The development of dynamic and efficient seed systems will play a large role in promoting intensification.

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<sup>15</sup> Common Ground, Common Future, Jeffery A. McNeely and Sara J. Scherr, The World Conservation Union and Future Harvest, May 2001

## 8. Potential Interventions in the Malian Seed Sector

USAID and others have made, and will continue to make, major investments in varietal development for Africa and Mali through the Consultative Group for International Agricultural Research System and for Mali through the *Institut d'Economie Rural*. However, in Mali and perhaps Africa in general, seed may have been underemphasized relative to research and extension.<sup>16</sup> Investments in seed are crucial to supporting these efforts, as improvement in seed and seed delivery allow research and extension expenditures to be more productive. Within USAID there is an understanding that research capabilities have been maintained at the expense of seed development activities in the last 15 years.<sup>17</sup> Confusion about appropriate roles for the public and private sectors may be contributing to under-investment in seed.

For the purposes of this study, and for consideration for inclusion in USAID/Mali's IEHA Action Plan, interventions in seed production will not be proposed. The SSSP program which began last year and will close in 2006 is actively undertaking a program to support basic seed production needs, and further interventions in seed production will not be necessary in the immediate future. However, support is appropriate in other areas, in collaboration with other development partners. As USAID develops seed-sector support projects there will be a strong need to closely coordinate with all active donors and government organizations, including NSS, the African Development Bank, the supporters of DNAMR, the sponsors of the area development projects, and the supporters of IER.

Potential interventions in several areas follow.

### 8.1. Support for On-Farm Testing

In the absence of PVP laws and a varietal exclusivity policy in the distribution of new varieties from publicly-funded research, there will be a need for public support of on-farm testing and of the distribution of the information acquired to researchers, seed distributors and to farmers. This assistance can be described as technical assistance in reducing the transaction costs in the acquisition and refinement of new technology. Support can be channeled through DNAMR or AOPP.

Possible interventions include:

#### 8.1.1. Development of a Variety Information Database

Development of a database that could generate useful information on patterns of variety performance and synthesize information from various government agencies and NGOs in a single source.

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<sup>16</sup> Tripp, 2000.

<sup>17</sup> Bertram. ASTA Presentation, December 13, 2002.

### **8.1.2. Subsidies for On-Farm Testing**

Subsidies for on-farm testing by private seed-supply companies as they come into existence. While currently not an option, information on varietal performance in trials would be more likely to be fed back to those who can use it once this type of intervention becomes possible.

## **8.2. Strengthening Demand for New Varieties**

Tradition, risk aversion and difficulties in commercialization make it unlikely that NSS will achieve the 30 percent penetration rate that they have set as a 2009 target in all seed markets. It is especially unlikely in the sorghum and millet markets. For more profitable crops, the establishment of commercial seed companies will help support demand.

Direct and long-term support for the use of new sorghum and millet varieties and other species where commercial success is unlikely can increase the public good through more efficient grain production and wider adoption of new varieties. It has a favorable environmental impact by increasing the amount of land that can be left fallow. This in turn can decrease the pressure on fragile ecosystems and biodiversity. Section 8.6 provides details of how this demand might be strengthened.

## **8.3. Support for NSS Activities**

While NSS is the beneficiary of the SSSP loan and has funding for most of its programs in the foreseeable future, there are several areas in which USAID support under IEHA may present opportunities for synergies to boost returns from the SSSP program, including the following:

### **8.3.1. Support for Compliance with PVP Principles**

Mali has much to gain from respecting the rights of individuals who develop varieties. NSS should begin by respecting those rights now, even before the passage of a PVP law. NSS should be encouraged to make contracts to pay royalties to the developers of varieties that they produce. For example, NSS is currently producing one vegetable variety developed by a local plant breeder. NSS use of vegetable varieties owned by international businesses active in West Africa should be discouraged. Compliance should be a condition for any USAID or SSSP support.

### **8.3.2. Support to the Selection of Village Seed Producer Associations**

The NSS policy of support to village seed producer associations through the SSSP program would benefit from USAID assistance in monitoring how associations are selected, and ensuring that all of the village seed production associations who wish to be involved, including those in ON, CMDT, etc., are included in the program.

### **8.3.3. Support for the Establishment of Effective Pricing Policies**

NSS pricing policy should be modified to reflect market realities in order to encourage private participation in the market for seed. The price of seed should be set at the market price of grain at planting (not at harvest) plus the cost of conditioning plus a margin. The earnings from changes in the market value of grain between purchase and sale can be channeled into higher prices to seed

growers, support of subsidies for the introduction of new varieties in sorghum, millet and forages below, or they could be used to support subsidy of seed for the poor.<sup>18</sup>

### **8.3.4. Support for Coordination of Vegetable Seed Production**

In the area of vegetable seed production, NSS should work out a joint plan with local vegetable seed companies to support the training of farmer-growers in the areas where those companies wish to produce. It would be desirable that the current companies and individuals should be eligible for commercial support under the SSSP loan; NSS staff will make this determination. If those individuals and companies are not eligible under the SSSP, they might be supported by proposed interventions for support to commercial businesses.<sup>19</sup> Any USAID intervention should include support for the three women's associations in vegetable seed production that NSS has identified. However, preliminary discussion should ascertain why these associations are not eligible for support under the SSSP loan. ICRISAT and Enterprise Works may be interested in cooperation in such an initiative.

### **8.3.5. Support for Floating Rice Production at Mopti**

If USAID or other projects include significant additions to the area of partially-controlled flood irrigation using floating rice, there will be a need for floating-rice seed-production capacity, and seed production for new controlled-flooding areas would need to be added. In such an event, upgrading the NSS floating rice seed production facility at Mopti could be integrated into possible USAID irrigation projects. USAID should evaluate alternatives where controlled flooding is possible.

### **8.3.6. Support for the Development of Fruit Tree Reproductive Stock**

Additional study of the existing commercial activity in the reproductive stock of fruit trees is recommended. A study should determine if NSS's programming will adequately support the development of the private sector in fruit-tree development in and around Bamako. A study of NSS plans should focus on training needs for NSS technicians. USAID might be of assistance in providing technical assistance in the establishment of stock orchards and training in grafting, starting root stocks and nursery management, to the extent that these activities are not included in the SSSP loan.

## **8.4. Support for Commercial Business Development**

Sustainable development of the seed trade will require that true private-sector seed businesses develop. These businesses must do the planning and marketing that is required to balance supply and demand. The asymmetries in markets for seeds that can be reproduced by farmers suggest that interventions in the private-sector seed trade can increase the public good to a greater extent than can be achieved by market forces alone. Support of the private sector is an area where USAID may be particularly effective when compared with other donors.

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<sup>18</sup> The author does not have specific suggestions on how USAID may influence NSS pricing policy. The argument that the large numbers of producers of R2 seed for the general farming population are likely to benefit should help. USAID involvement could increase leverage.

<sup>19</sup> During the course of this study, it could not be determined if existing commercial activities will be adequately supported under the SSSP loan.

DNAMR will be actively developing seed supply over the next few years with the support of the SSSP loan. With any degree of success in the next two to three years, supply-demand imbalances can be expected, and it may become appropriate for USAID intervention to support the development of commercial seed businesses. Support would likely take the form of technical training, business training, linkages to international organizations, linkages to sources of equipment and technology, and financing operating funds and investment. From among the traditional field crops, it is likely that rice, maize, peanuts, and cowpeas will make the transition to commercial status, in that order. Hybrid varieties of sorghum and millet may eventually become commercial, but are expected to remain of modest importance for some time. While new businesses need not be discouraged from opportunities in cotton and vegetables should they develop, these opportunities do not form part of the rationale for support.<sup>20</sup>

The most likely entrants into the seed business at present are, in decreasing order of likelihood:

- Tropicasem, a subsidiary of Technisem, a French company with an established vegetable seed businesses in Senegal, Burkina and Côte d'Ivoire. It is only involved with seed, represents Seminis, and produces and sells hybrid maize in Côte d'Ivoire. It has local testing. Seminis is a U.S. registered company.
- M.P.C. (Mali Protection Culture), at least partially French owned and managed. It sells agricultural chemicals, sprayers, and vegetable seed and is the exclusive representative of Villmorin, a branch of Limagrain, a French global seed corporation. M.P.C. has local testing.
- Kagnassy et fils. Involved with agricultural equipment and chemicals. It has a seed business but is not focused on seed. Exclusive representative of Tézier, another branch of Limagrain. Malian owned.
- CORADIS and Agri Mali Service. CORADIS represents Agri Mali Service in Ségou. They are primarily fertilizer businesses. They have a smaller business in vegetable seed.
- SOMAFERT, major fertilizer supplier. Focuses on DAP. Affiliated with Hydrochem in Côte d'Ivoire.
- Seydou Nantoumé, major fertilizer distributor. 100% Malian owned.
- There may be other candidates in the grain trade, however, in all cases it is assumed that these businesses have distribution systems.
- Premier Seeds in Nigeria. They operate under circumstances similar to those in Mali and have 15 years experience in the seed business, especially hybrid maize. If USAID can facilitate contacts, it should do so, but contacts are more likely to be fruitful after new entrants are already established in the seed sector. Hybrid maize is not key to the successful establishment of the new entrants.

Private businesses are already active in the vegetable seed trade, with links between local and international seed companies already a working reality. In this business, the difficulty of seed processing reduces the relative importance of the market asymmetries. The larger businesses are well organized and financed. In some cases they are foreign-owned. The large vegetable seed companies would not require support for vegetable seed trade operations.

Potential interventions might support the development of commercial businesses for non-vegetable crops, as well as the entry of small local private seed companies in the vegetable seed business.

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<sup>20</sup> There may be some specific vegetable crops which are not part of the activities of the commercial companies where support is appropriate.

#### **8.4.1. Monitoring Seed Prices**

The development of commercial seed businesses will depend on whether prices can rise to 2-3 times harvest grain prices.<sup>21</sup> Support for on-farm trials, promotion of seed purchase by DNAMR, advertising, non-food demand for crops, and the quality of varieties released by IER and the centers, will all play a role in the development of demand. The successful establishment of commercial businesses in seed is not certain. Seed prices may provide a useful tool for USAID and others to use in monitoring success in the seed industry.

#### **8.4.2. Support for Financing of Facilities and Equipment**

USAID interventions might provide support to new commercial entrants in the seed sector in financing for planning of commercial activities, and financing for purchase of facilities and equipment. While loans are likely to be administered through BNDA, technical assistance can be provided to assess the value of seed equipment that may exist currently in Mali, as well in the planning of new facilities. The SSSP provides financing for commercialization activities of the village seed producer associations. There is some possibility of competition in commercial activities between these associations and the new commercial companies that may be supported by the suggested interventions. Financing in conditioning and storage activities may overlap. Additional study will be needed to determine when the players will have sufficient capacity to serve the market. This can not be done currently as it is difficult to determine the size of the markets that will develop in each crop.

#### **8.4.3. Support for Long-Term Training Needs**

Some long-term technical training can be provided through U.S. universities, such as Iowa State University. Managerial training will also be necessary, potentially through the American Seed Trade Association Management School's short course organized annually by the Krannert School at Purdue University. Visits to seed companies in East and Southern Africa may provide the best avenue for exposure to lessons learned, but language will play a role the choice of training locations.

#### **8.4.4. Special Support to Local Vegetable Seed Breeders**

There are local vegetable seed breeders to whom USAID should provide technical and financial support to grow their commercial seed businesses. It is recommended that these entrepreneurs be given the same kind of support that the U.S. government provides for the development of small businesses who wish to exploit new technology under the U.S. Small Business Innovation Research program. The Malian candidates are Magnon Diarra, who is a breeder and former university professor, Ferdinan Nugozié Berte, who is a breeder, and possibly other private individuals who are involved with varietal development and selling vegetable seeds. ICRISAT is actively looking for new vegetable varieties for the public sector, and might be encouraged to work with these aspiring businessmen. ICRISAT's natural tendency is to use public mechanisms for distribution, but local private businesses could prove more sustainable. Care should be taken that SSSP activities do not hinder the development of these small scale private enterprises in any way. The type of support that could be provided for these vegetable seed businesses would be similar to the support for new entrants into field crops outlined in the interventions above.

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<sup>21</sup> Tripp, 2000.

#### **8.4.5. Support for the Market for Forage Crops**

Sorghum-by-sudangrass hybrids are a possible entry point for international seed companies where there is an established demand for forage tropical crops. Given local cost structures, the seed would have to be produced locally. Imported seed would simply be too expensive. Because of weak effective demand for forage crops, supply would probably have to be closely coordinated with livestock development projects. Initially, seed production could be subsidized. USAID support should be part of a wider study of forage needs and possible intervention in forage supply.

#### **8.4.6. Establishment of a Local Seed Trade Association**

There is a need for a local seed trade association to promote changes in government legislation and regulations. This organization could affiliate with the African Seed Trade Association. It appears possible that AOPP and DNAMR might be able to facilitate the growth of such an organization among the village seed producer associations, however, involvement of the commercial companies should be encouraged as broader commercial involvement increases. Commercial views of issues will be different. USAID may be able to provide some support for this organization's international contacts and initial meetings.

### **8.5. Support for Village Seed Producer Associations and AOPP**

While the SSSP loan will play the primary support role for the village seed producers associations being established with support from NSSS, some village seed production associations can be transformed into private seed companies. As discussed previously, few producer associations actually transform themselves in this way. In the long run, it is more likely that they will succeed by allying as producers with effective marketing organizations. If any do emerge with market orientation and good organizational skills, they should be given the same opportunity for training and support that may be available to new commercial companies under the potential interventions listed above. Additional study would be needed if there is a role for any outside donor in facilitating the change of the associations to cooperative status that will allow the associations the ability to merge into larger more effective organizations.

The interest shown by AOPP in on-farm testing and support for village level seed production should be encouraged. ICRISAT offered a good impression of their capabilities. The production support provided under the SSSP loan will not focus on variety performance. The first option in the support of the linkage between research and farmers seems to be DNAMR. AOPP offers an alternative that does not have some of the problems associated with years of ineffectiveness at DNAMR. AOPP is a new organization, and their support for farmer producer organizations could take many forms in the coming years. Any potential intervention through AOPP must first assess whether or not it will maintain organizational focus on seed and varietal selection.<sup>22</sup>

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<sup>22</sup> AOPP as a possible vehicle for support for a seed trade association and as a possible vehicle for support for on-farm testing and cooperative organization.

## 8.6. New Variety Introduction Programs

Launches of new varieties will involve on-farm testing and demonstrations performed by the research organizations and MALF's local agricultural development agents. NGOs will also be involved, but the ability of these organizations to adequately cover the launch of a new variety requires support.

### 8.6.1. Sorghum and Millet Seed

Even though tradition and economics work against the development of significant markets for sorghum and millet seed, there is an advantage in introducing new varieties of these crops. Free market approaches will not maximize the potential value of the varieties to Malian society, so three different kinds of subsidized programs should be considered:<sup>23</sup>

- Small Packet Programs. The risk to the farmer in varietal introduction varies with the size of the investment. Packets of 200 grams of seed can be sold through existing shopkeepers, even in remote areas. Generally these shopkeepers will not be agricultural input suppliers. Registration and certification would not be necessary, especially if production was managed by knowledgeable parties at the public research organizations. Sale prices can cover the cost of the seed. People will buy small quantities to observe the new varieties from affordable curiosity, if not other motives. This kind of varietal diffusion has the advantages of being very low cost and allowing wide distribution. The amount of feedback is limited because the ability to contact the farmer is limited to the recollection of the shopkeeper. The success of a variety is judged primarily by whether or not there is demand for it the following year. Where buyers can be tracked, more detailed feedback may be obtained through surveys.

One weakness of the system in the local context is that due to variability of soil, farmers may discount the results from such small plots. The IER millet program reports that farmers like to seed 0.5 ha requiring 3 kg in order to judge a millet variety. Another weakness is that in outcrossing species such as millet, seed saved from a small plot is unlikely to reproduce the variety, so the farmer would have to purchase a larger quantity to get started.

Small-packet programs would exist alongside government on-farm testing and demonstration programs, and should not be seen as a substitute, but a way to reinforce existing programs. These programs can be managed by research organizations or NGOs with USAID funding, or could be associated with on-farm testing programs in DNAMR or through AOPP. Within existing structures the cost of the programs should not be large. USAID may need to take an active role in choosing the right organization for each area.

- Coupon Systems. A small sample program could be followed by a coupon program. Making use of the demand generated in the samples and providing amounts of seed large enough that the variety could reproduce itself and spread in the traditional ways through the villages in following years. Organizations promoting new varieties can sell subsidized coupons for the purchase of seed. The selling price of the coupons is then discounted from their redemption

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<sup>23</sup> These same kinds of interventions can be considered for other crops where market asymmetries prevent sufficiently wide adoption, including forage crops, cassava starts, and seed potatoes. If commercial ventures into seed distribution fail in some crops, those crops could also be included in the special new variety introduction programs.

value, thus defining the subsidy. The government would certify a range of seed sellers, public and private. Seed of the new hybrids would be promoted, but the farmers would be free to redeem the coupons for any seed from any dealer who was acceptable to the managing agency or NSS. Acceptance of new varieties would be measured by sales. The managing agency could be an NGO contracted by USAID.

Coupons would be available in a defined area for a period of years (perhaps three-year periods). The period and amount of coupons would be made known to potential suppliers in advance. Areas would be chosen where the researchers were reasonably certain that new varieties were superior to older and traditional varieties. This system allows both large and small seed suppliers to participate; it allows public and private organizations to participate; and it encourages the development of seed trade in areas where it would not otherwise exist.<sup>24</sup>

A coupon system could be used to promote truth-in-labeling or quality declared seed, which would help spread varieties by allowing local farmers to sell to neighboring villages without violating seed laws. It would require that seed be labeled with the variety name and it would tend to make the name uniform and increase the value of the public information about the variety. (See additional discussion of truth-in-labeling under *Support for Regulatory Environment* below.) A coupon system might also help subsidize the cost of certification for at least some sorghum and millet seed purchasers.

- Support for Caisse Villageoise Lending Programs. Most villages in Mali now have a microfinance association called a *caisse villageoise*. These organizations could be financed to make loans specifically for seed and only seed. Funds could be provided to rotate and sustainably maintain commerce in seed in the area after subsidized coupons are no longer available. The administrative structures for this potential intervention are already in place.

In order to finance the entire purchase of seed projected in Table 1, excluding rice, the amount necessary would be less than US\$1.0 million. However, the geographic scope of support for a *caisse villageoise* seed lending project would probably entail a substantially smaller investment. Note that this system does not address issues associated with the cost of certification for the sorghum and millet seed purchaser.

In theory, the cost of millet and sorghum seed organized by NSS could be subsidized directly. This would be a reversion to previous policy, and would be more difficult to arrange now with the establishment and involvement of village seed producer associations. Subsidized seed might be eaten rather than planted, and the subsidy would set a negative and unnecessary precedent for other crops.

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<sup>24</sup> To use the example of providing coupons to promote a new variety of millet, the objective would be to sell enough seed to plant about ten percent of the millet used in the sale zone in a given year. If the variety is good, this should allow it to spread into wider use. If applied in 25 percent of the millet and sorghum areas in any given year, assuming a 75 percent subsidy, such a program would incur direct sorghum and millet seed costs of approximately \$40,000 USD per annum plus the cost of smaller packaging, management and transport. With success, one would hope that the cost would rise with seed prices to no more than \$50,000 USD per annum. Since the coupons could be used for any seed, the total amount of subsidy would have to be larger. Additional study would be needed to obtain a good estimate of the ratio of sorghum and millet purchases to other crops. It is estimated that the total subsidy would need to be at least three times the target level of sorghum and millet seed sales. Annual variation in costs and prices could be substantial as they are linked to variable grain markets which are influenced by rainfall.

Since NSS is unwilling to work with unregistered varieties, the impact will be somewhat limited. Therefore it is recommended that direct subsidy under no circumstances be considered as a potential intervention.

### **8.6.2. Forage Seed**

Due to the lack of demand for forage crops, supply of their seed is likely to be a subsidized activity for some time. NSS is planning to produce seed of *lalab purpureus*, also known as *dolicos lablab*. Livestock specialists would like to secure a supply of *bourgou* seed.<sup>25</sup> Challenges in the introduction of forage seed are likely to have some similarities to those in the introduction of sorghum and millet. Demand may be more location-specific and project-specific. Arrangements will have to be made in advance with forage-promotion projects. Small-packet, coupon or *caisse villageoise* approaches can be used where farmers have sufficient experience to know what to do with the seed. During the course of this study, individuals interviewed tended to lack information on the kind of forage crops needed. There may be a need for more basic forage research in association with livestock projects.

Where demand for forage exists, it comes at the end of the dry season. Thus, if irrigation systems can work in the winter months, there is an opportunity to grow profitable forage. In ON, maize could be grown for dry season forage, but the quality of the seed used for winter maize plantings must be superior. Many maize varieties can germinate at a soil temperatures as low as 10° C but, under these conditions, weak seed will fail to germinate. Additional research is needed on winter forage production to determine which varieties and crops best meet the nutritional needs of the animals and the crop rotations.

### **8.6.3. Vegetable Seed**

While vegetable seed will generally move through the private sector, there will be some species that the commercial sector will not be able to promote, such as cassava and potatoes. For these crops, the producer associations organized by NSS may need help in finding customers for their starts, tubers or cuttings, in the way that Enterprise Works is giving assistance with onion sets. There is additional work to be done in determining which crops will support a commercial market and which will not. NSS should focus on those crops where commercial involvement is least likely. Additional study is needed to define which vegetable crops are truly outside the area of commercial seed development. New variety introduction systems could be extended to the non-commercial vegetable species.

## **8.7. Support for Emergency Programs**

The emergency provisions of the SSSP loan provide mechanisms to allow seed production to continue after bad seed harvests. However, USAID might also support emergency programs as part of support to other interventions.

The coupon system described above can also function as an effective emergency seed-delivery mechanism. In this case, the coupons would be free, and recipients would be chosen based on need, thus providing additional benefits from, and justification for, USAID support of the coupon system.

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<sup>25</sup> *Bourgou* (*Equinochlia stagnina*) is an aquatic plant which can be produced for animals in flooded areas and on river margins. It is grown in the controlled-flooding rice-production areas.

In emergency situations outside the normal cash economy, a coupon system could be combined with seed fairs. Under normal circumstances, most farmers would have enough seed of their own and fairs would be less likely to be successful but, during emergencies, dealer status would be relaxed and coupons could be used to purchase seed from neighbors. This would increase the welfare of the community and limit the possibility that the variety might not be right for the location. *Caisse villageoise* seed-loan programs can also be used in emergency situations without dramatically changing program administration.

The need for interchange of seed in seed emergencies is another reason for relaxation of the seed laws. (See discussion of *Support for Regulatory Environment* below.)

## **8.8. Support for Government Extension Programs**

On-farm testing systems need public support and DNAMR does not have adequate resources to do the job of linking IER with farmers and assuring adequate communication in both directions. USAID might consider supporting this vital function within DNAMR. Support is needed for the cost of local testing, transportation, communication, convening meetings and the preparation of documents. USAID might consider several potential ways of supporting these needs:

### **8.8.1. Reorganization of DNAMR**

The current organizational structure of DNAMR does not allow for adequate focus on seed. The seed activities of the Agricultural Input Support Division and the variety activities of the Extension Division could be combined. The objective would be to feed the village seed production association with better information on new varieties so that the producer associations can anticipate demand. It is not clear that an intervention in this area would offer a high benefit-cost ratio, and investment in the development of a commercial sector is more likely to lead to linkage of demand and supply, making reorganization of DNAMR an ineffective intervention.

Another possibility for reorganization would be to move variety testing and seed-related activities from DNAMR to NSS, thereby bringing all of the seed activities together under a single management structure. The benefits of such reorganization would be many. Both demand and performance information could be fed back to IER, and performance information could be used in new production plans. Improved focus on the evaluation of effectiveness would be an improvement over current DNAMR efforts. However, the private-sector development may again be preferable to such an intervention.

### **8.8.2. Support for Programs to Train Village Producers of Seed**

If seed laws can be amended to allow for quality-declared seed, the possibility of providing training in the production of higher-quality, labeled seed to village-level producers opens up. This type of support would help spread new varieties faster and potentially improve the quality of the seed of traditional varieties available in the villages. The collective experience of such programs should be accumulated from ICRISAT and IER, and additional pilot programs conducted to determine if the village seed producer associations would be able to sell significant amounts of quality-declared seed. Success is not assured, but if village-level producers have assured sources for the newest varieties, they may be able to build a reputation. Such an intervention might work best in direct contact with public research programs, but not depend on that link for their long-term success. The extent to

which such support needs to be handled outside the SSSP program is dependent on SSSP's attitude to relaxed registration and certification standards. Additional negotiation is needed to determine if it might be conducted within the SSSP framework. If not, USAID funding of operating equipment and facilities loans for the villages involved might be a useful contribution. The preferred outcome would be government acceptance of relaxed seed regulations and integration within the SSSP program.

## **8.9. Support for Public Plant-Breeding**

Given the long-term planning horizon for investments in research and limits to government resources, foreign assistance will continue to be both productive and necessary in the area of public plant-breeding. Potential means of support include the following:

### **8.9.1. Building Linkages with Existing Plant-Breeding Programs**

ICRISAT's current plant-breeding programs assist in the generation of income by Sahelian farmers, and may create or identify technology that can be used in Mali. ICRISAT and ILRI programs to upgrade forage production may hold similar potential. IER may require support to build linkages with these programs. If IER does not have capacity to absorb the material being generated, additional support might be considered under the auspices of trade-development projects for livestock, and for vegetable and fruit trade. During the course of this study, it was not clear whether these linkages were being formed or whether there was adequate support in this area.

### **8.9.2. Evaluation of Research Performance**

The value of seed programs assumes that there is research output to be distributed. On-farm testing provides a fundamental mechanism for that evaluation, but periodic evaluation of research performance may be needed to verify that progress is occurring. While research evaluation will typically be the primary responsibility of others, USAID may be able to contribute to this process by assuring that those conducting on-farm testing are being heard at higher levels in the research community. The current system of peer review tends to be driven by what can be published, and while intentions may be good, the interests of the editors and the Sahelian small farmer are not always the same. Small rewards for on-the-ground accomplishments can have a surprising impact.

### **8.9.3. Support for Release of Public Varieties**

As discussed under the *Support for Regulatory Environment* section below, a change to recognize the value of varietal exclusivity would be useful in establishing returns to varietal testing in the private sector, and laws should be changed to allow varieties to be assigned to capable individuals or business on either on a lottery or rolling basis, or the basis of specially negotiated agreements. Since acceptance of this change appears unlikely in Mali for the time being, it is not recommended that USAID support the exclusive release of public varieties in the immediate future. The potential for intervention should be addressed only once commercial seed companies exist and international centers and IER are able to support varietal exclusivity by the release of unfinished lines that can be selected by private breeders and used in the private sector.

#### **8.9.4. Facilities and Equipment to Support IER Production of Foundation Seed**

IER's research financing is not sufficient for the amount of foundation seed production that will be needed to satisfy demand. USAID could effectively support IER by making resources available for the procurement of cold storage rooms and of equipment needed in the processing of foundation seed. IER may also need additional funding for programs in forage seed, and vegetable and fruit tree reproductive stocks.

### **8.10. Support for Regulatory Environment**

The Malian laws that apply to the seed sector need careful examination, and support is recommended in several areas based on a preliminary evaluation of needs in the area of policy and regulatory change. Support for the regulation of biotechnology is a necessary component of support to the regulatory environment and will be discussed under *Support for Biotechnology* below.

#### **8.10.1. Truthfully Labeled Seed**

Truthfully-labeled seed would encourage trade in improved varieties of seed beyond the cash economy and where the certification system cost would be a restriction to the distribution of seed through informal channels. Customers for uncertified seed currently get little information and have no recourse in the case of quality disputes. In the absence of certification, truthfully-labeled seed or quality-declared seed provides that the label of any seed package must provide basic information, such as the name of the producer, the weight of seed, the germination rate, when the seed was tested, physical purity, and the name of any treatment. Outside the village context, moisture content would normally be required, but it is difficult to determine moisture content at the village level. As some labels will contain false information, any law providing for the use of truthfully-labeled seed would have to include serious penalties for fraudulent labeling, which might be imposed by the extension or DGRC to avoid the administrative complexity of the court system. Truthfully-labeled seed has the added advantage of removing the requirement that all seed sold be of a registered variety. USAID could provide Malian seed officials with access to seed officials in the U.S. who support labeling of seed under various U.S. state seed laws.

#### **8.10.2. Plant Variety Protection Laws**

While Mali has made some progress in intellectual property rights recently and relatively new legislation provides copyright for musicians, there are no intellectual property or patent laws in effect that apply to the seed sector. Local vegetable seed breeders need PVP laws if a private sector is to develop. In one case, a local breeder developed an okra variety which is now in production by NSS, but for which no royalty is being paid. While a great deal of inertia is expected to slow the adoption of PVP laws, the World Trade Organization's requirement for a PVP law provides a motivating factor.

The potential of local vegetable seed production for export is perhaps the most immediate benefit from a new PVP law. In addition, cotton is important in Mali and the possibility of international cooperation with commercial cotton-seed companies should generate substantial benefits.

USAID could support publicity featuring local vegetable breeders to present the positive aspects of PVP law and other intellectual property rights in Mali. It might also consider sponsoring more visits by the staff of the *Union pour le Protection des Obtentions Végétales* (UPOV, based in Geneva, Switzerland) to Mali. The benefits of exclusivity in variety development and variety testing need to be communicated frequently and with conviction.

In the interim, some positive impact might be made through the creative use of existing law. A detailed investigation of the use of current law to ensure that parties who invest in plant varieties can profit from their investments could be supported by USAID to address the following questions:

- Is protection for owners available under the registration regulations? Would CNV be willing to use the seed law in this fashion? Is there an officially recognized variety maintainer apart from IER?
- Is protection available under trade-secrets laws? If so, can this information be passed to seed producers who might wish to use hybrids?
- Is protection for variety names available under the brand and trademark legislation? This information should be passed to all seed producers who might want to preserve the right to market a variety. It is difficult to sell an established variety and make money without referring to its original name.
- Do truth-in-labeling regulations exist that could be applied to seed? If so, buyers should be notified so that they can ask for written quality information.
- Is it possible to penalize a person for theft of parents of hybrids under property laws? If so potential property owners should be made aware.

Such studies would logically fall into the scope of activities of a new Malian Seed Trade Association. A small grant to study of the use of existing laws and regulations through that organization might help in the evolution of thought about such issues in Mali. Seed associations typically have ties to good intellectual property lawyers.<sup>26</sup>

### **8.10.3. Variety Registration**

While the National Variety Committee (CNV) is accelerating approvals, they should take steps to make sure that news and information about varietal performance and registration is widely distributed. The *Observatoire des Marchés Agricoles* may provide a means to distribute the information. During the course of this study it was not determined whether or not the *observatoire* would require additional funding. USAID should support CNV operations, or ensure that some other donor does. These operations consist of periodic meetings, publishing the catalogue of registered varieties, and publicity for the variety list. Linkages to the corresponding regional catalogue must also be assured. In a more developed country, de-linkage of research and varietal release activities would be desirable, but that rule does not apply in the Malian context. Given the current situation, those conducting registration trials should be rewarded for the quality of their work and the number of good varieties that are used by farmers, regardless of origin.

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<sup>26</sup> Contact with Mr. Amadou M. Djigo, African Seed Trade Association Member from Senegal, and the *Union Nationale Interprofessionnelle Semences* of Senegal may provide useful starting points.

## 8.11. Support for Biotechnology

USAID will face conflicting objectives in supporting biotechnology in Mali. As a U.S. government agency, USAID must remain committed to protecting the property of U.S. companies. However, it must also seek to put biotechnology to work to increase productivity in Mali's agricultural sector.

Several potential interventions are recommended:

### 8.11.1. Support for Biotechnology Programs at IER

The development of the capability to use biotechnology at IER should be supported. This support should be developed in cooperation with the USAID biotechnology support program: the Agricultural Biotechnology Support Program II at Cornell University. There are justifications which go beyond immediate seed-sector issues. In the short-term, there is a need for supporters who understand the potential of the technology and the safety issues.

### 8.11.2. Training in Regulatory Support of Biotechnology

Supporting the development of regulatory capacity in the area of biotechnology is a high priority in meeting both U.S. and Malian interests. USAID might effectively provide short and long-term training in biotechnology policy and regulation. A certain number of Malians need to be trained in biotechnology in order to be able to participate in discussions of regional harmonization. It would be preferable that this training occur in the U.S. where a science-based regulatory system is in operation.<sup>27</sup> In order to encourage the integration of biotechnological regulation into the existing Malian structure, the following organizations in the DGRC should be provided with training: the *Division de la Législation et des Normes* in drafting legislation; the *Division Contrôle Phytosanitaire et du Conditionnement* in environmental impact; and the Ministry of Health in food safety issues.<sup>28</sup>

Maximum use should be made of the USAID biotechnology regulatory support program at Michigan State University and ISNAR. There are also USDA, EPA and FDA programs to support the development of reasonable regulatory programs.

### 8.11.3. Facilitation of Approval for the Use of Biotechnology

Beyond regulatory approval, there are issues of technology ownership that can usefully be addressed for existing biotechnology. In some cases the owners may have decided that they have no interest in the Malian market and may be willing to donate their interest. When that is the case and a Malian or regional research organization has already identified the technology as of significant utility, USAID may be able to facilitate approvals by U.S. owners to proceed with introduction into Mali. Likewise,

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<sup>27</sup> If for some reason the Malian government wishes an alternative to the U.S. model they should be encouraged to use the Argentinean, or perhaps the Egyptian. ISNAR may provide useful assistance in development of risk assessment systems in French.

<sup>28</sup> Building the regulation of biotechnology into existing institutions is productive because those institutions are already accustomed to prioritizing risks. New separate biotechnology regulatory institutions such as those in Europe may have difficulty rejecting small risks.

arrangements for the regulatory evaluation of selected biotechnology could be made with the support of USAID. Presumably a research group would take responsibility for regulatory evaluation and stewardship of the technology, including whatever monitoring is needed while the technology is in use.

#### **8.11.4. Support for Approval and Field Trials of Bt Cotton**

Bt cotton can be expected to reduce the amount of insecticide treatment necessary in Mali. Given the labor-intensive nature of Malian cotton production, a reduction in insecticide use would likely represent a major improvement in farmer safety, as well as environmental safety. Mali is a commercial producer of cotton and should be willing to negotiate a royalty with Monsanto, the owner of Bt cotton technology. While Monsanto is usually aggressive on pricing Bt technology, it is generally fair in its determination of the added value to the customer. In order to start the process, the government will require support in order to approve and undertake field trials that will establish the added value.

USAID could support the introduction of biotechnology approval processes in Mali through Bt cotton. The fiber products are not eaten and should be of minimal concern to the Ministry of Health where food safety might be evaluated. Almost no Bt protein or DNA appears in the oil after it has been refined therefore the oil would also be of minimal concern. Significant amounts of the Bt protein and DNA do appear in cotton seed cake, and have been found to be substantially equivalent to normal cotton seed cake for use in animal feed in the U.S. and several other countries.

#### **8.11.5. Support for Food Approval of Maize Biotechnology Traits**

The food approval of biotechnology traits commonly used in U.S. maize production should be pursued in Mali as a precaution in the event that U.S. grain be supplied to Mali in a food emergency situation. Owners of the biotechnology traits would be cooperative.<sup>29</sup>

### **8.12. The West African Regional Context for Support**

Regional seed movement can stabilize supplies, reduce cost and increase the range of varieties available to the average customer. Regionalization of the seed industry will allow for higher returns to research investment, lower cost of production, lower cost of holding inventory, stable supply, better variety testing, and a reduction in the phytosanitary and treatment restrictions to trade. Regionalization of seed trade is already happening in the vegetable seed sector, where Technisem operates in Senegal, Cote d'Ivoire, Burkina and Mali. Although current regulations may not be entirely favorable, support of regional information about seed prices, demand and availability can help the sector become more efficient. USAID should include information about seed availability for the major crops in any regional activities focused on agricultural market information.

Harmonization of seed laws is proceeding with respect to phytosanitary, certification and registration regulations. The CILSS-INSAH process is relatively advanced, and they have drafted regional compromise standards for certification, phytosanitary laws and for registration.<sup>30</sup> A copy of the

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<sup>29</sup> Once a regulatory system is operational, some assessment of the roles of the technology owners versus the U.S. government should be undertaken if sufficient precedent has not be established elsewhere.

<sup>30</sup> CILSS, *Institut du Sahel, Etude de l'harmonisation des réglementations de contrôle de qualité et des normes phytosanitaires des semences dans les pays du CILSS, Rapport de consultation*. October, 2002

combined catalogue of registered varieties has also been prepared. There is mutual agreement that there is no need for phytosanitary restrictions for shipment of seeds among the CILSS countries, as well as an ECOWAS initiative proceeding with the help of USAID's African Trade and Investment Policy Program (ATRIP).<sup>31</sup> This initiative should probably be a CILSS function, and USAID should work toward that end and support agreement on standards with the remainder of the countries that fall outside ECOWAS. Agreement among the Francophone countries was relatively easy because their regulations have a common origin. The next phase will be more difficult, and the ATRIP program must fully inform itself about the CILSS initiative and foster cooperation between the two programs. There is also a need for an agreement on who should lead the effort to harmonize the seed laws of all the ECOWAS countries. Given the planned role for CILSS in agriculture and the environment, CILSS should probably lead, with facilitation from USAID.

None of these efforts at regional harmonization is addressing uncertified, quality-declared seed, nor are they addressing PVP law. The ECOWAS-ATRIP document does include reference to self-regulation of quality, but quality-declared seed is not mentioned, as such, in either document. USAID should support amendments on quality-declared seed and other sorts of self-regulation that can make seed-quality assurance less expensive for the consumer but also ensure certain seed information rights and means of recourse. In Mali, USAID should also support development of PVP laws in preparation for Mali's full participation in the WTO. Senegal may have some form of PVP law, but that remained unconfirmed during the course of this study.

Success in some of the regional harmonization issues might make West Africa more attractive to US seed businesses. They could be offered incentives similar to the ones discussed here for commercial seed companies in Mali for the development of commercial seed business in West Africa. The Nigerian market is large enough to interest US seed companies in participation in development activities supported by USAID. Any successful regional harmonization of seed laws that included Nigeria would extend the area of interest by the US seed businesses. Legal harmonization within the Francophone countries might lead to interest after the current turmoil in Cote d'Ivoire is resolved.

Accumulation of information about donor-funded projects similar to Mali's SSSP program that may be happening in other West African countries would be a first step in information exchange between such projects. INSAH has a study in progress comparing the seed industries of the CILSS countries, the results of which were not available at the time of this study. There may be substantial gains in sharing information on best practices as well as generating contacts for seed sales to resolve shortages and surpluses. USAID should evaluate the INSAH study to determine whether or not it provides sufficient information on seed-sector support in other the other CILSS countries. If there is serious consideration of a regional seed-support program, additional information should be gathered regarding the status of seed-sector support in all the countries of the region.

The proposals for harmonization have not addressed biotechnology, though it can be best addressed at a regional level if there is a West African consensus. If there is general support for biotechnology in the region a regional approval mechanism for the evaluation of agricultural biotechnology would be very efficient and deserving of USAID's full support. Maximum use should be made of the existing USAID projects for supporting technology and regulatory development.

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<sup>31</sup> USAID, African Trade and Investment Policy Program. A meeting on policy reform to enhance agri-inputs trade in West Africa: Targets for seed and fertilizer trade and investment policy reform in the sub-region. Lomé, Togo. September 13-14, 2002

If there are countries that are staunchly opposed on the grounds that biotechnology is either unsafe or politically incorrect, and if they threaten to block regional acceptance, it is in the best interest of the U.S. that the evaluations be done separately. The level of acceptance of biotechnology seems to be good in Nigeria and Mali, but its status in other countries is unclear. If there is no regional consensus, it is unlikely that a regional organization would be given the power to proceed with science-based approvals. Given the spread of fears about the safety of biotechnology from Europe<sup>32</sup> there is a substantial possibility that consensus might be difficult. USAID should carefully monitor consumer acceptance levels.

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<sup>32</sup> The European Union voting approach has been a failure in terms of approving technology: there is no fundamental agreement to proceed. Political involvement has blocked all progress since 1997.

## 9. Conclusions and recommendations

The National Seed Service (NSS) was a government-run business. It was under-funded and used its in-house production poorly in the 1990s. The NSS has been reorganized as a seed-production coordinator with no in-house production capacity. It will spin off production capacities to the extent possible, but may pick up some new activity in vegetables and fruit as time passes. Production will be carried out by village seed-production associations. The African Development Bank (ADB) has financed NSS activities from late 2002 until 2009.

The ADB-financed project for the National Seed Service, known as SSSP, generally covers Mali's seed production needs. USAID does not need to be involved in the production aspects of the seed sector. The SSSP target is to produce enough seed to cover 30 percent of the area of Mali with a three-year replacement cycle. The project is workable as a seed production program. The project has a weakness in the identification of the seed production associations and in marketing, distribution and sales. Private company activity in those areas may develop if prices rise to 2-3 times those of grain at harvest. Weak marketing and demand are likely to hold down prices, as will seed traditions, former subsidies and lack of confidence in, and connection to, research among seed customers.

Because public organizations are the primary sources of new varieties and because plant variety protection is not available, varieties will mostly be non-exclusive. Without varietal exclusivity, commodity and agricultural-input companies – i.e. grain traders and companies trading in vegetable seed, agricultural chemical and fertilizer – may be the only organizations interested in the seed trade. They have developed connections in the right locations to develop such trade. The National Seed Service should be encouraged to respect variety property rights as if plant variety protection did exist in Mali.

Non-cash crops will not develop commercial seed businesses without subsidy. Sorghum, millet, some vegetable crops and forage crops are likely to be in this group. The farmers who grow them are especially risk-averse and have a tradition of not buying seed. Small sample, coupon programs and loans to village micro-finance associations exclusively for seed purchase can help distribute new varieties. More relaxed seed laws can help spread new varieties at the margin of the cash economy.

Because of varietal non-exclusivity, public support for the link between research and the farmer should continue. DNAMR has two divisions that will be involved with seed: one is the extension service and the other supports agricultural input distribution. The extension division is currently underfinanced for the job of maintaining the bi-directional link between research and the farmer. USAID support would be useful. Support from some source is crucial to maintain a proper research focus.

The other DNAMR division will help the NSS with the identification of seed-producer associations from among the existing farmer associations. It will try to assist the development of the seed trade between producers and consumers. A change in the organizational structure of DNAMR might help increase focus on seed. Both seed functions in DNAMR could be moved to the NSS. The impact of organizational change may be limited if commercial seed companies come to be important.

Support of the Association of Professional Farmer Organizations is an alternative to support of DNAMR for on-farm testing and coordination of village seed production associations.

The current private seed sector is limited to vegetables. There is one regional company that deals only with seed. The other major companies are involved with agricultural chemicals and with farm equipment. Other possible entrants into the broader seed business are fertilizer companies and grain traders.

The Institut d'Economie Rurale, responsible for agricultural research, is now responsible for production of foundation seed. They are selling to all responsible seed producers. They lack the appropriate facilities for foundation seed storage and equipment for handling small seed lots. It may also need operational financing and equipment for some new activities in vegetable seeds and fruit tree stocks.

The actions that USAID Mali could effectively take in the seed sector are:

- 1) Encouragement to NSS to change its seed pricing policy to reflect market realities at planting time. This is gentle persuasion, not a project.
- 2) Support of the expansion of the commercial seed sector with loans for equipment and operation, and training for technical and business staff.
- 3) Support for the distribution of new sorghum and millet varieties and the expansion of commercial seed business into sorghum and millet areas.
- 4) Distribution of very small packets of new varieties in specific sorghum and millet-growing areas to which they are adapted, at the rate of one year per new variety. Packets will be sold in local stores.
- 5) Sponsorship and subsidies for a coupon system allowing farmers to purchase subsidized coupons and redeem them for seed, encouraging commercial seed companies to expand into the area. This would proceed at the rate of two to three years per zone. Duration and quantity of coupons will be announced in advance. Administration can be contracted to an NGO.
- 6) Financing seed loans through local micro-finance organizations (*caisses villageoises*).
- 7) Support for miscellaneous projects at the NSS:
  - a) women's associations producing vegetable seed
  - b) upgrading the 60 ha floating-rice seed-production facility at Mopti (at an approximate cost of \$400,000), if USAID proceeds with significant number of controlled flooding irrigation projects requiring floating rice.
- 8) Funding the purchase of cold-room facilities, foundation-seed operations and foundation-seed equipment at IER.
- 9) Financing an on-farm testing program either at DNAMR or AOPP.
- 10) Support to Malian regulatory changes favoring quality-declared seed, PVP, and evaluation of biotechnology, possibly accompanied by appropriate training.
- 11) Building forage seed needs into livestock development programs with forage research, including winter crops.
- 12) Donor coordination and coordination with the owners of biotechnology for freedom to operate.

Chapter 8 lists other possible activities but these are either (a) regional in nature, (b) contingent on certain future conditions being met or (c) of lesser importance than those listed above.

Table 2 arrays the actions by their estimated benefits and the corresponding costs and risks.

**Table 2**  
**Benefits, costs and risks of proposed actions**

Project cost	Level of Benefits		
	Low	Medium	High
Low	7a. Women's vegetable seed (L)	4. Small packet distribution (L)	1. Change NSS pricing (H)
Medium		10. Regulatory changes (M) 11. Forage seed (M)	8. IER foundation seed (L) 12. Donor coordination (M)
High		7b Floating rice (M)	2 & 3. Commercial support (H) 5. Coupon program (L) 6. <i>Caisse villageoise</i> funds (H) 9. On-farm testing (L)

Note: Associated risk level: low (L), medium (M), high (H)

## Annex I: Seed Sector Concepts

Biotechnological event – When, in the process of genetic engineering, a piece of DNA is inserted into an organism, the components that are actually inserted and the context that of the DNA that surround it are called the *event*. Performance can be influenced by the placement of the event in the surrounding DNA. The event can include sequences of DNA with various functions and various intellectual property claims on them.

Biotechnology stewardship – Responsible use of a biotechnological trait may require restrictions on use. For example, use of *Bt traits* (see below) frequently requires restrictions on the percentage of the total area in an area that can be planted to *Bt* varieties in order to limit the probability of the development of insect resistance. The steward is responsible to make sure that guidelines for responsible use are followed.

Breeder's seed – Very pure seed used in the production of foundation seed. It is always grown in nurseries. It is known as pre-basic seed in Europe.

Bt or Bt trait – Plants derived through biotechnology with a protein from the bacterium *Bacillus thuringiensis* that is toxic to insects but safe for food consumption.

Caisse Villageoise – Malian local micro-finance organization.

Certified seed – Seed that has been inspected by government-recognized agencies to ensure that rules for varietal identity and purity have been followed and that quality standards are met. The OECD Seed Scheme provides mutual recognition of certification standards. Non-OECD nations can participate in the Seed Scheme. OECD maintains a list of varieties that are eligible for certification in the Seed Scheme.

Foundation seed – Seed produced from *breeder's seed* (see above) under strict genetic purity standards that can be used to sow fields used in commercial seed production. It is called *basic seed* in Europe.

Genetic purity – Trueness to type generally determined by a set of production procedures. The purity can be measured after harvest or through field observation of the growing plants.

Germplasm – Various plant varieties and segregating plant genetic material used in the creation of new varieties. It is a collection of genetic resources for use in breeding.

Germination testing – Testing the percentage of plants that germinate. Standards specify the conditions for germination and the categorization of abnormal plants. International standardization is available under ISTA, the International Seed Trade Association, which has recently become the International Seed Federation.

Hybrid variety – This is a plant variety that is created by crossing two other varieties. A single-cross hybrids is the cross of two *inbred* lines (see below); a double cross hybrid is the cross of two single crosses. A varietal cross is a cross of an open pollinated population by an inbred line or another population. The resulting seed is intended for use for a single generation.

Inbred – Relating to varieties of plants that are self-pollinated until they reproduce themselves uniformly.

Physical purity – The degree of absence of non-seed matter and weed seed in a sample.

Plant variety protection (PVP) PVP is an intellectual property system for plants. It requires that varieties be new, distinct, and genetically stable. PVP gives the owner a standard set of rights that are equivalent to the claims in a patent. It provides for access to seed for experimental use and for a farmer's exemption. It is generally simpler to obtain than a patent. PVP is available in many more countries that plant patents. *Utility patents* for plant varieties and PVP coexist in the US and some other countries. In the US there is also a Plant Patent which applies to asexually propagated plants.

Quality declared seed – Uncertified seed but with labeling so that buyers know what they are buying. Seed laws sometimes require that all seed be labeled with certain information for the buyer. Quality information is included. The information is provided by the seller. The supporting law provides for penalties for false information.

Registration – The process of having a variety accepted by the national government for use in a country. Only registered *hybrids* (see above) can have their seed certified. The list of registered varieties is frequently referred to as the “catalogue.”

Registration testing – The trials through which a variety must be tested to become registered.

Seed conditioning – Processing of seed to prepare it for sale. This may include cleaning, sizing, application of fungicides, application of insecticides, etc.

Seed storage – Storage taking account of the temperature and humidity that favour seed survival. Seed is alive. It is tolerant of a wide variety of conditions, but has its limits. Many seeds have long shelf lives if stored at 10°C and 50 % relative humidity. Fluctuations in temperature and humidity can cause damage.

Seed treatment – The application of colorants, fungicides, insecticides, polymer coatings, etc. Generally the last step before the seed is packaged.

Stages of production – Production of successive generations of seed. Genetic purity of variety production requires different procedures as seed is increased from small stocks to larger amounts. Pre-basic or *breeder's seed* (see above) is produced by hand-crossing. *Foundation seed* (see above) is grown from breeder's seed in isolation, or it can be produced by hand crossing in small amounts. Foundation seed is used to grow first generation *certified seed* (see above), known as R1 seed in Mali. First-generation certified seed is used to grow the second generation of certified seed, known as R2 seed in Mali. Quality and isolation standards may differ with the stage and the crop.

UPOV – (*Union pour la Protection des Obtentions Végétales*) – An international diplomatic convention for plant breeder’s rights, commonly called *plant variety protection* (see above). Membership has been expanding in recent years. It now includes many members from Europe, Eastern Europe, North America, Asia and Latin America. In Africa, Zimbabwe and South Africa are members.

Varietal stewardship - With varietal exclusivity, the party with the rights to use the variety can be given certain responsibilities to ensure that the variety is used appropriately, i.e. that users get the information on how to use the variety.

Variety maintainer – Under *registration* (see above), the stewardship of the variety belongs to a person who is recognized by the government. Production and use of foundation seed must have approval of the maintainer. Under some conditions this can create varietal exclusivity without *PVP* (see above).

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