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(Continued on the inside back cover.)
Seed Systems in Sub-Saharan Africa

Issues and Options

V. Venkatesan

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Seed production and distribution are important amongst the factors which determine the pace of agricultural development. Agricultural policies of the countries in Sub-Saharan Africa should therefore emphasize seed system strategies which would result in good quality seed of the right varieties being available to farmers at the right time and at affordable prices.

Many seed programs in the region are currently being undertaken without paying sufficient attention to the factors in the country which impact on the seed system, especially the prevailing cropping systems. This study stresses the need to put in place a seed system which is specific to the country and which would meet the seed needs of a gamut of farmers, particularly smallholders.

The study emphasizes the need to expand farmer-based seed production programs to include not only the traditional seed varieties but the modern ones as well. Such an approach would, in due course, increase the awareness of the farming community of the modern varieties, and expand the market for the formal private sector.

The paper also examines the implications for the seed system of many factors, such as, the status of research and extension, rural infrastructure and seed law, and analyzes some of the available options regarding the kind of seed system to be set up.

The study which is part of the Africa region’s efforts to promote agricultural development in Africa, is being published for diffusion inside the Bank, to other development agencies, and more important, for the use of those in the Sub-Saharan countries who are engaged in the critical task of increasing the incomes of smallholder farmers.

Kevin M. Cleaver
Director
Technical Department
Africa Region
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I am deeply thankful to Mrs. Marie-Helene Trepy-Kelly for her painstaking efforts at desk-topping the document.
Abstract

This study stresses the need for the countries in Sub-Saharan Africa to put in place a seed system which would meet the seed needs of a wide range of farmers, classified according to their risk tolerance capacity and resource endowments. Obviously, a single strategy cannot meet this objective. The study therefore recommends a mix of strategies, and argues for a "fit" between the country concerned and the seed system. It also examines the relationship between the seed system and other services to farmers such as research, extension, rural infrastructure and marketing. In the light of a detailed analysis of the issues relevant to seed systems, it examines the options available to the policymakers in the countries while setting up seed systems or modifying an existing one, and the implications of each of the options.
### Abbreviations and Acronyms

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<td>ADB</td>
<td>African Development Bank</td>
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<tr>
<td>ADMARC</td>
<td>Agricultural Development and Marketing Corporation</td>
</tr>
<tr>
<td>AED</td>
<td>Agricultural Extension Department</td>
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<tr>
<td>AISCO</td>
<td>Agricultural Inputs Supply Corporation</td>
</tr>
<tr>
<td>CDC</td>
<td>Commonwealth Development Corporation</td>
</tr>
<tr>
<td>CEAO</td>
<td>Communauté des Etats de L’Afrique Occidentale</td>
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<tr>
<td>CFA</td>
<td>Communauté Financière Africaine</td>
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<tr>
<td>CIAM</td>
<td>Centre d’Introduction et d’Adaptation du Matériel Végétal Fruitier et Maraicher</td>
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<tr>
<td>CIDA</td>
<td>Canadian International Development Agency</td>
</tr>
<tr>
<td>CNSA</td>
<td>Centre National des Semences Améliorées</td>
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<tr>
<td>DEPA</td>
<td>Département de la Recherche Agricole</td>
</tr>
<tr>
<td>EC</td>
<td>European Community</td>
</tr>
<tr>
<td>ESC</td>
<td>Ethiopian Seed Corporation</td>
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<tr>
<td>FAC</td>
<td>Fonds d’Aide et de Cooperation</td>
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<tr>
<td>FAD</td>
<td>Fonds d’Aide au Développement</td>
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<tr>
<td>FAO</td>
<td>Food and Agricultural Organization of the United Nations</td>
</tr>
<tr>
<td>FED</td>
<td>Fond Européen de Développement</td>
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<tr>
<td>GDP</td>
<td>Gross Domestic Product</td>
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<tr>
<td>GTZ</td>
<td>The Deutsche Gesellschaft fur Technische Zusammenarbeit</td>
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<tr>
<td>IARC</td>
<td>International Agricultural Research Centers</td>
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<tr>
<td>IDA</td>
<td>International Development Agency</td>
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<td>IFAD</td>
<td>International Fund for Agricultural Development</td>
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<td>ICRISAT</td>
<td>International Crops Research Institute for Semi-Arid Tropics</td>
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<td>IITA</td>
<td>International Institute of Tropical Agriculture</td>
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<td>ISNAR</td>
<td>International Service for National Agricultural Research</td>
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<td>ISTA</td>
<td>Association Internationale pour les Tests des Semences</td>
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<tr>
<td>MIDEVIV</td>
<td>Mission de Développement des cultures Vivrières</td>
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<tr>
<td>ODA</td>
<td>Overseas Development Administration, United Kingdom</td>
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<tr>
<td>R&amp;D</td>
<td>Research and Development</td>
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<tr>
<td>Rs.</td>
<td>Rupees (Indian)</td>
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<td>Swedish International Development Authority</td>
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<td>SONADER</td>
<td>Société de Développement Rural</td>
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<td>UNDP</td>
<td>United Nations Development Program</td>
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<td>USAID</td>
<td>United States Agency for International Development</td>
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<td>WARDA</td>
<td>West Africa Rice Development Association</td>
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<td>World Bank</td>
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Executive Summary

Bank support to agricultural services in Sub-Saharan Africa (SSA) started in the early 1980s with extension and research, and now includes other areas, such as inputs, marketing and credit. Extension projects follow a well-understood management system based on the Training and Visit (T&V) system of extension, with such modifications as the countries have found necessary (see Venkatesan et al., 1992 and Bagchee 1993). The SPAAR initiative and the Frameworks for Action prepared as part of this initiative, would enhance the capacity of African researchers (see Spurling et al., 1992 and Weijenberg et al., 1993). But appropriate strategies for seed development in the SSA countries have not evolved to the same extent as extension and research.

Most countries in the region have invested considerable resources in strengthening their research systems. Many of them also spend substantial amounts of foreign exchange in importing fertilizers. But not many of them address adequately the important issue of providing farmers with access to good quality seed, particularly of the modern varieties. The challenge before countries and donors therefore is to devise appropriate strategies covering seed production, distribution and pricing.

An effective seed system* must have a strategy for each category of farmer — it must meet different seed requirements classified according to the crops grown, varying resource endowments and must factor in risk-tolerance capacity. For example, some farmers can afford to buy hybrid seeds while some others would be satisfied with good quality seed of the modern, open-pollinated varieties which they could buy from neighboring farmers. While there is general agreement on this end objective, there is no unanimity as regards the means to attain it. As a necessary precondition to attaining this objective, farmers need to be actively involved in the various stages of varietal and seed development right from the stage of plant breeding.

Presently, the seed systems in most SSA countries focus on a narrow band of crops, principally maize and sorghum; less attention is paid to strategies which are appropriate to tuber crops, grain legumes, and horticultural crops. In most countries, government policies relating to the regulation of seed production and price setting inhibit the emergence of private initiatives in seed production and distribution; and the public sector or parastatal agencies play a dominant role in the multiplication and marketing of many varieties of seed.

Seed systems can be classified into formal and informal systems. The former generally consists of public sector research institutions, public and private sector seed

* In this study, the term "seed system" is used to denote the activities starting from selection and breeding, to the marketing and the use of seed by farmers for growing crops.
production and marketing agencies, and seed certification and quality control organizations. The latter consists of a large number of farmers who produce both traditional and modern seed varieties, market their production, and also, sometimes do their own research and development (R&D). Most government-induced seed systems in SSA are formal ones. Farmers are sometimes involved in seed production, but only as contract farmers who produce seed on contract for either a parastatal or a private sector seed company. These systems are generally the ones which are also supported by the donors and the financial institutions. The informal seed systems in SSA, such as the very successful operation supported by USAID in Senegal and the Gambia, are generally confined to traditional seed varieties, and depend very much upon farmers' own R&D efforts. Very rare indeed are instances of modern varieties bred at formal research stations being passed on to the informal sector for further downstream multiplication and sale, as an essential part of the national seed policy, with the active encouragement of the government agencies.

The quality of seed used by farmers for growing crops can be enhanced in many ways. Notable among there are:

(i) By training farmers in the better selection, treatment and storage of seeds from their own farms;

(ii) By encouraging farmers to make their own selection of traditional varieties, multiply and store seed of such varieties and sell such improved seed of traditional varieties to other farmers; and

(iii) By developing a modern variety through breeding at research stations, and production of good quality seed of modern varieties, through either formal or informal seed production channels.

Since, in most countries, informal farmer-to-farmer spread of seeds is the single most frequently used source of seed by farmers, it is necessary for governments to recognize the informal sector as an important low-cost source of quality seed, and to use it as a vehicle for providing resource-poor farmers with improved seed of modern varieties at affordable prices. While the informal sector can be provided with assistance by the government agencies in many ways, the most important vehicles comprise facility of access to foundation (and/or breeder seed), extension advice on seed production, processing, treatment and storage, and through a legal framework that permits the marketing of uncertified, "truthfully labelled" seed.

* "Truthfully labelled" seed conforms to the standards regarding the genetic purity, germination and the moisture content laid down for the variety, except that it does not carry an official certification tag. Where the variety is "notified", it meets the technical requirements of the notification. See footnote 23.
The main thesis of this paper is that government commitment to the encouragement of the informal sector is necessary to:

- Ensure a widespread adoption of modern varieties bred at research stations;
- Provide a gamut of farmers with access to good quality seed within easy distance, in time and at affordable prices;
- Encourage the healthy and sustainable development of the private sector seed industry; and
- Provide a viable and cost effective seed system for many crops which are important to farmers, but which tend to be neglected by the formal private sector, mainly due to the low profits which they offer.

The paper argues for deregulation of the seed industry with both the formal and informal seed systems providing quality seed to the consumers. Such a "bundle of strategies approach" to the seed system will increase the awareness of seed consumers of seed quality and price, and lead to an overall increase in seed use and consequently to agricultural production.

Private sector seed companies, including multinationals, and the seed parastatals constitute a powerful lobby in many developing countries, and have been successful in preventing the growth of competition to their operations from the informal sector. This has been done through preventing the latter from gaining access to germ plasm of modern varieties, and insisting on a legal system, including mandatory certification, which the informal sector would not be able to satisfy. The argument generally put forward by them defending these decisions is that farmers should be provided with good quality seed and that only the formal sector would be in a position to do so. If the price of seed from the formal sector is too high, the response suggested is a subsidy, which is not means-tested, and helps both the better-off and the not so well-off farmers. This argument overlooks the following facts:

(i) Farmers can be taught to grow seed of modern varieties, and it is the responsibility of the research and extension systems to provide them with the necessary training;

(ii) The extent to which the expensive process of certification, bagging and tagging, increases productivity is not statistically validated;

(iii) The informal sector would make more farmers conscious of the value of good quality seed, and would, in the long
run, increase the offtake of seed from the formal sector; and

(iv) In any case, farmers are the best judges of the cost-effectiveness of different sources of seed. Governments cannot substitute their judgements for those of the farmers. This is not to say that there is no place for quality control in the seed system; it is necessary, however, to distinguish between quality control and seed certification.

There is a perception that the informal seed system is "low-tech" and would delay the adoption by farmers in the SSA of "high-tech" comprising (mostly) certified hybrid maize seed from formal systems and fertilizer. This argument is often used to delay the deregulation of the seed industry in SSA which is now mostly in the formal sector. This paper argues that given adequate training, farmers can be taught to produce good quality seed of even hybrids. This is now borne out by the fact that in many countries, contract seed growers produce most of the hybrid seed for the private and public sector seed companies and even sell such seed to neighboring farmers.

The paper highlights the fact that the various components of a seed system are interrelated - seed legislation, for example, can determine the extent of private sector involvement in varietal development and seed production, and the growth of the informal sector. The seed system also has linkages with other systems, particularly, research and extension systems; it depends upon the former for its germ plasm, and on the latter for training farmers not only on the various aspects of seed production, but also on how to use the seed in the best manner for growing crops. Equally, research and extension systems depend upon an effective seed system to attain their objectives. The character of an appropriate seed system for a country is also determined by factors such as infrastructure and economic policies. It is necessary to policymakers to understand the linkages between the seed system and other systems, and between the different components of a seed system, so that they are aware of the consequences which their decisions in one area will have in another.

In most developing countries, governments are the providers of many services in the agricultural sector. While there is general agreement that they should, in due course, move out of this area, there is less unanimity among countries, donors and financial institutions regarding the sequence in which this should be done, and how this is to be achieved. Often, people start at the wrong end and talk of privatizing research and extension in SSA, forgetting that historically, these are the last services to be privatized in a country, and that a beginning should be made with seed, fertilizers and marketing. Again, as regards seed services, privatization cannot replace overnight the seed parastatal with a vibrant private sector competing for farmers' business. Further, privatization is not an end in itself, but a means to an end, which includes efficiency and competition. It is easy to replace a monopolistic public sector with an oligopolistic private sector, with
government controlling all operations including the "allocation" of germ plasm to a few fortunate private sector seed companies, all in the name of privatization. But it is more difficult to understand what basket of strategies would best serve the needs of farmers of all categories, such as, large, small, those in favorable agro-ecological zones and those who are not.

Since governments in many SSA countries are still either in the business of seed production, or control in many ways the manner of functioning of the seed system, policymakers and administrators have to face many issues relating to production, seed pricing, seed subsidy and marketing. Governments, however, often spend scarce managerial time on issues which would not have arisen in the first place if the proper mix of strategies had been followed while setting up seed systems.

An interesting question has been posed: "What would the supply of seed have been in the absence of government seed production programs?" (Pray and Ramaswami 1991, p. 35). These writers feel that it is not necessarily true that "in the absence of government programs farmers would not reproduce varieties and private companies would not produce hybrids." This issue is very relevant in SSA where there is an untested assumption of the need for government's presence in all stages of the varietal and seed development process.

Coming to the options available to countries, much depends upon the status regarding the factors relevant to seed systems, such as research, extension, infrastructure and policies. For most countries in the region, a suitable mix of strategies would appear to be the best choice, which recognizes that since farmers fall under different categories, so should seed systems, which should be pluralistic, giving farmers a wide choice.
I. Introduction

IMPORTANCE OF SEED IN THE AGRICULTURAL DEVELOPMENT OF SUB-SAHARAN AFRICA (SSA)

1.1 The agricultural sector in SSA employs more than 70 percent of the active population in the region, contributes more than 32 percent to the Gross Domestic Product (GDP), and remains the main source of foreign exchange earnings for the countries concerned (World Bank 1992). Despite substantial support from bilateral and multilateral development agencies, agricultural production in the 1980s did not keep pace with the rapid growth in population; from 1980 to 1990, the average growth of 2.1 percent in the economies of the Sub-Saharan countries was less than the average population growth rate of 3.1 percent.

1.2 The World Bank Technical Paper, A Strategy to Develop Agriculture in Sub-Saharan Africa and a Focus for the World Bank (Cleaver 1993) suggests a five-pronged strategy for the attainment of food production targets in SSA, of which the increased uptake of technology by farmers is an important component. One of the major constraints to a sustained increase in the uptake of technology has been the non-availability of good quality seed, particularly of modern varieties, at prices which farmers can afford. The evaluation of the performance of extension in Kenya (Bindlish and Evenson 1993) shows that the farmers' adoption rates for extension recommendations involving the use of purchased inputs is less than for those which focus only on the improvement of cultural practices, suggesting thereby that it would be possible to increase farmers' uptake of technology if suitable strategies are devised which would make appropriate seed available to farmers at affordable prices.

1.3 Seed is the most important and least expensive of the cash inputs. Until farmers are provided with access to good quality seed, particularly the modern varieties, it would be uneconomic for countries in SSA to spend precious foreign exchange on fertilizers (which are imported in almost all SSA countries), as such access is essential for farmers to reap the full benefit of the fertilizers. Investments in plant breeding research would also be uneconomic if the fruits of plant breeding are not passed on to farmers in the shape of good quality seed. "Even where national and international research centers have made plant breeding breakthroughs, ineffective seed multiplication and distribution systems in many developing countries have limited the spread of improved seeds at the farm level, especially among small-scale farmers" (Jaffee and Srivastava 1992, p.3). It is surprising that while countries in SSA are spending substantial resources on the import

[1] The term "modern varieties" refers to varieties bred at the research stations. These are generally non-lodging and responsive to fertilizers; the breeders manipulate the germ plasm to introduce several characteristics into the variety such as, maturity period, drought tolerance, resistance to certain pests and diseases, etc.
of fertilizers and on plant breeding research, few have seed development strategies consistent with their level of agricultural development. The challenge before the countries and the donors therefore is to devise appropriate strategies covering seed production, distribution and pricing.

SEED SYSTEMS

1.4 In this study, the term "seed system", / is used instead of "seed sector" to denote the activities starting from selection and breeding, to the marketing and use of seed by farmers for growing crops. Seed systems can be classified into two main categories; namely, formal and informal (see page 13, Figure 1)./* The former category, which is generally supported by most donor-assisted projects, comprises modern, formal institutions, such as parastatal seed agencies, and a legal framework providing, among other things, for seed certification and quality control. The latter comprises a bundle of strategies to improve the quality of seed used by farmers, including the improvement of farmer-selected and saved seed, and farmer-managed seed production programs. In this study the term "seed system" refers to both, except where it is referred to specifically as "formal" or "informal."

1.5 Seed systems have close linkages with other systems, particularly research and extension. For example, it is the responsibility of extension to provide advice to farmers regarding seed selection, treatment and storage, and give them information regarding the release of new varieties and their characteristics. Without an effective extension system responsive to farmers' needs, it would be difficult to develop a seed system, particularly informal seed systems, where extension's role is critical. Research has responsibilities for the development of both formal and informal seed systems, which it carries out through its breeding programs and training of extension staff. A detailed discussion of the linkages of seed systems with other systems is contained in Chapter IV.

OBJECTIVE AND APPROACH OF THE STUDY

1.6 The objective of this study is to analyze the issues relating to the different components of seed systems and indicate the options available to the countries in SSA and the donor agencies while developing seed systems. It describes the implications of seed policy, particularly the seed regulatory framework, for the attainment of institutional objectives, such as the development of informal seed systems and the private sector seed industry. It also contains a brief description of the seed systems of SSA countries and India (Annex 6).

/ The term is also used in many recent books on seed systems, e.g. Jaffee and Srivastava, 1992; Cromwell, E., et al, 1993.

/* They are also referred to, sometimes, as "modern" and "traditional."
1.7 The study is intended primarily to benefit the operational staff of the World Bank's Africa region, particularly the task managers of seed programs, with a view to helping them appreciate the various aspects of seed development, the issues relevant to each of these and the different options available while setting up seed systems. It would also be of use to the staff of donor agencies, NGOs and seed organizations in the SSA countries responsible for the preparation, appraisal or implementation of seed programs.

1.8 The study approaches the subject of seed system development from the farmers' angle, as they are the consumers of seed. It recognizes that the environment in which farmers operate influence their decisions regarding the use of seed, and that based on agro-climatic and resource endowment factors, they can be broadly classified into different categories. The main objective of agricultural administration relating to seed should be to ensure that farmers of all categories are made "seed secure"; i.e. the seed production and diffusion strategies are consistent with the need to make quality seed available to each of the categories within easy distance, in time, and at a price which they can afford; in other words, the seed system should satisfy the criteria of quality, timeliness, access and affordability. This presupposes a basket of seed development strategies, as the strategy appropriate for one category of farmers might not be so for the others. The study discusses the implications of such a farmer-centered approach for agricultural administration. The key feature of this study is its discussion of both formal and informal seed systems and their interrelationship, with specific reference to SSA countries. It also indicates the measures which the agricultural administrations of these countries should take in order to induce the development of both these systems in a complementary manner, with the more formal elements helping strengthen the informal ones, which, in turn, would contribute to the growth of the former. Strategies which would stimulate such mutually reinforcing developments are seen as essential to enable the seed system to be flexible enough to meet the needs of a variety of farmers. Institutional development is seen as one of the means available to the agricultural administration to attain this objective.

1.9 The Bank has only recently started supporting free-standing seed projects in SSA and the regional experience with such projects is therefore limited. The present study draws upon the author's earlier experience in implementing seed development programs in India, and the many publications relating to African experience with seed development. There are many studies of seed systems which the author has consulted

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1/ The term "seed programs" refers to free-standing seed projects, and those which contain seed development components.

2/ These are more fully discussed in Chapter II.

3/ This term is used in this paper to collectively denote research, extension and other agricultural services.
in the course of preparing this study. Some of them '/' focus on formal seed systems and describe the institutional and regulatory framework relating to seeds. A recent World Bank Discussion Paper '8' examines the appropriate role of the formal private sector in seed systems, and the strategies which are conducive to its development. A few recent studies deal with specific SSA countries and look at issues relating to seed systems from the farmers' angle; they also contain useful statistical analysis of farmers' views '/' regarding the functioning of formal seed systems, and the extent to which these systems satisfy their needs. Some studies document the successful efforts of NGOs in developing informal farmer-based seed systems.'9/

CURRENT STATUS OF SEED DEVELOPMENT IN SSA

1.10 Countries in SSA are at different levels of seed development. In some countries, there is neither a national seed policy, nor a seed development strategy, nor quality control and certification procedures. The enforcement of seed legislation is often also weak. Breeding and testing programs are still rudimentary and often limited to testing varieties made available by the international research centers or other countries. Moreover, farmers' involvement in the development of these varieties and on-farm trials, which are essential for the successful adoption of the varieties by them, is minimal. At the other end of the spectrum, a few countries (e.g. Kenya, Zimbabwe) have placed emphasis on breeding and testing programs, and have made efforts to formulate and enforce seed legislation. The common features of the seed systems in most SSA countries are:

(i) The focus of the plant breeding and/or testing programs is limited to a few crops, principally maize and sorghum, and less attention is paid to tuber crops (which constitute the staple diet of the population of many SSA countries), grain legumes, and horticultural crops;

(ii) The public sector or parastatal agencies play a dominant role in the multiplication and marketing of many varieties of seed;

(iii) Government policies relating to the regulation of seed production and price setting inhibit the emergence of private initiatives in seed production and distribution; and

7/ See for example, Douglas, J., 1980.
Farmers are involved in seed multiplication generally as contract farmers,¹¹/ and not as seed producer-sellers (see para 3.6), and there is little official encouragement given to informal seed systems, nor a recognition of their role in meeting the seed needs of a large segment of the farming community.

DONOR SUPPORT TO SEED DEVELOPMENT IN SSA

1.11 The World Bank's support to seed development in SSA includes three free-standing seed projects (Nigeria, Guinea and Zaire) all of which are ongoing, and forty-two with seed development components;¹²/ fifteen of these latter projects are presently active (Annex 1, Table A1.1). Other international lending agencies, such as, FAO, UNDP, USAID, FAC, FAD, ADB, GTZ, FED, CEAO, CIDA, SIDA and EC have also funded a number of projects with seed components; Annex 1, Table A1.2 gives a list of such projects; this list is not exhaustive, but covers most of the projects approved by these agencies so far and is illustrative of the type and scale of seed-related initiatives in the SSA countries which are supported by donor agencies other than the World Bank.

¹¹/ The term "contract farmers" refers to those who carry out seed multiplication on their farms for parastatals or private seed companies on contract.

¹²/ A seed development component refers to a single activity or a set of activities in the seed development process, such as the development of seed farms, seed laboratories, seed processing plants, seed conditioning centers, etc.
II. Characteristics of Effective Seed Systems

2.1 The previous chapter stressed the need for a seed system to be able to meet the needs of a wide range of farmers. This chapter describes the various categories of farmers based on agro-climatic and resource endowment factors, and the seed strategies appropriate for each of them. It also discusses the other features required of effective seed systems.

STRATEGIES APPROPRIATE TO THE DIFFERENT CATEGORIES OF FARMERS

2.2 Farmers in SSA can be classified according to their risk tolerance capacity on the basis of the agro-climatic conditions of their location and their resource endowments, as illustrated in Table 1. The columns of the table represent the agro-ecological potential. Thus, Kitale in Kenya will be high potential, and Sahelian Burkina Faso will be low potential; the rows represent the farmer's resource endowment, the size of the farm being the most dominant criterion. The cells indicate the farmer's risk tolerance capacity.

Table 1. Table Classifying Farmers According to their Risk Tolerance Capacity

<table>
<thead>
<tr>
<th>Potential --- &gt;</th>
<th>Low</th>
<th>Medium</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resource</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Medium</td>
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<tr>
<td>Medium</td>
<td>Low</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>High</td>
<td>Medium</td>
<td>Medium</td>
<td>High</td>
</tr>
</tbody>
</table>

2.3 At one end of the spectrum of farmers are those who cannot afford the cash outlay involved in purchasing seed, and who can be helped to increase production through better use of their own saved seed. These are the ones categorized as "low" in the Table 1. They can be helped by extension to carry out seed selection, seed treatment and adopt better seed storage techniques. Improvement of the quality of farmer-saved seed is the single biggest source of improvement, since about 90 percent of farmers in developing countries use their own saved seed of both traditional and modern varieties (see Box 1) and this can be achieved with little cash input.
Box 1. Senegal and The Gambia - On-Farm Seed Project

The On-Farm Seed Project (OFSP) being implemented in Senegal (Annex 6) and The Gambia is an example of farmers' involvement in seed selection, production, storage and distribution.

According to Winrock International (see Osborn 1990), "More than 90 percent of farmers in developing countries sow seed selected and saved from their own fields. The farmers' principal sources of seeds are the locally adapted varieties that have evolved through traditional selection and production practices. These varieties sometimes lack high production potential, disease and pest resistance, drought tolerance, early maturity, and other desirable characteristics. Even if improved varieties are adopted, potential benefits may be lessened by inappropriate crop production practices. The challenge for OFSP is to work with both traditional and improved varieties, introducing modifications into the conventional seed-production system so farmers have an increased supply of better seed."

The main objective of the project is to increase the availability of better seed to farmers by improving their selection, production, storage and distribution systems. The project also teaches farmers how to adapt new varieties and technologies to the indigenous knowledge systems and traditional practices. The focus of the project in both countries is on rice; the new varieties of rice from the research system were given to farmers for trials on their fields (without subsidized fertilizers and other inputs). Their level of technology was improved in gradual stages with their own resources. And finally, they were given extension advice regarding seed selection and storage. Since rice is a self-pollinated crop, maintenance of varietal purity was not a problem. The project has resulted in good quality seed being available to farmers in a decentralized fashion, at low cost.

Spurred by the success of the Senegal and the Gambia efforts, Winrock International has plans to start similar programs in the Southern Africa (Antoine and Byrnes 1993b). It is proposed to include modern varieties in these programs.

2.4 The next level of farmers are those who can do some experimentation, and are potential consumers of seed of modern varieties, perhaps not hybrids. Initially however, research should work with them and help them stabilize some varieties which they themselves have selected. They are generally farmers who are in areas ranging from medium to high potential, but with a low level of resource endowment; they can afford to take some risk, but not enough to purchase all their inputs.

2.5 Farmers who are categorized as "medium" in Table 1, by either of the parameters, can be persuaded to buy inputs, provided the outlay is small. The seed strategy which would meet their needs should therefore ensure that they have access to good quality seed of modern varieties, at prices which they consider worth the risk. This can be achieved by selling foundation seed to the intending seed-producers, and by providing them extension advice on the further multiplication of foundation seed into
commercial seed, for their own use or sale to neighboring farmers. Costs can be kept low if this seed is unprocessed and uncertified. Farmers who purchase such seed would pay less than for certified seed, and would have access to good quality seed with proven genetic potential. Field experience in many countries shows that the yield obtained from such seed is not very much less than from seed from more formal sources, e.g. parastatals or private sector seed companies; but little research has been done in this field in systematically comparing the yields from these two kinds of seed, i.e. processed, certified on the one hand, and unprocessed, uncertified on the other. It is generally assumed, without statistically validated field trials, that the increase in yields through the use of seed from formal sources would justify the higher cost of such seed.

2.6 It needs to be recognized, however, that even though farmers' varieties have better adaptability than the modern ones and a reasonable level of tolerance to insects and diseases, their resistance to these tends to diminish. Therefore, when there is an outbreak of a new disease which affects the traditional varieties it would be necessary to introduce farmers to modern varieties which are resistant to the disease. For example, in Nigeria, the traditional maize varieties have tended to succumb to downy mildew. The solution to the problem lies in progressively introducing farmers to disease-resistant varieties bred by researchers. The example of cassava mosaic in Western Africa illustrates the fact that farmers would be willing to change to modern, disease-resistant varieties, when their traditional varieties succumb to new diseases, provided the new varieties are made available to them at prices which they can afford; farmers in Ghana and Nigeria, are changing to mosaic resistant cassava variety introduced by the International Institute of Tropical Agriculture (IITA).

2.7 At the "high end" of the spectrum are farmers who are categorized as "high" in Table 1. They constitute the potential market for the "certified" seed of hybrids and open pollinated varieties (OPV). Many seed systems generally focus more on this end, and less on the strategies suitable for the other categories of farmers described in the foregoing paragraphs.

2.8 It must be stated here that there are many examples in the SSA where Table 1 might not apply. In Malawi, farmers even in marginal areas grow hybrid maize, which is considered appropriate only for "less risk prone" environments. It has, however, to be borne in mind that in Malawi, government bears the risk through subsidy on hybrid seed, a factor which will be discussed later in this report. It is generally true that wherever the crop does not fit in with the risk situation of the farmer, there is a

\[\text{These farmers are also called "seedsmen" (see para 3.6).}\]

\[\text{"Certification" is a process by which the official agency designated by the seed law of the country tests the seed marketed for its genetic purity and germination (see para. 4.12). The options regarding certification and their implications are discussed in Chapter IV.}\]
concealed subsidy element, either on seed, or on prices of grain (e.g. Zambia), which distorts the economics of crop production.

2.9 In addition to containing elements which meet the needs of a variety of farmers, seed systems should have other characteristics as well, in order to be effective. The key ones are given here:

(i) Seed systems should cover all crops which a majority of farmers grow, including vegetatively propagated crops (e.g. cassava, yam, plantain), and crops with a high seed rate or low multiplication rate (e.g. groundnut and some legumes), which are generally given low priority in the seed systems in many countries.

Box 2. Varietal Development in Tuber Crop

Experience has shown that formal research intervention in staple food tuber crops in SSA is necessary to bring in disease-resistant genes. But since taste, cooking and storing quality are of paramount concern to the consumer - this is so for all crops, but more so in tubers - most research in these crops has involved collection, selection, testing and dissemination. This has been done in many countries, Togo being an example where it has been done to a high degree. The fact remains, however, that the attention paid to these crops is not commensurate to their share of the calorific intake of the population in most countries.

(ii) The varieties offered to farmers have to be appropriate and they must have a number of critical characteristics if they are to be adopted by farmers and used successfully. It is particularly important to recognize that smallholders, and those in "high risk" areas give priority to stability in their crop varieties over higher production. This would be possible only if farmers are involved at every stage of the development of varieties.

(iii) Seed has to be developed within a stable political and legal environment which ensures the release of new varieties of high quality seed to farmers in a sustained manner supported by appropriate agricultural policies; and involves the honoring of commercial agreements. Often, price regulation, import tariffs or quantity restrictions could weaken or prolong the process of the switchover to modern varieties by farmers.

"The Indian Green Revolution is an excellent example. The fact that farmers realized remunerative prices for wheat and rice is as important as the genetic potential of the "miracle" varieties."
(iv) Seed systems should "fit" the level of agricultural and infrastructural development, and the maturity of institutions in the agricultural sector of the countries. For example, in a country, such Ethiopia, Eritrea or Zaire, where a majority of farmers are poor, and services poorly organized with a low level of infrastructure development, it might not be desirable to put in place a sophisticated seed system, involving too many institutions, before the "basics" such as research and extension systems are taken care of; "institutional engineering" could make seed systems a "misfit" in such countries. Further, institutions, such as seed parastatals, which are part of the seed system, might not be sustainable if they require the props of continual state subsidies and expatriate technical assistance.

(v) The seed system should also "fit" the policies generally followed in the agricultural sector. For example, in SSA there is a movement towards liberalization and privatization, mostly driven by the international donor community. Any donor assistance to seed system in these countries which recommends a greater role for government in seed production and distribution, or compulsory seed certification, would require a very strong justification.

(vi) The importance of effective research and extension services to the seed system was seen earlier; in addition, to be effective, a seed system also needs the support of other services, such as fertilizer and pesticide supply, agricultural credit and an efficient commodity marketing system. Chapter IV elaborates on the linkages between the various components of the seed system, and between the seed system and other systems, such as research, extension and credit.
III. Methods of Seed Development

3.1 Figure 1 illustrates that seed development comprises two distinct phases:

- Varietal development phase;
- Seed production phase.

This chapter examines the options regarding these phases and the implications of each option.

SEED DEVELOPMENT

3.2 Seed development is a term which is generally used in the context of formal seed systems. It comprises a chain of processes stretching from the manipulation of the germ plasm at the research stations, through multiplication, processing, and marketing, and eventually to seed purchase and use by farmers. The terms used in this study to denote the different stages of seed are: breeder seed, foundation seed and commercial or certified seed. "Certified seed is generally used by farmers for growing crops, and is produced from foundation seed; the generation before foundation seed is called breeder seed. Seed that is marketed without certification is called commercial seed and may have been grown from breeder seed or an equivalent seed stock. These stages are also referred to as pre-basic, basic and certified seed respectively. The seed development chain comprises the following components:

(i) The first component comprises the agricultural research and varietal release process. Agricultural research develops new varieties, tests them and makes recommendations for their use. These varieties are released through a varietal release mechanism which includes several stages of varietal testing.

(ii) The second component consists of the different stages of seed multiplication. Small quantities of breeder seed provided by the breeder are multiplied, first into foundation and then into commercial seed and made available to farmers in commercial quantities. This involves different actors at different stages. In most SSA countries, these stages are generally implemented by governments either departmentally or

4/ The technical terms used in this paper are described in Annex 8.

5/ For the sake of convenience, the term "multiplication" is used for both hybrids and open-pollinated varieties.
through a parastatal agency. In some countries, the same agency is also responsible for seed quality enforcement and certification (see Annex 6).

(iii) The third component comprises seed processing. In the multiplication of breeder seed to foundation seed and foundation seed to commercial seed, seed is mechanically processed, i.e. dried, cleaned, separated from impurities, sorted, calibrated, treated, packed and labeled, to ensure its quality. In many countries, separate organizations have been set up to handle processing.

(iv) The fourth component is market promotion and distribution. Seed legislation provides the legal framework for the seed development process. It includes regulations relating specifically to varietal release, notification, seed certification, pricing, marketing, subsidies, taxes, import and export. The components of the seed system are highly interdependent - seed legislation, for example, can determine the extent of private sector involvement in varietal development and seed production, as will be discussed in Chapter IV. 

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**VARIETAL DEVELOPMENT PHASE**

3.3 This phase includes all activities starting from the breeding of a variety at the research station until the variety is "notified" under the seed law. A plant breeder starting the breeding program at the research station, is generally aware of the characteristics which farmers prefer, and tries to incorporate those in the new variety to be developed from the available germ plasm. Once a variety is developed, it is necessary to find out how it would fare in the different agro-ecological zones of the country and under the management of the various categories of farmers. This is done by undertaking a number of trials at various locations, called *multi-location trials*, and on farmers' fields under their own management, called *on-farm trials*. On the basis of the results of these trials, the research system decides whether or not to propose the variety for "release" to the varietal release committee"/ which then takes a decision regarding its release. A variety is sometimes released only to a part of the country, depending upon its characteristics and its suitability.

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"/ Generally, this committee is chaired by the Minister for Agriculture or a senior official of the Ministry. Its membership includes representatives of research, extension and other agricultural services. In some countries, it also includes representatives of cooperatives and the private sector.
Figure 1. The Components of a Seed System

Seed Legislation
1. Regulations relating to variety release;
2. Quality standards regarding different categories of seeds, via breeder, foundation and commercial seed;
3. Quality control and seed certification.

Seed Development
- Varietal Development
  1. Agricultural Research
  2. Varietal testing and release
- Seed Production Phase
  3. Seed multiplication
  4. Processing and marketing

Strategies to Improve the Quality of Seed Used by Farmers
1. Improvement to the quality of traditional varieties used by farmers;
2. Development of seed varieties selected by farmers.
3. Farmer-based seed production program for seeds of modern varieties and multiplication of vegetatively propagated crops;
3.4 It is difficult to specify the criteria to be applied for releasing a variety. The seed laws of most countries give unfettered discretion to the varietal release committee regarding the release of a new variety. The breeder who has spent a number of patient years breeding the variety is naturally very keen on getting it "released" and the research system would generally support the breeder. The varietal release committee often finds it difficult to resist the request of the research system. This partly explains the existence of a number of "released" varieties which have not been multiplied for use by farmers. It is therefore necessary to adopt measures which would curb the enthusiasm of researchers to embark on plant breeding as an "end-in-itself" exercise and check their tendency to breed varieties which are not going to make it with farmers. The most important of these are:

(i) The involvement of farmers in the early stages of plant breeding; and

(ii) The evolution of criteria for the release of new varieties, such as pronounced improvement over the existing varieties in respect of yield, pest and disease resistance, drought tolerance, maturity period etc. general (as against very specific) applicability and consistency with the prevailing farming systems.

3.5 The stage following the "release" is "notification." "Notification" under the seed law (where it exists) generally specifies the physical and performance characteristics of the variety, and often also safeguards the intellectual property rights of the breeder. More specifically, if a variety "x" has been notified under the seed law, then no person can sell any seed labeled as "x" unless:

(i) The person had obtained the breeder seed of "x" from the breeder of that variety or his/her nominee; and

(ii) The seed conforms to the characteristics of "x" specified in the notification.

The various stages of this phase are shown in Figure 2 and Figure 3. Figure 2 pertains to the development of varieties bred by public sector research, and Figure 3 to those bred by private sector research.

SEED PRODUCTION PHASE

3.6 This phase starts with the breeder seed emanating from the research stations, and ends with the production of commercial seed, either certified or uncertified, to be sold to farmers. There are various options available here depending upon the extent of involvement of the public sector, private sector seed companies and the informal sector.
Development of suitable plant varieties for cultivation by farmers can take about five to ten years depending upon the crop. For most crops, in order to have homogeneous lines, varietal selection process continues up to six generations. This would normally take six years. It is however possible to take advantage of the presence in the country of a variety of agro-ecological situations and cut short this time. When the Rockefeller Foundation started assisting the Indian research system in the 1960s, it suggested that by exploiting the existing ecologies in India it would be possible to reduce the period from the normal six years to three years. In the case of wheat, for example, the scientists were able to carry out the first crossings of wheat in winter in the North Indian plains, and move to the cooler climates in the high altitudes of South India in summer for the next generation, returning to the North Indian plains in winter for the next (third) generation. It is possible in many countries in SSA to exploit the comparative advantages of regions within countries. Under the Frameworks for Action (Spurling et al. 1992 and Weijenberg et al. 1993), a regional approach to research is evolving and this development would enable the countries to take advantage of the ecological variations within regions.

consisting of seedsmen. 20/ The tables in Annex 2 give the details relating to the various seed production models.

3.7 Model 1: State/Parastatal - Contract Seed Grower Model (Figure 4)

This is the most common model in many developing countries. Researchers provide the breeder seed to parastatal or state agencies who multiply them in state or parastatal farms and/or through contract seed growers. All the remaining activities, such as seed cleaning, processing, marketing, etc. are performed by parastatal or state agencies. The planning and implementation of seed production programs under this model are described in Annex 3. This model is invariably followed for the production of seed by public sector agencies in SSA.

3.8 Model 2: Private-Cooperative Model (Figure 5)

In this model, the private sector (including cooperatives) plays an important role in multiplication. Researchers, including those working in private sector research, provide

20/ This term is used in this paper to denote farmers who buy parental seed material, either breeder seed or foundation seed from public sector sources (private sector does not normally sell its breeder or foundation seed to farmers), and produce commercial seed to be sold to other farmers, generally uncertified. These farmers constitute the informal sector of the seed industry. They should be distinguished from contract farmers who grow seed for parastatals or private sector seed companies; the former are seed entrepreneurs, while the latter only undertake seed growing on contract and get paid the contracted amount.
Figure 2. Stages of Varietal Development (Public Sector)

<table>
<thead>
<tr>
<th>Stage</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breeding</td>
<td>This is generally done at public sector research stations (including IARCs) by plant breeders.</td>
</tr>
<tr>
<td>Variety</td>
<td>Multi-location trials on testing sites. On-farm trials on farmers' fields.</td>
</tr>
<tr>
<td></td>
<td>The results of these trials are fed back to the breeder, who may decide to take a selected number of varieties to the next stage.</td>
</tr>
<tr>
<td>Varietal Release</td>
<td>The breeder submits his/her proposals for the release of the variety to the Varietal Release Committee in the Ministry of Agriculture. If the Committee decides to release the variety, then it is very often &quot;notified;&quot; if not, the proposal is returned to the breeder.</td>
</tr>
<tr>
<td>Notification</td>
<td>This often presupposes the existence of a seed legislation. Notification includes a description of the variety, its key characteristics such as maturity period, pest and disease resistance, etc. The important contribution of notification is the prescription of quality standards.</td>
</tr>
</tbody>
</table>
Figure 3. States of Varietal Development (Private Sector)

Stage

Breeding

This is done by private seed companies and NGOs in addition to public sector research stations.

Variety

Multi-location trials on testing sites. On-farm trials on farmers' fields.**

The results of these trials are fed back to the breeder, who may decide to take a selected number of varieties to the next stage.

Varietal Release

Private sector still chooses to participate in the "release" mechanism

Optional

Private sector releases its own varieties each having a set of announced characteristics

Notification

Compulsory

** In some countries the private sector participates in the testing program organized and managed by the national research system; and in some others, private sector companies undertake field-testing of their varieties on their own.
Figure 4. Seed Production: Parastatal/State Contract Farmer Model (Model 1; Para 3.7)
breeder seed to private companies\(^2\) to produce foundation and commercial seed. The downstream activities of processing and marketing activities are performed by cooperatives and private companies. This is the preferred model for the multinational seed companies in SSA. In respect of the planning and implementation of seed production, this model is similar to the one mentioned previously, with the following major difference, due to the different concepts of accountability in the two sectors.

**Box 4. Seed Village Program in India**

Production of seed, particularly of cross-pollinated varieties, including hybrids, requires isolation of the seed crop, from other crops, in order to avoid contamination. The recommended isolation distances vary from 200 m. to 1000 m. In self-pollinated crops, such as wheat and rice, the isolation distances could be less. It is often mentioned that the barrier to the implementation of a decentralized farmer-based seed production program is the smallness of the holdings of many farmers, which prevents them from providing the necessary isolation distances. In Malawi, for example, maize (both composite and hybrid) seed production programs, which follow Model 2 (para 3.8) is invariably implemented through farmers in the "estate" sector, as their holdings are generally larger. The argument often heard for not following the decentralized, farmer-based model for composite and hybrid maize, is that most farmers in the "non-estate" sector cannot maintain the prescribed isolation distances, and that therefore, there is a genuine risk of admixture.

In India, this problem of isolation has been overcome by forming seed farmers’ groups and encouraging them to organize seed production over large areas. In Maharashtra State, many villages are known as "seed villages," as farmers in those villages have decided to undertake seed production on holdings adjacent to each other so that there is one large contiguous area of land under seed production. Incentives are offered to small farmers to undertake seed production in groups, often as contract seed growers, but sometimes also as seedsmen.

As a result of efforts to form seed farmers’ groups, the number of seed farmers has increased from 46705 in 1991 to 54212 in 1992 (16 percent increase); and the area under seed production has increased from 46442 ha, to 63444 ha, (37 percent increase).

Both the seed parastatals and the private sector seed companies benefit from such a concentrated seed production program. It would also result in substantial economies to the seed certification agency which is obliged to inspect all the seed plots.

3.9 The private sector seed companies are accountable to their shareholders (or members in the case of cooperatives) and their main concern is to sell all the seed produced by them since it is expensive to carry over seed from one season to

\(^2\) The term private companies includes "cooperatives."
Forecasting the quantities of seed that can be sold is very difficult, since seed consumption by farmers depends upon many factors, including importantly, the climatic ones. Therefore, the private sector companies tend to play safe and plan to produce only whatever quantities can definitely be sold. They also tend to focus on "high profit" areas, such as, hybrids and vegetable and flower seeds; these, first of all, are grown by farmers in low-risk situations, and second, farmers have to replace them every year. When farmers' risk is low, so too is the supplier's risk. The public sector, on the other hand, has an obligation to meet the seed requirements of farmers, irrespective of where they are situated, and in respect of all crops and varieties, including OPVs. Their operations are not confined only to low-risk areas, crops and varieties. This fact, often coupled with lax financial accountability, results in losses to public sector seed operations and also large quantities of unsold seed which then have to be carried over to the next season.

INFORMAL SEED SYSTEMS

3.10 In informal seed systems, there are three main strategies, which are described in paras 2.3 thru 2.5. Out of these three, the first two consist of upgrading the traditional varieties and do not depend upon any interaction between the formal and informal seed systems. The third strategy is the "bridge" between the formal and informal systems, with the germ plasm coming from the formal system in the form of breeder or foundation seed and the subsequent downstream activities being carried out by the informal one. This model is known as the "decentralized farmer-based model" and is described here.

3.11 Model 3: Decentralized Farmer-Based Model (Figure 6)

In this model, described in para 2.5, the researcher's involvement in the seed chain stops at producing breeder and/or foundation seed, which is sold to farmers, who perform the further downstream activities of multiplication, harvesting, drying, processing, storage and marketing. Seed processing is generally done locally, if at all, and often manually, through the use of handheld sieves etc. Commercial seed is sold as "truthfully labeled" to other farmers (consumers).  

3.12 Many "farmer-based seed production programs" in SSA, assisted by some donors and NGOs, actually comprise multiplications of "improved selections" made by the

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29/ Seed carried over from one season to another requires re-validation as considerable changes in quality may have occurred in the carried over seed, and under poor storage conditions the deterioration in quality is more rapid. In many SSA countries (e.g. Malawi) such carried over seed is sold without any further revalidation, although this is technically not the right thing to do.

30/ "Truthfully labeled" seed conforms to all the technical requirements mentioned in the notification of a variety, but is not "certified."
Figure 5. Seed Production: Private-Cooperative Model (Model 2: Para 3.9)

- Research
- Breeder Seed
- Seed Co-op or Private Companies
- Foundation Seed
- Domestic and International Markets
- Certified Seed
- Farms owned and managed by the seed coop or private company.
- Contract Seed Growers
Figure 6. Seed Production: Decentralized-Farmer Based Model (Model 3; Para 3.11)
Box 5. Strategies for Planting Material of Vegetatively Propagated Crops

The decentralized farmer-based model is particularly suitable for the propagation of the planting material of tuber crops, as the propagation of yam in Nigeria through the mini-sett technology, evolved by the International Institute of Tropical Agriculture (IITA), would show. Under this technology, each farmer can grow seed yam from yam mini-setts (which are thin slices of yam), on a portion of his (or her) field, and in the following year, sell the seed yam to other farmers for crop production. This would result in considerable saving of planting material. Many farmers have recently emerged as seed yam producers (from mini-setts). Such a decentralized strategy is also possible in cassava, where there is considerable demand for mosaic-resistant varieties. Each farmer can be given a few parental stalks of cassava to plant on a portion of the field. In the next season such farmers would obtain enough cassava planting material from this portion to cover a larger area, and so on. There is no danger of varietal admixture in cassava, and no need for isolation.

Ghana, however, has chosen to adopt a formal system run by the government department. Under the IFAD-funded "Smallholder Rehabilitation Project," a program for the introduction, testing, release and multiplication of elite planting material is being undertaken by the Crops Research Institute (CRI) and the Crops Services Department (CSD). Four cassava varieties have been released so far. CRI grows the parental material of cassava on its research farms at Kumasi and Ohawu. Cuttings from this are given to farmers selected by the CSD in five cassava growing regions; CSD gives these farmers subsidies for land improvement, etc. They are required to give the stalks back to the CSD (the roots are for them to keep), who would then give them to other farmers to multiply. In addition, the Ghana Grain and Legumes Board (GLDB) is also engaged in the multiplication of planting material of cassava.

Even though the genetic birthplace of the "Galmi" onion (called violet de galmi), which is widely grown in West Africa, is in the Birni Nkonni district of Niger, there is no national seed production program for this variety, which is usually mixed with others in the field. To maintain varietal purity, farmers of the Guidan Ider region of the country have developed a seed production system. Bulbs which are selected for their genetic purity and performance are cut in two (horizontally) and the lower part, with the roots, is planted. It results in 10 to 20 shoots which are used for producing seed.

farmers themselves, and fall under the models described in paras 2.3 and 2.4. Some countries, (e.g. Malawi, Nigeria) implement seed production programs which carry the title "Small Farmer Seed Multiplication Scheme" or something similar, suggesting that the seed multiplication model is similar to what has been described in the previous paragraph. But actually, many of them are government or parastatal programs where the farmers involved in seed production are contract seed producers, rather than seedsmen; that is, they follow Model 1 described in para 3.7. Very few SSA countries adopt the decentralized strategy described in para 3.11, which presupposes an interaction between the formal and the informal seed systems, combining the advantages of research with the cost advantages of farmer-management of seed production. It is very difficult to agree
entirely that "farmers cannot efficiently reproduce and store hybrid seed equal to seed purchased commercially." (Srivastava and Jaffee 1993, p. 4). Many farmers who produce hybrid seed for private seed companies and parastatals on contract basis do keep aside some hybrid seed which they sell to other farmers. While the size of their operations is necessarily small, those who purchase the seed are obviously satisfied with the quality of the seed.

3.13 Many countries have more than one model operating at the same time. Nigeria, for example, has a seed system which is predominantly government-run; but increasingly, it is also encouraging the growth of private sector initiatives in seed development, veering round to the private sector model (Model 2) described in para 3.8.
IV. Seed System Linkages

LINKAGE BETWEEN THE SEED SYSTEM AND THE CROPPING SYSTEM

4.1 The prevailing crops and cropping system in a country or a region influence the characteristics of the seed system, and also those of the seed-related institutions. A region where the predominant cereal is rice, e.g. Senegal and The Gambia\(^2\) will illustrate this. Since rice is a self-pollinating crop, even seed of modern varieties can be multiplied by farmers, with some training, with little risk of admixture, as off-types can easily be removed. The isolation distances required are minimal. In such a situation, it is hardly necessary to set up expensive seed processing plants and seed certification units. Breeder seed can be sold to intending seedsmen, and the seed system can be an informal one, with only the minimum necessary linkage with the formal sector. Such an option requires a suitable legal framework which permits the sale of uncertified, "truthfully labeled" seed of notified varieties. This is an example of how the technical characteristics of a crop determine the most cost-effective manner of propagating good quality seed of modern varieties.

4.2 In a region where the predominant crops are cross-pollinated, such as maize or sorghum (the common cereal crops in SSA), there are two options open to the agricultural administration. Such crops are more difficult to manage, since it is more difficult to detect and remove off-types, and the isolation distances required are more. The first option is to select good seed growers who can manage the seed crop properly, register their seed plots, and certify only seed grown on their plots. They can be hired as contract farmers by either public or private sector seed companies (Model 1 or 2 of Chapter III). This option is preferred in many SSA countries where there is an exclusive emphasis on formal seed systems. It would favor parastatals and multinational seed companies which can afford to have operations large enough to permit production of seed through contract seed growers. The second option is to encourage the development of an informal seed system described in para 3.11. In such a seed system, farmers develop faith in the quality of seed produced when they are able to see the seed plot and convince themselves that the seed produced would be of the right quality.\(^3\) Farmers (seed consumers) should therefore be educated on the various aspects of seed production, so that they would be able to force quality on seed producers. Such a decentralized strategy would stimulate competition amongst seed producers, some of whom would eventually emerge as bigger-scale seed companies, producing seed in one area to be sold elsewhere.

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\(^3\) In Ethiopia, a recent survey found that 25 percent to 50 percent of small farmers borrow or buy seed very year, but mostly from neighboring farmers; they prefer this system, as they can see the seed crop. Cromwell, E. et al., 1993.
4.3 Open-pollinated varieties (OPV)\(^1\) are less favored than hybrids by the formal private sector seed companies. The main reason is that farmers can use their own saved seed of their varieties, and seed companies are therefore faced with uncertainties regarding the demand for their product. Even though the recommendation based on research is that farmers should buy a fresh stock of seed once every five years, in practice, farmers replace their seed less often and there are no dependable estimates on which to base seed production planning. Heisey and Brennan (1989) have reported that in Pakistan farmers generally change wheat seed every thirteen years. Srivastava and Jaffee (1993, p.6) say that, "rice production in Thailand requires less than roughly 10 percent seed replacement, and wheat production in the United States requires less than 30 percent seed replacement." Therefore, in a cropping system comprising mainly of OPVs, (e.g. Ghana) a mix of the options, with an emphasis on a decentralized, informal seed system would meet the requirements of a wide range of farmers.

4.4 Another type of crop which often determines the kind of seed system to be put in place is the one with a high seed rate and low multiplication rate, such as groundnut. In many SSA countries, groundnut is an important crop in the farming system. The formal sector has not shown much interest in the production and distribution of groundnut seed, as the process of bagging and certifying and transport would add to the cost of seed, making it uneconomical for farmers to buy it. The most economical way of producing groundnut seed would be to produce it locally and sell it to neighboring farmers without bagging or certification. Informal seed production channel is well suited for such a strategy.

LINKAGE BETWEEN THE SEED SYSTEM AND THE LEGAL FRAMEWORK

4.5 The legal framework can be either a positive factor in the development of a bundle of strategies, or a limiting factor restricting the choice of strategies available. There are two crucial areas in the legal framework which are important in this connection:

(i) Varietal release and notification; and

(ii) Certification.

4.6 Varietal Release and Notification

The key issue here is whether the legal framework governing varietal release and notification would result in pluralistic plant breeding research, with farmers being served by a number of institutions, including, importantly, those in the private sector. There are advantages to a country in encouraging private sector initiatives in plant breeding. First, a multinational is much more flexible than National Agricultural Research Systems

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\(^1\) Both self- and cross-pollinated.
(NARSs) and can transfer to a country the fruits of their international experience in plant breeding, as they are not constrained by political and geographic boundaries. As Box 3 shows, such a cross-country approach to plant breeding is both economical and technically advantageous as it could exploit the presence of different ecologies in a region. Second, farmers would not have to depend upon only one source, i.e. NARSs for their new varieties. Much of this is also true of International Agricultural Research Centres (IARCs).  

4.7 It is generally believed that if the seed law makes notification compulsory and requires private breeders to divulge the details regarding the genetic origin of the variety sought to be notified (or its morphological characteristics), it might scare away private sector research leaving farmers at the sole mercy of the official research agencies. The administration of the seed law relating to varietal release and notification thus has an important bearing on the emergence of private sector initiatives in plant breeding. Many countries have made notification compulsory but do not require private breeders to disclose details regarding the genetic origin of the varieties, but only the physical characteristics. This compromise retains the compulsory nature of notification without the "sting." Kenya and Nigeria are examples of this approach. In Kenya, the private sector participates in the national varietal trials by submitting the genetic material to the National Performance Trials Committee; they are obliged to disclose to the varietal release committee, the details of the crossings which have resulted in the variety being offered for release, and any other information which does not infringe upon the plant breeders' right to secrecy. The Nigerian situation is somewhat similar.

4.8 While on the one hand there is a fear that very strict varietal release and notification standards might act as a damper on the private sector initiatives in plant breeding, on the other hand, both the consumers and the private sector seed companies in some countries would prefer such strict government controls. In many developing countries, the private sector is looked upon with suspicion by governments and even consumers often feel that it is safer to go with the public sector or private seed companies which are "blessed" by the government; notification is regarded as a manifestation of such "blessing." That is one reason why even private breeders in these countries want their varieties to be notified, as they feel that association with government would enhance the marketability of their product. There are also instances of private sector seed companies preferring compulsory (rather than optional) notification; this happens when a reputed private sector company does not want spurious seed marketed by "fly-by-night" private sector firms tarnishing the image of the private sector seed industry. The former also want very strict notification standards in order to prevent the latter category of firms from trying to secure an aura of respectability through notification of a poor variety.

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27/ More information on private sector plant breeding research can be found in Umali, D., 1992, p. 45.
4.9 The impact of the legal framework on the growth of private sector initiatives in plant breeding can be illustrated through the recent Indian experience. The "New Policy on Seed Development" announced by the Government of India in 1988 is aimed at attracting private research initiatives, but some of its provisions are indicative of how difficult it is to introduce liberalization in an otherwise overcentralized government-directed seed system. The new seed policy envisions that "the foreign company supplying the seed should also agree to supply the parent lines within two years of the import of the first consignment. Keeping the parent lines secret is a must for any private company to survive in the seed business. Therefore it is doubtful whether they would part with the technology. Further, the absence of a Rights Protection Act in the country would make the foreign companies hesitant to supply the parent lines." (Singh et al., 1990).

4.10 As seen in para 3.4, the legal framework regarding release and notification is also expected to be a check on unfettered plant breeding programs by NARSs resulting in too many varieties, many of which do not result in farmer acceptance. Any loosening of the legal framework might result in an increase of such programs. At the same time, as was seen earlier, a very rigid legal framework would not be in the interests of farmers. Besides, there is also a possibility of notification of many varieties being delayed because the varietal release committee, generally chaired by a Minister or a Permanent Secretary could not meet.  

4.11 There is no simple solution to this dilemma. The balance of advantages would lie in favor of a flexible legal framework governing varietal release and notification, which is administered in the interests of farmers, and which meets the criteria of: ensuring quality standards; encouraging a plurality of research institutions in the public, private and cooperative sectors; enforcing a rational allocation of resources by the NARSs by "upstream" screening of characteristics of varieties proposed to be bred; and quick decisions on the release and notification of varieties.

4.12 Seed Certification and Quality Control

Seed certification and quality control are distinct concepts though in many SSA countries they are treated as synonymous. Seed certification is the "official" seal declaring that the "certified" seed has been grown from proven, tested and recognized genetic source, and that it has the stipulated germination percentage, purity, health and

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21/ Also see Grobman, 1992.

25/ This has happened in India both at the central level and in the states, delaying the release of many varieties; such delays tend to cause frustration among plant breeders. It is not very logical that a government spends a lot of money on plant breeding research, but then due to bureaucratic delays, there is a delay in the release of varieties, resulting in a delay in the implementation of seed production programs.
moisture content. Seed law would prescribe the procedures for certification, particularly, the number of times the seed plots are to be inspected during the growth of the seed crop, and the registration of seed processing plants. The primary purpose of quality control is to check adulteration of seed by seed marketeers. It is the responsibility of the agricultural administration to step up a quality control organization, independent of the agency responsible for seed certification, whether certification is mandatory or not. This organization would have the power to test samples of seed sold in the market for genetic purity and germination. Such tests can be performed on both certified and uncertified seed. If the variety is notified, the test would compare the characteristics of the seed sample with those specified in the notification; if not, they are compared with the declaration on the label. Such tests would also act as a check on the functioning of the seed certification organization; they should not therefore be the responsibility of the same organization.

4.13 In many countries in SSA, seed certification is mandatory, that is, no person can sell a "notified" variety, without obtaining the "certification" tag. The underlying assumption of such an approach is that the government has the responsibility of protecting the interests of seed consumers. This has some bearing on the character of the seed system. First, the seed development strategy would be restricted to the formal sector, as seedsmen producing seed in dispersed locations cannot subject themselves to the certification requirements, particularly those relating to processing. Second, in the interests of keeping the costs of certification low, the certifying authority would be reluctant to register seed plots in dispersed, far-flung areas, as inspection of such plots would be costly. This would encourage the concentration of seed production in a few pockets and the need to transport certified seed over long distances for marketing, thus increasing the cost of seed. Third, certification could delay the availability of seed to farmers in time, due to seed produced on the fields of contract seed growers having to be transported to seed processing plants, and back again to seed consumers for growing crops. Sometimes, though in law seed certification is compulsory, in practice, due to the lack of staff in seed certification agencies, the legal provisions are not followed. One such example is Malawi where, for example, under the Smallholder Seed Multiplication Scheme, seed plots are not inspected as required by law, due to the shortage of staff and budget to meet the recurrent costs; therefore, in fact, seed plots are not inspected, and the requirements of certification are not fulfilled.

The absence of a statistically validated analysis showing that the benefits (measured in terms of incremental yields) of certification outweigh the costs (including hidden costs, such as subsidies) which was

\[\text{In fact, in many SSA countries, the functions of quality control and seed certification are performed by the seed parastatals themselves (see Annex 6).}\]

\[\text{Obviously, where "notification" itself is optional, "certification" cannot be mandatory.}\]

\[\text{See Cromwell, E., 1991.}\]
mentioned earlier (para 2.5), further erodes the credibility of making certification mandatory.

4.14 A seed law which provides for "optional" certification would encourage seed production in the informal sector and would make the certification agency "earn" its honor, rather than having it given to it by a government fiat; if farmers develop confidence in the agency, they might be prepared to pay a higher price for "certified" seed. But it would cast the responsibility on the seed consumers to protect their own interests. Even though farmers are generally aware of the precautions to take in order to make up for less than acceptable germination percentage of uncertified seed, extension should train the seedsmen and consumers in conducting germination tests.3

4.15 The government's responsibility for quality control in respect of tree crops (including horticultural crops) is much more than in annual crops. This is because the pedigree of the planting material used by farmers would be known only after a few years, and if the quality of the seedlings supplied to them is poor, they would lose valuable time and the government would come in for heavy criticism. In SSA, the quality of seedlings of the cash crops, e.g. coffee, and cocoa, is taken care of by the respective "Boards;" but there are no similar arrangements for horticultural crops. In this area, it is difficult to expect private sector initiatives; very few countries have developed "pedigree mother orchards" from where seedlings or bud sticks could be supplied to farmers.

Box 6. Seed System Management during Shortage of Certified Seed

In India, the germination of seeds in seed plots i.e. fields where certified seed is grown, is sometimes affected by rain. The seed does not therefore pass the germination test for certification, resulting in a shortage of certified seed, which often pushes up its price. In order to prevent this, the government would permit the sale of rain-affected seed despite its lower than prescribed germination, if the suppliers agree to the "over-packing" of seed, i.e. if more seed is put in one packet (enough for 1 ha) than the recommended seed rate. This would enable farmers to make up for lower germination through "over-seeding." Such a practice used to be "officially" permitted up to a certain deviation (generally 10 percent) from the prescribed germination percentage standard.

LINKAGE BETWEEN THE SEED SYSTEM AND THE RESEARCH AND EXTENSION SYSTEMS

4.16 Figure 7 illustrates the linkages between the seed system on the one hand and the research and extension systems on the other. In the varietal development phase, the seed system has a very close linkage with the research system; in the seed production phase, its linkage with the extension system is more than with the former. There are two important factors which determine the demand of seed of modern varieties by farmers:

\[3\] The most common precaution which farmers generally take is using a higher seed rate than normal.
• Relevance of released varieties to farmers;

• Relevance of the seed system to the varieties and farmers.

Both these factors are examined in Chapter 5. The Asian Green Revolution was made possible to a large extent by the presence of wheat and rice varieties which made sense for farmers to grow, and seed systems which responded to the needs of farmers.

4.17 The responsibility of the research system to bring out varieties which fit in with farmers’ management practices and the importance of such varieties to a sustainable development of the seed system has been mentioned before (see para 2.9). Most NARSs allocate considerable time and resources to plant breeding. A large number of varieties are developed, some of which may be only marginally superior to the existing ones or which are very specific in their applicability. Many of these varieties are not widely adopted by farmers, and are not followed up by further downstream activity of seed production. Since plant breeding is regarded as a very prestigious venture, many NARSs often spend what is perhaps their scarcest resource, i.e. scientists’ time, on it. It is estimated that approximately 3.0 scientist years are required for a plant breeding program (Dagg and Eyzaguirre 1988.). The main reasons for this overemphasis by the NARSs on plant breeding are as follows:

• Keenness to publish research papers through developing a new variety;

• Since plant breeders have been credited with having ushered in the Green Revolution, most scientists feel that is the only way to go; and

• Lack of appropriate field testing procedures and/or recurrent resources to carry out extensive field trials in order to eliminate lines which would never find favor with farmers.

There is a strong case for many small countries in the SSA to consider importing seed, and they should examine the cost effectiveness of their own breeding program, and seed systems.

4.18 Just as the seed system depends for its success on research coming out with varieties which are preferred by farmers, resources spent on plant breeding programs can be justified only if there is a viable seed system which can carry the work of plant breeding further (see Jaffee and Srivastava 1992, quoted in para 1.3). It has been estimated that the critical level of production needed to justify the costs of a full-scale wheat breeding program is 322,000 t (Brennan 1991). In the absence of a seed system, many plant breeding programs might not meet the required economic criteria. The character of the breeding programs also depends upon the kind of seed system available; breeding very specific varieties suitable for a small agro-ecological zone might not be economically justifiable in the absence of a seed system which is flexible enough to be
able to respond to the need to produce small quantities of seed for consumption within
the agro-ecological zone; a formal, centralized seed system depending on high production
volumes might not meet this requirement. Similarly, if the seed systems are geared to
produce and market hybrids through formal seed production channels, breeding of OPVs
which are more suitable for resource-poor farmers might not be followed by seed
production.

Box 7. Fit between Seed Systems and Plant Breeding
— Examples from Eastern and Southern Africa

Tanzania has a long history of breeding programs for many crops. While many
modern varieties of sorghum, beans, cowpea and millet have been released, there is little
adoption by farmers due to lack of seed. The Tanzania Seed Company (TANSEED), a
seed parastatal has been the main producer and distributor of seed for several years, and
recently Cargill, a multinational seed company has also entered the market. Both the
companies, however, mostly produce maize seed. Maize occupies about the same area
(1.80 mill. ha.) as sorghum, millet, rice and pulses put together (1.93 mill. ha.), but there
is little official push to put in place a sustainable seed system for the latter crops. The
position regarding the availability of modern varieties of seed even for maize is only 5
percent; and for sorghum, as low as 0.9 percent.

In Zambia, a number of seed companies are involved in seed production. The Zambia
Seed Company (ZAMSEED), a parastatal, is, however, a major supplier of certified seed.
These seed companies focus on hybrid maize, in line with the policy of the government,
and the demand for hybrid maize seed is growing. The current credit policy favors
farmers who purchase hybrid maize seed, as hybrid maize seed and fertilizer form part of
a package which is available from the parastatal credit organization. The availability of
seed of improved varieties of sorghum, beans and groundnut is very low.

The seed situation in Zimbabwe is described in Chapter VI (see para 6.4) in the context
seed system assessment.

These examples show that in many countries the fruits of plant breeding programs are
not available to a majority of farmers in the form of quality seed at affordable prices.

4.19 The importance of an effective extension system to the development of a seed
system was mentioned earlier (see para 1.5). Extension should play a crucial role in
training farmers in seed production, and is therefore a prerequisite in the establishment
of a seed system; its role is even more crucial in informal seed systems, where farmers
(seed producers) need training in the various aspects of seed production. Extension’s
role in creating an awareness of good quality seed in farmers as seed-users was
emphasized in para 4.14. Just as it would be difficult for a seed system to be effective
in the absence of extension, it would be equally difficult for farmers to adopt many
extension recommendations in the absence of a seed system which satisfies the criteria
described in Chapter II. For example, the timely availability of seed is an essential
precondition for farmers to feel "seed secure," and extension recommendations regarding timely sowing is of no avail if seed arrives late. A survey conducted in Malawi has indicated that:

"Farmers want to have hybrid seed ready by September/October, considerably in advance of the recommended planting date of mid-November, but deliveries are rarely available at this time." (Cromwell 1991, p.61)

Many other extension recommendations depend upon the crop grown from the seed behaving as expected, e.g. resistance to pests and diseases, flowering-time, maturity period etc. If the seed supplied to farmers fail to conform to these characteristics, farmers would tend to lose confidence in extension recommendations. The seed system thus has an obligation to the extension system to "perform."

**Box 8. The Importance of Extension in Seed Selection**

*Example of Senegal*

Senegal offers a good example of the important role of extension in assisting farmers make their own seed selection. Farmers generally make their own selection in millet and sorghum. But they go by cob sizes and do not take into account the health of the plants, as many of them do not know which plant is healthy and which is not. Many do not make even such a selection; they store the harvested crop and at the time of sowing take out the crop for sowing at random. Many farmers believe that a cowpea with holes is acceptable as seed, as long as the spot from which the sprout comes (the germ) is healthy. They do not understand that if the cowpea seed is weak, the plant will become prey to many pests and diseases.

Extension is not advised to recommend hybrids to farmers who cannot afford good management, as poor fertilization makes the plants susceptible to pests and diseases. Often, farmers tend to save seed from hybrid plants and sow the seed in the next season, unaware of the poor results that will result. After the development of composite maize, farmers are advised to move away from hybrids, which they do. But many of them do not have access to good parental material of composite maize.

*Source:* The author's discussion with Mr. Madikhe Niang, Agricultural Extension Specialist, World Bank, Senegal.

4.20 It is essential that the extension system is seen as the champion of farmers rather than as the spokesperson of the seed industry; it should be a watch dog of farmers' interests and should put pressure on the seed system to "deliver." It is also necessary for the extension system to provide advice to farmers that interests them and which would benefit them, even though it might not be in the commercial interests of the seed system. It could, for example, tell farmers whether they would be better off using their own saved seed, and teach them how to maximize yields from this seed. This role is not easy. For example, a question arose in Nigeria recently as to whether extension should
teach farmers seed selection, treatment and storage, and whether it should lay out field trials comparing the yields from certified seed and uncertified seed from the same genetic stock. The initial response of the National Seed Service was that this would reduce the market for seed from the organized, formal seed system. Quite apart from the misplaced concern of the seed agency for the "institution," rather than for the farmers, the suggested action would actually increase the demand for seed from the formal seed system in the long run by making farmers aware of the value of good quality seed. In Ghana, the practice of farmers saving their own seed for future use is seen as a "real dilemma," instead of something to be actively encouraged by extension, leaving it to farmers to decide whether they would like to purchase a fresh stock of seed or save their own seed. To quote: "Many farmers are able to purchase seed once in four or more years and yet are confident that they can continue to save their own seed and maintain it in good condition comparable to the quality of seed they could purchase from any other source. Seed saving by farmers has created a real dilemma. This approach probably conflicts with the interest of a viable seed industry" (Brobbey-Kyei, et al., 1994).

**LINKAGE BETWEEN THE SEED SYSTEM AND INFRASTRUCTURE**

4.21 The most important infrastructure for the seed system is the rural roads network. It was mentioned earlier that farmers would generally prefer to see the seed plot in order to convince themselves that the quality of the seed would be good. They would, however, buy certified seed of a seed parastatal or a multinational seed company, as in that case, they do not have to see the seed plots to convince themselves of the quality of seed offered for sale. This is because the brand name of a seed parastatal or multinational "sells," and such companies can produce seed in one area (or country) for sale in another. This however depends upon a good network of rural roads. In the absence of a satisfactory rural roads network, it would be difficult to transport seed from centralized processing plants, which are generally a feature of formal seed systems. Seed would then tend to arrive late as the Malawi study cited in para 4.19 would show. Therefore it would be difficult to put in place an effective formal seed system in the absence of a good rural road network. Poor rural infrastructure would also make it difficult for farmers to market their produce. It does not therefore seem advisable for them to grow hybrids and go for higher yields. This would lead to the poor offtake of hybrid seed which in turn would affect the economic viability of the seed system particularly in the private sector. Under such circumstances extension should offer recommendations to farmers regarding low external input technologies and on how to make the best use of available resources. The seed system should be flexible enough to be able to assist them in doing so, and should offer an enhanced role for an informal (decentralized) system.

4.22 Another type of infrastructure facility which is essential for the seed system is seed storages, where seed can be stored without its viability being lost. It is the responsibility of the agricultural administration to provide safeguards against shortages of seed, particularly breeder and foundation seed, as ensuring "seed security" depends
critically upon the government building a "reserve stock of seed," just as "food security" in most countries depends critically upon reserve food grain stock. Generally, such reserve seed stocks consist of breeder and foundation seed, as only small quantities of these are required to be stored. The quantity of such seed to be stored depends upon the frequency of unseasonal weather patterns affecting the foundation seed crop. In an informal seed system, this is less critical than in a formal seed system, and less critical in OPVs than in hybrids.

**LINKAGE BETWEEN THE SEED SYSTEM AND ECONOMIC POLICIES**

4.23 Farmers are unlikely to buy seed if the grain prices do not justify the cost of seed. Setting up formal seed systems can therefore be justified only if economic policies are favorable to farmers. These include realistic exchange rates, remunerative prices to farmers for their produce, which take into account the risk element in producing a crop \(^4\) and a basket of policies which reduces the risks associated with farming. Some of the components of risk management strategy were seen earlier, such as:

- Research and extension systems which address the needs of the different categories of farmers and take into account the prevailing farming systems;

<table>
<thead>
<tr>
<th>Box 9. Hybrid Maize Seed in Nigeria</th>
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<tr>
<td>The importance of a stable policy environment for a viable seed system can be illustrated by the recent Nigerian experience. The consumption of hybrid maize seed in the 1993 season in central and northern Nigeria was lower than expected and one reason given by farmers for this was the rumor that the government would be importing maize which would depress the prices for local maize. Farmers therefore did not see much rationale for purchasing hybrid maize seed.</td>
</tr>
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</table>

- Research on crop varieties which are drought tolerant, pest and disease-resistant, and of shorter duration;\(^5\)

- Introduction of a new crop which replaces a less risk-tolerant one (e.g. growing sorghum instead of maize in many parts of SSA);

\(^4\) Some crops are more risk prone than others. For example, groundnut and pulse crops are generally regarded as risk prone, as compared to other options available to farmers. Unless the price realized by farmers for those crops justifies the risk, it is unlikely that there would be much demand for high cost seed of such crops. The Indian experience with seed of oilseed and pulse crops described in para 5.1 (iv) is an example.

Figure 7. Linkage between the Seed System and the Research and Extension Systems
• Supportive policies, including in the areas of foreign exchange, trade, prices and marketing; and

• Effective delivery of agricultural services, e.g. timely availability of inputs, and credit.

Some others are:

• Information regarding agro-climatology and extension recommendations based on it; information on market, prices, etc.

• Having a number of varieties of seeds (of the same crop or of different ones) ready for sowing, depending upon the climatic variations; */

• Infrastructure (which would provide easier access to markets) and crop insurance;

• Water harvesting (vegetative bunds);

• Availability of farm power, which would enable farmers to finish planting in a short span of time, thus enabling them to minimize the effects of water stress; and

• Irrigation management.

NATIONAL SEED POLICY

4.24 Many countries have national seed policies which are hardly distinguishable from each other. A sensible national seed policy should be country-specific and must recognize the interrelationships described in the foregoing paragraphs. The policy should be internally consistent, and above all, it should be farmer-focused rather than institution-focused.

"Farmers must be the basis of seed policy. Any effective seed policy must recognize what farmers can and cannot do. Farmers can efficiently reproduce and store seeds of most varieties of self-pollinated crops, such as wheat and rice. They can reproduce and store some varieties of open-pollinated crops and some clonal varieties. Many farmers will experiment with new varieties on small plots in their fields. They can learn of new varieties from relatives, neighbors, and merchants who sell agricultural inputs. Even poor farmers can afford to buy small amounts of expensive seeds, which they can use to reproduce enough seed to plant their entire farm with a new variety in a few years." (Pray and Ramaswami 1991)

*/ The concept contained here is called contingency seed planning discussed in para 5.14.
A national seed policy is an evolving document, and changes in the agricultural scene, whether in services, or policy or infrastructure should lead to suitable changes in the policy. The essential elements of a national seed policy are given below.

(i) An analysis of all relevant issues such as the agricultural situation, the status of research, prevailing cropping systems, the policy framework and a profile of the farming community, leading to a suitable basket of strategies for the production of seed of different crop species.

(ii) Procedures for the implementation of the various stages of varietal development, and the criteria for the release of new varieties and the withdrawal of some of the released ones.

(iii) Notification of varieties, specifying whether it is mandatory or optional.

(iv) Providing private seed producers with access to the lines and varieties developed by the NARS, including access to breeder and/or foundation seed, and the criteria for pricing these.

(v) Definition of the roles of the various agencies in the seed chain, particularly, those of research, extension, public and private sector seed producers, and farmers (both as seed producers and consumers), for different crop species.

(vi) Policy regarding seed development, and the preferred model or mix of models for it, in the light of factors outlined in (i).

(vii) Policy regarding seed pricing and subsidy.

(viii) Quality control and certification procedures, the status of the seed certification agency, and whether certification is mandatory or optional.

(ix) Import of germ plasm, and of certified seed when necessary. */

(x) Arrangements for seed marketing.

*/ The Indian Green Revolution was accelerated by the import of 18,000 t of wheat seed from Mexico in the mid-1960s. Later on, the Government of India started imposing restrictions on the importation of both seed and germ plasm and this has served as an impediment to research by seed companies in India (see Umali 1992, p. 56.).
V. Issues

SEED DEMAND AND PRODUCTION ISSUES

5.1 An important issue relating to seed production is the one regarding seed demand; this issue is often raised in discussions relating to seed systems, and ironically, many donor-assisted seed projects stipulate that an assessment of seed demand be made. The methodology generally followed in estimating the demand for seed in a formal, government-controlled seed system is described in Annex 3. Seed demand is actually determined by many factors; two of the most important factors related to research management were mentioned in para 4.16. The others are explained in the following paragraphs.

(i) Type of Agriculture

Para 2.2 classifies farmers according to their risk tolerance capacity. This determines the type of agriculture followed by them, which in turns determines the seed demand. Generally, in irrigated and high rainfall areas (900 mm to 1100 mm) farmers can be motivated - through extension and various policy measures - to adopt "high input-high output" agriculture; modern cultivars perform better here than the local ones. It is possible to predict the demand for seed in this situation. On the other hand, in low rainfall areas (400 mm to 900 mm), the overriding production constraint is not seed, but soil i.e. water and fertility. Repeated plantings are necessary here due to uncertain rainfall patterns and frequent drought and uncertain inter-spell duration. It is very unlikely that farmers here will be able or willing to purchase certified seed from a formal system.

(ii) Seed Price

Seed price is a function of the character of the seed system; the more pluralistic it is, and the more providers of seed it has, the more farmers would find the price affordable. This would enable the see system to meet the seed requirements of more farmers, increasing the demand. In an informal seed system, the presence of many seedsmen who, in their own commercial interests would market seed to neighboring farmers, would increase the demand for seed.

(iii) Development of a New Variety

Demand would also grow when a new variety is developed (e.g. dwarf wheat and rice varieties which propelled the Asian Green Revolution, flint hybrid maize in Malawi, or CSH-1 hybrid sorghum or MBH variety of pearl millet in India), and would tend to level off and might even decrease.
(iv) New Technology

The yam mini-sett technology described in Box 5 is an example of how the development of new technology leads to the emergence of seed farmers and increases the demand for seed.

(v) Prices for Crops

The Nigerian example cited in Box 9 shows how prices fetched by crops influence the demand for seed. A recent example from India is the sudden increase in the demand for the seed of pulses. For a long time, pulses were considered a high-risk crop and the prices fetched did not compensate the risk element. Consequently, they were seldom grown as a sole crop, and farmers generally preferred to use their own saved seed. With the release of the irradiated variety of black gram (TAV-1) which is disease-resistant and the good prices which farmers get for pulses, the sales of certified pulses seed has tripled between 1991 and 1993.

It would therefore be very ingenuous to talk of seed demand without a serious consideration of the various factors which influence this demand.

5.2 The estimate of seed demand could go wrong not only in the aggregate but also in the varietal mix. For example, in western India, where hybrid sorghum is largely grown, farmers would prefer a hybrid of a longer maturity period (120 days) if the monsoon arrives on time; if the monsoon is delayed by a few weeks, they would prefer one with a shorter maturity period (100-105) days. If the monsoon is late by a month, or takes a break after an initial spell, farmers would be better off growing pearl millet instead of sorghum. This is also in conformity with research and extension recommendations; in fact research has responded to farmers' needs by developing varieties to suit a range of agro-ecological situations. But its implication for the seed parastatal is that it has to be ready with all the possible varieties for which demand would grow, as the date of onset of the monsoon cannot be predicted.

5.3 It is generally accepted that it is almost impossible to estimate the demand for certified seed of OPVs. One important factor which influences farmers' decisions is the price of seed. There are no studies on the price which farmers in many SSA countries would be willing to pay for certified seed of OPVs. Some scattered data show that the production of certified OPV through a formal seed system would be profitable only when the sale prices of seed are three times the local market food prices. There have to be some good reasons for farmers to pay that kind of premium. The reasons usually given to suggest that farmers would pay such a premium are the following.
(i) The seed is of greater genetic potential

Unfortunately, under farmer conditions, this is seldom a convincing argument in the case of rained crops in SSA, except when the traditional varieties used by farmers become susceptible to pests and diseases. If constraints on labor lead to late sowing and weeding, and cash and return constraints limit the use of inputs, the farmer would not be able to exploit the genetic potential of the purchased seed (see Box 1). All too often little benefit is seen in changing to another open-pollinated variety, whatever its performance might be at a research station.

(ii) The seed is cleaner

This largely ignores the hand-harvesting methods of small farmers. In fact, farmers' samples of maize, sorghum, millet or bean seed are seldom contaminated with any weed seed.

(iii) The seed has a better germination

Farmers usually store their seed in the roofs of kitchens where the atmosphere is dry and smoke discourages insects. Large seed producers in the wet tropics have much more serious problems of maintaining germination in bulk store and are often unable to match farmer performance.

(iv) The seed is dressed

It only costs a fraction of the price to help farmers dress their own seed.

This is not to suggest that there is no market for certified seed of OPVs in SSA. The central message here is that one should not be misled by the claims of researchers but examine the issues from the farmers' point of view, before estimating the demand for certified seed of OPV.

5.4 Another production issue which often crops up is whether the production of seed should be concentrated in a few pockets in the country or should be dispersed. This issue is particularly relevant in the case of seed parastatals, as the private sector seed companies generally organize their seed production programs in the most favorable locations, either within the country or outside. The issue arises because an area suitable for growing a crop need not necessarily be suitable for growing the seed of that crop. For example, in Nigeria, large areas in the south are under the maize crop, but northern Nigeria has a dry climate which is more suitable for maize seed production. The obvious climatic advantages of organizing seed production in a few favorable pockets in a country should be seen in the light of climatic risks involved in a concentrated production program; if there is drought or unseasonal rain in the area where the production program
is organized, there could be a substantial loss of seed crop. The problem of moving seed over long distances to the markets could be daunting, and would render the model infeasible in practice in most SSA countries. It is difficult to prescribe a universal "best practice." One has to balance the advantages of concentrated seed production against the risks involved, in the light of the situation in each country. In countries with poor infrastructure, the balance of advantage would lie in favor of a decentralized seed production program. It is also possible to think of "concentrated dispersal," often used in the context of industrialization of "under-developed" areas within a country; here, seed production is organized in many concentrated pockets scattered across the country, as part of a defensive strategy. The "seed villages" arrangement described in Box 4 is an example of this approach.

PRICING AND SUBSIDY ISSUES

5.5 An important pricing issue is whether or not the price of seed should be controlled. In a monopolistic situation, where there is only one dominant seed producer (most likely in the public sector), there is often a strong "moral" argument favoring control on seed prices, particularly when there is a shortage of seed. Apart from being difficult to enforce, such price controls inhibit the growth of private sector seed industry (see para 5.7). In many countries, the government agencies decide who would have access to breeder and foundation seed, and limit such access to a few seed companies, including parastatals. A situation of oligopoly is thus created, leading to a vicious cycle of seed shortages, price control and more shortages. In India, when the World Bank-assisted National Seed Project (NSP) was started in the late 1970s, the monopoly for foundation seed production was given to the National Seed Corporation, a parastatal. The NSC attempted central planning for foundation seed production for the entire country; predictably, this led to seed shortages, which were surmounted only when this monopoly and the associated central planning for seed were given up. It is seldom realized that it is not difficult in SSA countries to put in place a seed system which would have a built-in price control mechanism through more competition among providers of seed. All this takes is an increase in the availability of breeder seed, which can be achieved for a fraction of the resources which the country has spent on plant breeding research, and an enabling "official" environment.

5.6 Research and extension are key determinants of the use of good quality seed by farmers, including those of modern varieties, and the efficiency of their use. These are public sector services in most developing countries. It is now accepted that investments in these services have a high pay-off, and that for a long to come, in SSA, they would remain as public sector services. The real issue relating to subsidy, therefore, is not

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*/ In the World Bank-assisted National Seeds Projects I and II in India, seed production in compact pockets was originally envisioned, but the idea was subsequently given up. Quite apart from the logistic problem mentioned, it was feared that the "compact area approach" would create a powerful lobby of "contract seed growers."
whether research and extension should be subsidized, but whether seed production and marketing by parastatals should be subsidized. The related issues are the extent of the subsidy, and its impact on the growth of private sector initiatives in seed production. When the government decides to subsidize seed, it first determines the price to be paid for seed by farmers, and the seed price announced by the seed parastatal over and above that level is the subsidy element borne by the exchequer, i.e. the taxpayers. Since such a subsidy cannot be open-ended, that is, since government cannot obviously subsidize the difference between the price charged by the seed parastatal and the price which, according to the government, is a fair price that farmers should be asked to pay, there is generally an exercise to determine the amount of subsidy; specifically, if "x" is the price which, according to the government, farmers should pay for seed, and "y" is the price announced by the seed parastatal, then "y-x" is the subsidy, and the exercise revolves around the determination of "y-x." Government decides on the level of "x" based on a variety of considerations, which are often more political than economic; and then embarks upon a detailed calculation of the cost of production of seed, and some notional figure to represent profit, in order to determine "y" (as the seed industry is expected to function on a "cost plus" basis). All this, particularly the latter, involves elaborate paperwork, results in a figure which is independent of the price which the market is willing to pay for seed, and ignores efficiency criteria, including the efficiency of seed use by farmers, and the efficiency of the working of the seed parastatal.

5.7 Many countries subsidize seed with the best of intentions. India has been one of them; for a long time now, seed of oilseed and pulse crops has been subsidized, due to the government’s keenness to increase the production of these crops. But these subsidies actually went to the public sector seed companies and made their seed cheaper, thereby discouraging the private sector from undertaking the production of seed of these crops. A similar situation exists in many SSA countries such as Malawi and Nigeria, for example. Subsidizing seed would restrict the choices available to farmers, by eliminating effective competition, and they would eventually have to depend upon one source (most likely to be in the public sector) for their seed requirements. Seed subsidy thus creates a vicious cycle: if there is subsidy, the chances of the growth of the private sector seed industry are dim, and if there is no private sector, subsidy becomes inevitable. Further, subsidy on seed is no substitute for poor services, poor marketing arrangements and wrong policies.

MARKETING ISSUES

5.8 It is generally accepted that the market network should be as pluralistic as possible. There should be a large number of private dealers meeting the demand for seed, and in many instances, creating that demand through aggressive marketing. The extension work provided by seed dealers is much appreciated and valued by farmers in many countries.

39/ Private seed companies are not eligible for government subsidy; the main reason is that government would not like to be seen as subsidizing the operations of the private sector.
Whether there should also be seed outlets in the public sector in addition to this network of private dealers, is a policy decision for the government to make. Such outlets are sought to be justified in the public interest as an instrument to hold down seed prices. While they may be economically justified in areas where the seed demand is thinly spread, and where the private sector would not find it a viable proposition to open dealerships, the justification for doing so in other areas is questionable.

5.9 Another marketing issue, which is particularly relevant for the seed parastatals, relates to the relationship between the parastatal and the seed retailers. In many countries, the latter are also public sector agencies, e.g. ADMARC in Malawi, or AISCO in Ethiopia. The first question is whether seed should be sold to these agencies on a "cash and carry" basis. While the seed companies would prefer this arrangement, as they would not then be responsible for the carry-over stock, the distributors would prefer an "agency transaction" for the same reason; under this latter arrangement, all the left-over seed is returned to the parastatal. In the latter case, there is no incentive for the seed marketeer to aggressively market the product. This problem does not normally exist in the private sector as the private seed companies generally operate in "safe areas" and in seed varieties (e.g. hybrids) which have a high chance of selling, quite apart from the flexibility which they have in pricing. This problem is also attributable to the dual roles of government in seed mentioned earlier, i.e. commercial and developmental. The government feels that it is its responsibility to deal in all varieties of seed, and to position seed in interior areas with little infrastructure; subsequent losses are justified in the name of "developmental burden." In practice, quite a lot of staff time is spent in resolving the dispute between the seed parastatal and the distributing agency.

OTHER ISSUES

5.10 Conflict between the Developmental and Commercial Roles of the Seed Parastatal

It was seen earlier that the seed demand depends upon a number of factors, many of which are external to the seed system. But many countries undertake such an estimate and try to satisfy the estimated demand. The main reason why they do so, is that for historical reasons, seed production and distribution are in regarded in developing countries as a public service, and while the governments are accountable for shortages, they are not accountable for the losses incurred by the parastatal seed organizations. In the words of one former official of the Kenya Seed Company (Pray and Ramaswami 1991):

"To perform the seed multiplication and distribution functions properly requires immediate i.e. commercial decisions which involve a significant element of risk taking. An example of the typical decision which involves risk is: How much to produce? In a developing country, especially one in which you are the sole source of seed, you must not produce too little. Politically, adequate seed production is
a sensitive issue... That's one reason we choose to over-produce and go to the
banker when we have problem financing our inventory of seeds."

This fundamental conflict between the developmental and commercial roles of the seed
parastatals has not been satisfactorily resolved. Many countries, under pressure from
donors and financial institutions, agree to run their seed parastatals as "commercial"
undertakings but it is very unlikely that they will succeed in doing so as long as the seed
system is a public sector monopoly, or if the seed system is mostly a formal one
comprising both public and private sector seed companies.

5.11 One problem which the seed parastatals have to face is inherent in the relationship
between the contract seed growers and a seed parastatal. Under Model 1 (para 3.7), seed
parastatals enter into a contract with seed growers, under which the latter are provided
with foundation seed, and are expected to give back to the parastatal a fixed quantity of
seed, calculated on the basis of the average productivity in that area. If the seed crop
growing season happens to be good and results in over-production of seed, the contract
farmers tend to put pressure on the parastatal to buy their entire production, arguing that
the excess production is no fault of theirs. If the seed crop season turns out to be bad,
and if the contract farmers feel that there will be a shortage of seed in the market, then
there will be a scramble for the scarce seed, especially if it is a good hybrid. The
contract farmers will sell their seed to the highest bidder (generally to a private seed
company) or to other farmers. Either way the seed parastatal loses. */ The "legal
response" to such economic phenomena, of controls over seed movement, and forcing
farmers to honor their contract generally fail, particularly when the seed parastatals do
not often honor their side of the bargain by paying the contract seed growers on time.

5.12 The quantity of certified seed produced by a seed company (either in the public or
private sector) could differ from the initial estimate of production due to a variety of
unforeseen causes.

(i) The crop season could turn out to be very favorable or unfavorable,
resulting in a much higher or lower production than anticipated.

(ii) If there are unseasonal rains during the crop-growing season, seed crop
would be damaged and there would be heavier than normal rejections
during certification (see Box 6).

When more certified seed is produced than planned, either because of a favorable season
for the seed crop, or because of an over-optimistic estimate of demand, or because the
rains during the crop season are late (a common feature in Africa), or for any other
reason, depressing the demand for certified seed the seed parastatal is left with a

*/ This is a common feature in many states in India.
substantial stock of unsold seed. Private seed companies generally manage to end the season without much unsold seed stock, due to many reasons: they generally produce only hybrid and other seed which have a good chance of being sold; and for reasons mentioned in para 3.9 they plan to produce only what can be marketed, they are not obliged to meet farmers' demand for seed however unforeseen may be, and however uneconomic it is to meet it; and, since they are very flexible in their operations, they can raise or lower their prices depending upon the market conditions. When a parastatal seed organization is left with carry-over seed stock, the question often arises as to who should meet the attendant costs? The conflict between the developmental and commercial roles of seed parastatals is apparent here. One way of resolving this conflict would be for the government to bear the cost of carry-over stock; but then the parastatal could be irresponsible enough to plan an unreasonably large production program. Another solution to this problem would be for the parastatal to cross-subsidize its activities, if it has some high profit areas, such as vegetable and flower seed; but such areas are very limited in SSA. The least undesirable among the available options is to put a cap on government subvention to the parastatal, and to be realistic enough to expect such eventualities, rather than expect a parastatal to be commercial in its operations just because a donor has imposed a "conditionality" to that effect.

5.13 One hotly-debated issue is whether the private sector seed companies should have free access to publicly-bred hybrid and vegetable seeds, which are the areas in which the private sector generally concentrates. It is often argued that public funds should not benefit private parties. This argument overlooks the fact that the government is spending huge amounts on research and extension anyway for the benefit of private farmers.

5.14 Contingency Seed Stocking Scheme

Seed strategy can be used by the governments in SSA as an effective instrument for drought management. Droughts are common in most countries in the region, and when they occur, crop failures and food imports are a regular feature. In many instances, the severity of the impact of drought on the food security and incomes of farmers can be mitigated if the governments run a "contingency seed stocking scheme," which has been tried in some countries. Under this scheme, governments can stock seed to be given to farmers for resowing whenever the initially sown seed is lost due to drought. The scheme will not be useful if there is a devastating drought for a prolonged period; but if there is a prolonged lack of water after the initial sowing, killing the initially sown

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*/ This has been a common feature in India. See World Bank's Evaluation of India's National Seeds Projects I and II quoted in Annex 3.

*/ The cost of carrying over seed stock from one season to the next includes, in addition to inventory carrying cost, that of re-validation and re-certification, after opening all the bags and conducting fresh germination tests. Many countries in SSA do not undertake such expensive re-validation.

*/ The reader is referred to a detailed treatment of this subject in Umali, 1992.
crop, and the rains revive, the scheme has been found to be useful. If the rain do not come, the seed can be used during the following year, if stored properly; or written off as a developmental expenditure if not used at all. The question is whether the seed subsidies and losses on account of government being in the business of seed production and distribution can be better spent on such a contingency seed stocking scheme. It is necessary to work out, for each country, the economics of operating such a scheme. Some of the factors to be taken into account are:

(i) The probability of drought, and the pattern of drought; and

(ii) The effectiveness of the research and extension systems and the existence of a "contingency cropping plan. "/*

/* A "contingency cropping plan" refers to the cropping plan which farmers could adopt in the event of rain taking a long break after the initial onset. Most traditional farming systems are based on the contingency of drought. Research and extension systems should assist farmers in doing better what they are used to. 

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VI. Seed System Assessment, Options and Recommendations

6.1 This chapter pulls together the discussion in the earlier ones, and indicates the factors which should be taken into account by the policymakers while setting up a seed system, or strengthening or modifying an existing one. In doing so, it is necessary to ensure that the proposed seed system serves the needs of the gamut of the farming community, and that it satisfies the criteria mentioned in para 2.9. The seed system should therefore comprise a bundle of strategies, which are crop-specific and country-specific.

SEED SYSTEM ASSESSMENT

6.2 The starting point while undertaking an assessment of a seed system is to consider the relevant factors which impact on it. These were discussed in the earlier chapters and the important ones are listed below:

- Agro-climatic factors;
- Policy environment;
- Infrastructure, particularly the rural roads network;
- Status of extension;
- Status of research and the availability of seed varieties and chemical fertilizers; */
- Support services, particularly credit and produce marketing; and
- The nature of dominant crops in the cropping systems.

6.3 It is possible to obtain an insight into the suitability of to the country of its seed system by analyzing the extent to which it takes into account the above factors. Taking the Kenyan seed system as an example, since it is often cited as a successful one in SSA (see Annex 6 for details), one finds that it comprises:

- A research system which is mostly in the public sector;
- The Kenya Seed Company (KSC) in which the Government of Kenya has a substantial shareholding, producing mostly hybrid maize, beans and vegetables;
- Seed production for other crops (called bulking) is carried out by the district agricultural administration.

*/ It is possible that a country does not possess research capabilities in all crops, but is willing to import germ plasms from IARCs for example, and field-test them. What is important is that governments should provide farmers with access to internationally available technology.
It is possible to say that as far as hybrid maize, beans and vegetables grown in the highlands are concerned, the seed system answers the needs of a majority of farmers in these areas. But when it comes to other crops grown both in the highlands and in the arid and semi-arid areas of the country (e.g. sorghum, cowpea and fodder crops), the present seed system is not appropriate. It is advisable to devise an informal seed system based upon traditional and modern varieties, accompanied by government withdrawal from "bulking." This however requires a strong government commitment to such an approach, and an enabling legal environment.

6.4 **Zimbabwe** is another country with a well-established seed system (see Annex 6 for details). Several crops play a key role in that country in household food security - maize, sorghum, pearl millet, finger millet, groundnut, cowpea and beans - to name the important ones. Modern varieties of many of these crops have been released by the research system. But the main problem is that while the seed system is well established for maize (particularly for hybrid maize), it is not so for the other crops. The Ministry of Lands and Water Development has an agreement with the Seed Coop Company of Zimbabwe and the farmers' unions that gives a monopoly to the company over the new varieties released. Therefore, only the company can multiply and market seed of these varieties. Like most monopolies, this one also fails to meet the needs of the consumers. There are serious shortages of seed of modern varieties of sorghum, millet, groundnut, cowpea and beans. The company's complaint is understandable; there is little profit in the seed of these crops - most of them OPVs - and estimating the demand for seed is difficult. The answer again is government encouragement to an informal seed system backed by a suitable legal framework, so that the seed consumers do not have to depend upon a monopoly company. The Zimbabwean seed system is therefore not appropriate for the needs of all the farmers of the country.

6.5 Besides the factors mentioned in para 6.2, there are others which are relevant to an assessment of the seed system. These are:

- Seed marketing arrangements;
- Legal framework; and
- Seed quality control.

The impact of these factors on the performance of the seed system were analyzed in Chapters IV and V.

**OPTIONS**

6.6 The options available to the policymakers while designing a seed system or strengthening or modifying an existing one would depend upon the above factors and the

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4/ The source of much of the information given here regarding Zimbabwe is Antoine and Byrnes, 1993a.
interplay between them. Some factors, such as macroeconomic policy, are external to the seed system, and those who design seed programs often do not have much influence over them in the short term. They should, however, take into account their impact on the seed system while designing the programs. Some factors, such as the character of the seed law, are, however, internal to the seed system. The designers of seed programs thus have a choice as far as they are concerned, and should be aware of their influence over the available options. The various options and their implications are given in Table 2. The mix of options are shown on the "X" axis and their implications are described in the columns below the mix of options. For example, on the "X" axis of the table:

- "A" means that release and notification are mandatory, and "a" means that they are optional; the implications of either of these options were analyzed in para 4.7, and shown in Table 2 in the columns below the mix of options ("Y" axis); and

- "B" indicates price control, and "b" means there is none; the pros and cons of seed price control and its impact on the growth of private sector were discussed in para 5.5 and shown in the columns below the mix of options ("Y" axis).

The codes for the various options available are explained below.

<table>
<thead>
<tr>
<th>Factor</th>
<th>Explanation of the code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Varietal release and notification:</td>
<td>A: mandatory; a: optional.</td>
</tr>
<tr>
<td>Seed Production Model:</td>
<td>Model 1, 2 or 3 (see Chapter III).</td>
</tr>
<tr>
<td>Seed price control:</td>
<td>B: yes b: no</td>
</tr>
<tr>
<td>Subsidy on seed</td>
<td>C: yes c: no</td>
</tr>
<tr>
<td>Seed marketing</td>
<td>D: predominantly by parastatal d: private seed dealers; the role of government marginal and restricted to limited areas.</td>
</tr>
<tr>
<td>Seed certification</td>
<td>E: mandatory;</td>
</tr>
<tr>
<td>National quality control agency with powers to take seed samples for testing for genetic purity and germination</td>
<td>F: yes; f: no such agency.</td>
</tr>
</tbody>
</table>
Thus "A1BCDEF" means that:

- Varietal release and notification are mandatory;
- The seed production model is Model 1;
- There is seed price control;
- There is subsidy on seed;
- Seed marketing is predominantly by parastatal;
- Seed certification is mandatory;
- There is no independent seed quality control organization.

Malawi is an example of a country which has this combination.

6.7 The first column of Table 2 shows the implications of a highly government-directed and controlled seed system, where varietal release and notification are compulsory, with seed price control, subsidy on seed, and so on. The implications are: little chance of emergence of private plant breeders, the seed system is not flexible enough to meet the needs of a variety of farmers, little chance of emergence of multiple providers of seed to farmers, poor poverty focus, etc. The columns are arranged according to a decreasing role for government. The last column represents a seed system in which varietal release and notification are not compulsory, seed certification is optional, there is no subsidy on seed and so on. Obviously, the more to the right of the table a country falls, the more pluralistic its seed system is likely to be, with a consequent better service to the gamut of farmers.

Table 2. Main Options Available While Setting Up a Seed System or Modifying an Existing One

<table>
<thead>
<tr>
<th>Options</th>
<th>A1BCDEF</th>
<th>A2BCdeF</th>
<th>a2bcdEF</th>
<th>a3bcdeF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Implications</td>
<td>Little chance; public sector would be able to import germ plasm from the IARCs.</td>
<td>Very few private companies would be attracted when seed price control is enforced; but as in Malawi, if seed prices are subsidized there could be a private sector oligopoly; but little competition. Government should encourage competition through de-regulation of prices and encouraging more players on the scene.</td>
<td>Good chance of private firms, with research facilities; they would be ready to import germ plasm from their research facilities elsewhere, if the National Seed Policy permits such imports.</td>
<td>Will encourage the growth of a decentralized seed system, alongside formal private sector; Will encourage private sector plant breeding and the import of germ plasm, if the National Seed Policy permits such imports.</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Options</th>
<th>AIBCDEF</th>
<th>A2Bcdef</th>
<th>a2bcdEF</th>
<th>a3bcdEF</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Ability to meet a variety of seed demand.</td>
<td>Little chance, unless seed operations are heavily subsidized.</td>
<td>The few private companies who would be attracted, would focus on high profit areas.</td>
<td>Formal private sector is unlikely to meet the demand for seed with low profit margin and high risk of carry-over.</td>
<td>Good possibility; the decentralized sector would depend upon the availability of breeder/foundation seed from public sources.</td>
</tr>
<tr>
<td>3. Timeliness and access.</td>
<td>Experience so far, both in SSA and elsewhere is negative.</td>
<td>Private firm's record has been favorable.</td>
<td>Since prices are not controlled, there would more competition and farmers' accessibility to seed would increase.</td>
<td>Good possibility.</td>
</tr>
<tr>
<td>4. Affordability</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
<td>Excellent</td>
</tr>
<tr>
<td>5. Strain on the government budget.</td>
<td>Heavy</td>
<td>Heavy</td>
<td>This option would entail a heavy strain on the budget, because formal private firms would be interested in producing only high profit items, e.g. hybrids, leaving it to the government to meet other demands. If the government does this, it faces the risk of heavy strain on the budget; if it does not, then it cannot meet its obligations to all areas and categories of farmers.</td>
<td>Low. Under this option, seedsmen would meet the needs for non-hybrids (and sometimes even of hybrids) and organized (formal) private firms would meet the needs of better-off farmers. This option would bring about the best alignment of the production pattern and the demand pattern with minimal financial burden on the government.</td>
</tr>
<tr>
<td>6. Quality</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>7. Poverty focus. Income distribution. Food security.</td>
<td>Poor</td>
<td>Poor</td>
<td>Poor</td>
<td>Good</td>
</tr>
<tr>
<td>8. Growth of private sector seed industry.</td>
<td>Poor</td>
<td>Poor</td>
<td>Good</td>
<td>Good</td>
</tr>
</tbody>
</table>
STAGES OF DEVELOPMENT OF SEED SYSTEMS

6.8 Writers on seed systems discern distinct stages of development in seed systems, and classify the countries according to the stages at which their seed systems are. According to one writer, there are four stages, and the stage at which any seed system is, depends upon the stages of evolution of the components of the seed system, such as, quality control and seed marketing (Douglas 1980). Other writers have endorsed this four-stage model (Pray and Ramaswamy 1991). Table 19 from their book is reproduced in Annex 7. The stages identified by them are:

- **Stage 1:** Farmer selection and supply
- **Stage 2:** Introduction of improved varieties
- **Stage 3:** Widespread use of improved varieties and early spread of private varieties
- **Stage 4:** Mature seed industry

The authors indicate, for each stage of development of the seed system, the manner in which the various components of supply are provided and the determinants of demand met. For example, in Stage 1, R&D is provided mostly by farmers; public sector R&D efforts emerge in Stage 2, and in Stage 4 much of R&D is provided by private firms. These four stages are also mentioned by Srivastava and Jaffee 1993.

6.9 In reality, the seed systems of most developing countries do not strictly fall under one of the four stages mentioned here, and their seed systems do not pass from one stage to the other sequentially. They generally fall under more than one stage, as elements of different stages often exist in juxtaposition to each other. The example of Nigeria was mentioned in para 3.13. In that country, hybrid maize is past stage 2 and marching towards stage 3, but in some other crops (e.g. soybean, maize composite) its seed system is still between stages 1 and 2. In Kenya, as seen previously, a predominantly public sector seed company produces and markets mostly hybrids and the Agriculture Department carries out "bulking" (seed multiplication) of other varieties. In some countries, (e.g. Ethiopia) R&D is at a satisfactory stage, and new varieties are emanating from the research system. However, the marketing arrangements and infrastructure are poor, and many aspects of the policy environment are not in place. In some others, (e.g. Uganda, Ghana) policy reforms have advanced but research and extension systems are still being rebuilt, and infrastructure is only slowly improving. They are not yet ready
for a modern formal seed system. The options available to the countries would therefore depend upon the stage at which their seed systems are in respect of each of the components of supply and determinants of demand described in Annex 7.

**STEPS INVOLVED IN SETTING UP INFORMAL SEED SYSTEMS**

6.10 The following paragraphs outline the steps involved in stimulating the growth of informal seed systems. The pre-requisite is a firm government commitment to the idea, and putting in place policies and practices which would be conducive to their growth. The other steps are:

(i) **Identify crops and regions which are favorable to the growth informal seed systems**

Crops which are vegetatively propagated and those with a high seed rate and low multiplication rate are well-suited to an informal seed system in the initial stages. The On-Farm Productivity Enhancement Program (OFPEP) implemented by the Winrock International Institute for Agricultural Development in many countries in SSA focusses not only on self-pollinated crops (e.g. rice, cowpea and groundnut), but also on cross-pollinated crops, such as millet.

(ii) **Give wide publicity to the commitment of the government to encourage an informal seed system and the crops for which it will be encouraged**

(iii) **Identify farmers who are willing to participate in such a system and train them in seed production**

(iv) **Provide access to the breeder and foundation seed of modern varieties to the informal system**

While doing so, focus on the varieties which are suitable for local conditions, since farmers in informal seed systems generally market their seed in local communities.

(v) **Provide extension to farmers regarding the use of modern varieties**

(vi) **Provide information to farmers regarding the informal system and what they can expect from it. It is very important for farmers to be convinced of government’s commitment to it**

(vii) **Educate farmers in seed testing.**
For more details regarding the steps involved in setting up informal seed systems, see Antoine and Byrnes. (1993b).

ROLE OF THE WORLD BANK IN DEVELOPING SUSTAINABLE SEED SYSTEMS IN SSA

6.11 The traditional Bank-assisted projects in SSA comprise mostly assistance to the public sector, either seed parastatals or seed development agencies which are charged with the development of private sector seed companies. Nigeria is an example of such "old style" seed projects (see Annex 6 for details). The project provides support to the National Seed Service which is a parastatal organization. It has withdrawn from seed production, but is responsible for the development of a sustainable seed system in the country, including the legal framework. It is yet to work out crop-specific strategies for the different regions of the country. Many private sector companies have closed down for lack of demand at prices which they consider adequate return for their investment, even though they were mostly producing hybrid maize seed (Box 10). The new thinking in the Bank is that there should be a move away from such projects, towards a more broad-based seed program which recognizes the complementary roles of the formal and informal seed systems, and encourages the governments to put in place an enabling legal framework so that such a complementarity results. It is necessary for the Bank to:

- Work more closely with the NGOs who have undertaken successful farmer-based seed production programs in SSA, so that the countries have a coherent national seed program; and

- Convince the governments that encouragement to the informal seed system is a pre-condition to the healthy growth of private sector seed industry which is sustainable, both financially and institutionally.

6.12 It is necessary for Bank-assisted research and extension projects to examine the seed systems in place in the countries, and their relevance to the countries, farming systems, and other factors mentioned in Chapter V. These should also be examined in the context of projects relating to poverty and food security. The example of Zimbabwe cited previously underlines the relevance of a seed strategy to these areas. Very restrictive credit policies tying farmer credit to the purchase of seed from monopoly seed parastatals are unlikely to result in the seed system of the country meeting the criteria mentioned in para 2.9.

SUGGESTIONS AND RECOMMENDATIONS

6.13 Steps to be taken by most countries in SSA

For most SSA countries, the first steps should be to get research and extension going, and to encourage seed production in the informal sector, of both the traditional and
modern varieties. The appropriate seed system would seem to be a mix of the formal and informal modes. The formal private sector could focus on hybrids, and vegetable and flower seed. The development of an informal sector should be encouraged through access to germ plasm and extension advice on seed production. This informal sector would not only produce seed which the formal private sector might not - such as seed of OPVs, crops with a high seed rate and low multiplication rate, and planting material of vegetatively propagated crops - but also hybrids, and in fact whatever the seedsmen wish to produce, and are willing to pay for, such as breeder and foundation seed. They should have access to the latter on the same terms as the formal sector, and should not be subject to any government control other than quality control. Seed law should enable the emergence of such an informal sector, which would not only provide competition to the formal sector, helping keep the seed prices at an affordable level for the resource-poor farmers, but would facilitate the eventual growth of the formal private sector. In a country where there are no institutions, setting them up, if needed, should be an evolutionary process. However, they should be set up in response to the felt needs of farmers, rather than of the donors or of the government officials in the countries concerned.

6.14 Roles of the Public and Private Sector in the Development of Seed Systems

Government has a critical role to play in the development of the seed system. First of all, it has the primary responsibility for stimulating the demand for improved and modern varieties of seed. It is now generally agreed that the seed system should be demand-driven unless seed is heavily subsidized by government, and unless subsidy is used as means of stimulating, but not necessarily sustaining, seed demand. The public and private sector roles in seed production are described in Jaffee and Srivastava. (1992) and in Dina Umali. (1992). This paragraph only focusses on the roles of these sectors in stimulating seed demand in a sustainable fashion. The important tools available with the public sector in stimulating seed demand are:

- Research and extension;
- Encouragement to the development of appropriate seed system which is crop-specific, and takes into account the linkages described in Chapter IV:
  - type of agriculture;
  - cropping system;
  - commercial value of the crops;
  - economic policies; and
  - infrastructure.
- Developmental role e.g. contingency seed stocking to help farmers in re-sowing; and
• Avoidance of supporting unsustainable seed production systems through subsidies.

The role of the private sector in stimulating seed demand comprises offering the right product, of the right quality, at the right price.

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**Box 10. Privatization of Seed Industry in Nigeria**

The National Seed Policy states clearly that private sector seed industry would be encouraged, and the government has taken the following steps to implement this policy: elimination of subsidy in the production and marketing of "public sector" seed; the public sector to deal only in OPV leaving the remunerative hybrid maize seed business to the private sector; the public sector's phased withdrawal even from the production of OPVs, as the private sector develops; representation of private seed industry on the National Seed Council and their involvement in policymaking on seed issues; access to breeder and foundation seed of varieties bred by the NARS to private seed industry; and assistance to private seed enterprises in the importation of genetic material for the development of their own varieties and hybrids.

Despite encouragement to the private seed industry, production of seed in the private sector declined in 1993, even in hybrid maize (from 710 m.t to 600 m.t.). Actually, the slack created by the withdrawal of the public sector from seed production was to be taken up by the private sector. The public sector seed production declined from 3825.86 mt in 1993 to 882.67 mt. As a result of the private sector not taking up the slack, the overall availability of seed to farmers declined in 1993.

This matter was discussed at the seed workshop convened by the National Seed Service (see Annex 6) on April 12, 1994, which was attended by the private seed producers and the State ADPs. One of the decisions at this workshop was that:

- The seed production system should be sustainable. To this end, efforts should be directed towards developing private seed industry, defined broadly to include also individual seed growers.

- One of the lessons from the Nigerian efforts at privatization of seed industry is that a successful private sector in seed cannot be brought into being overnight, and that it is an evolutionary development. A beginning should be made with the development of the informal sector, a fact that the workshop acknowledged.

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6.15 Governments should also pay particular attention to:

- Production of breeder seed, and in some cases, also the foundation seed;
- Quality control, maintenance of reserve stock of seed; and

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6.16 The question often raised is: Is there a place in the contemplated scheme of things, for a parastatal seed organization? It is difficult to provide a short answer to this question. If, after the adoption of a national seed policy in which both the formal and informal sectors have their due places, there are some areas which might not be covered by both, e.g. soybean, there is certainly scope for a seed parastatal. It should be clearly understood that the parastatal would enter such areas as part of the developmental responsibility of the government, and should vacate them as soon as the private sector develops. What is important is to put in place a sustainable seed system.

6.17 An organization (it might be called the National Seed Council) should oversee the implementation of the National Seed Policy, the main elements of which were mentioned in para 4.24. This body should have on it the representatives of the farming community, the formal private sector, the seed parastatal (where there is one), public sector seed marketing organizations (where relevant), seed certification organization, research and extension. This body should decide on critical issues such as: the import of seed, the legitimate activities of the seed parastatal in order to fulfil its developmental role, the policy regarding the pricing of breeder and foundation seed, plant breeders' rights and the manner in which the research system is to be rewarded for its successful plant breeding program and matters relating to quality control.
Annex 1. Donor-Assisted Seed Projects and those with Seed Components

Since 1965, bilateral and multilateral donors have funded many free-standing seed projects and those with seed components. The World Bank has funded forty-five such projects in twenty-one countries in Sub-Saharan Africa. Table A1. 1. gives the summary of these projects. There are three ongoing free-standing seed projects - in Zaire, Guinea and Nigeria. The Zaire project has not been functioning well, partly due to the political situation, and partly due to the project’s excessive reliance on SENASEM (the seed parastatal); one of the main production problems was the fact that the deliveries of seed to SENASEM by contract seed growers were not paid for promptly, due to inadequate counterpart funding, leading to low levels of seed availability. If SENASEM’s mandate were restricted to advising on seed policy and quality control, with the production and distribution of seed left to the private sector, the project would have had a better chance of success. The Guinea project has been experiencing problems, again resulting from support to PSN (Project Semencier National) which is a seed parastatal; the project’s original intention was to start the seed production and distribution activities in the public sector and eventually hive it off to the private sector. But according to the latest World Bank supervision report (January 1993), such a privatization is not likely to come about, as long as PSN’s profitability remains in the red. The Nigeria project appears to be proceeding well (see Annex 6), but its future depends upon how soon the National Seed Service (NSS) and the Agricultural Development Projects (ADPs) (parastatals operated by the state governments) divest themselves of seed production and distribution activities, and confine themselves to seed policy and quality control.

Two projects with seed components (Angola and Rwanda) and one free-standing seed project (Ethiopia) are presently under preparation. The percentage of Bank support to seed system development, to projects which include seed components has been 4.7 percent. Of this amount, more than 50 percent is accounted for by ongoing free-standing seed projects; more than 95 percent of Bank support to the former set of projects have been used for "public sector" activities, such as strengthening national research systems, extension services, farm input supply, crop protection measures, construction of feeder roads, storage facilities, improving rural markets and rural credit.

Table A1.2 gives the list of projects supported by other international organizations, such as UNDP, and bilateral donors. As stated in para. 1.08, this list is not exhaustive, but is illustrative of the kind of effort that is being put in this area. These are generally small-scale initiatives, of local importance, and include many farmer-based seed production programs mostly involving traditional varieties.
Table A1.1. World Bank Support to Seed Projects and those with Seed Components

<table>
<thead>
<tr>
<th>Types of Projects</th>
<th>Number of Projects</th>
<th>WB Support to Seed Portion (US$ million)</th>
<th>WB Support to Project Cost (US$ million)</th>
<th>Percentage of (3) to (4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Completed projects with seed components</td>
<td>24</td>
<td>14.25</td>
<td>651.1</td>
<td>2.2</td>
</tr>
<tr>
<td>Completed free-standing seed projects</td>
<td>0</td>
<td>nil</td>
<td>nil</td>
<td>0.0</td>
</tr>
<tr>
<td>On-going projects with seed components</td>
<td>15</td>
<td>9.75</td>
<td>610.0</td>
<td>1.6</td>
</tr>
<tr>
<td>On-going free-standing seed projects</td>
<td>3</td>
<td>37.90</td>
<td>37.9</td>
<td>100.0</td>
</tr>
<tr>
<td>Projects under preparation</td>
<td>3</td>
<td>nil</td>
<td>nil</td>
<td>0.0</td>
</tr>
<tr>
<td>Total</td>
<td>45</td>
<td>61.10</td>
<td>1299.0</td>
<td>4.7</td>
</tr>
<tr>
<td>COUNTRY</td>
<td>NAME OF PROJECT</td>
<td>EFFECTIVE DATE</td>
<td>CLOSING DATE</td>
<td>CONTRIBUTION (Million US dollar)</td>
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<td>---------</td>
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<tr>
<td>BENIN</td>
<td>GTZ,FED,FAC,USAID, UNDP/FAO</td>
<td>1985</td>
<td>na</td>
<td>na</td>
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<td></td>
<td>FAO</td>
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<td></td>
<td>UNDP/FAO</td>
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<td>na</td>
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<tr>
<td>BURUNDI</td>
<td>FAO</td>
<td>na</td>
<td>na</td>
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<td></td>
<td>ADB.&amp;.FED</td>
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<tr>
<td>CAMEROON</td>
<td>FAO</td>
<td>1981</td>
<td>na</td>
<td>$U.S. 83,000</td>
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<td>USAID</td>
<td>1982</td>
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<td>2 seed.farms</td>
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<td>Seed.conservation.</td>
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<td>Train.abroad.</td>
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<td>Equipment.</td>
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<td>Soybean.trials.extension.</td>
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<td></td>
<td>Seed legislation.</td>
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<td>Seed control.</td>
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<td>Training.</td>
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<td>Ext.of.beans.</td>
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<td>Testing.&amp;Breeding.</td>
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<td>Prod.&amp;Ext.of.seeds.</td>
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<tr>
<td>CONGO</td>
<td>FAO</td>
<td>1988</td>
<td>na</td>
<td>na</td>
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<td>COTE D'IVOIRE</td>
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<tr>
<td>Country</td>
<td>Agency</td>
<td>Year1</td>
<td>Year2</td>
<td>Year3</td>
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<td>ETH.</td>
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<tr>
<td></td>
<td>UNDP/FAO</td>
<td>1982</td>
<td>1985</td>
<td>Birr16,9 bill</td>
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<td>1986</td>
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<td>na</td>
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<td>FAO</td>
<td>1987</td>
<td>1988</td>
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<td>FAO</td>
<td>1985</td>
<td>1986</td>
<td>$US52,000</td>
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<tr>
<td></td>
<td>UNDP</td>
<td>1987</td>
<td>1991</td>
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<tr>
<td>MAURIT.</td>
<td>UNDP</td>
<td>1983</td>
<td>na</td>
<td>Ouguiha.12.mill</td>
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<tr>
<td></td>
<td>Arab/FAO</td>
<td>1989</td>
<td>na</td>
<td>na</td>
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<td></td>
<td>USAID</td>
<td>1982</td>
<td>1988</td>
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<td>Agency/Program</td>
<td>Year 1</td>
<td>Year 2</td>
<td>Amount</td>
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<tr>
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<tr>
<td></td>
<td>FAO</td>
<td>1986</td>
<td>1987</td>
<td>$U.S.250,000</td>
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<td>1986</td>
<td>1987</td>
<td>$U.S.244,000</td>
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<tr>
<td></td>
<td>UNDP/FAO</td>
<td>na</td>
<td>na</td>
<td>na</td>
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<td>TANZ.</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>FED/ONDR</td>
<td>1986</td>
<td>1989</td>
<td>ECU3.6 mill</td>
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<td></td>
<td>FEN</td>
<td>1986</td>
<td>1988</td>
<td>na</td>
</tr>
<tr>
<td></td>
<td>CEE</td>
<td>1987</td>
<td>1989</td>
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<td></td>
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<td>1987</td>
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<td></td>
<td>FAC</td>
<td>1984</td>
<td>na</td>
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<td></td>
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<tr>
<td></td>
<td>Ida/Bird/Pnud</td>
<td>1985</td>
<td>1990</td>
<td>Zai.120.644 mil</td>
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<tr>
<td></td>
<td>ONG/IDA</td>
<td>na</td>
<td>na</td>
<td>na</td>
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<tr>
<td></td>
<td>IDA/UNDP/FAO</td>
<td>na</td>
<td>na</td>
<td>Zai.95.488 mil</td>
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<td>ZAMBIA</td>
<td>Zambia-Gov't</td>
<td>1964</td>
<td>1980</td>
<td>K400,000</td>
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<tr>
<td></td>
<td>GRZ/IDA</td>
<td>1980</td>
<td>1989</td>
<td>K1,675,000</td>
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Annex 2. The Details Relating to the Different Seed Production Models

Table A2.1. Parastatal/State Farm Model (para 3.7)

<table>
<thead>
<tr>
<th>Activity</th>
<th>Input</th>
<th>Output</th>
<th>Location</th>
<th>Actors</th>
<th>Funding Agency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research</td>
<td>Local germ plasm and/or germ plasm from IARCs</td>
<td>Breeder seed</td>
<td>Research centers</td>
<td>Researchers</td>
<td>Gov't</td>
</tr>
<tr>
<td>Multiplication</td>
<td>Breeder and/or foundation seed</td>
<td>Foundation and/or commercial seed</td>
<td>State or parastatal farms; and/or farms of contract seed growers</td>
<td>Gov't agencies and/or seed growers</td>
<td>Gov't and/or donors</td>
</tr>
<tr>
<td>Processing</td>
<td>Commercial seed</td>
<td>Commercial seed</td>
<td>Seed processing centers</td>
<td>Gov't agencies</td>
<td>Gov't</td>
</tr>
<tr>
<td>Marketing</td>
<td>Commercial Seed</td>
<td>Commercial seed</td>
<td>Parastatal outlets/ private markets</td>
<td>Gov't agencies and/or private seed dealers</td>
<td>Gov't</td>
</tr>
</tbody>
</table>

Table A2.2. Private/Cooperative Model (para 3.8)

<table>
<thead>
<tr>
<th>Activity</th>
<th>Input</th>
<th>Output</th>
<th>Location</th>
<th>Actors</th>
<th>Funding Agency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research</td>
<td>Local germ plasm and/or germ plasm from IARCs</td>
<td>Breeder seed</td>
<td>Research centers - public and private</td>
<td>Researchers incl. those in private sector research</td>
<td>Gov't and/or private sector</td>
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<td>Multiplication</td>
<td>Breeder and/or foundation seed</td>
<td>Foundation and/or commercial seed</td>
<td>Private farms belonging to seed companies or contract seed growers</td>
<td>Private companies and contract seed growers</td>
<td>Private</td>
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<tr>
<td>Processing</td>
<td>Commercial seed</td>
<td>Commercial seed</td>
<td>Private sector seed processing centers</td>
<td>Private seed processors</td>
<td>Private</td>
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<tr>
<td>Marketing</td>
<td>Commercial seed</td>
<td>Commercial seed</td>
<td>Private markets</td>
<td>Private sector seed merchants</td>
<td>Private</td>
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</table>
Table A2.3. Decentralized Farmer-Based Model (para 3.11)

<table>
<thead>
<tr>
<th>Activity</th>
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<th>Output</th>
<th>Location</th>
<th>Actors</th>
<th>Funding Agency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research</td>
<td>Local germ plasm and/or germ plasm from IARCs</td>
<td>Breeder and/or foundation seed</td>
<td>Research centers</td>
<td>Researchers</td>
<td>Gov't</td>
</tr>
<tr>
<td>Multiplication</td>
<td>Breeder and/or foundation seed</td>
<td>Foundation and/or commercial seed</td>
<td>Farmers' fields</td>
<td>Farmers</td>
<td>Private</td>
</tr>
<tr>
<td>Processing</td>
<td>Commercial seed</td>
<td>Commercial seed</td>
<td>Farmers</td>
<td>Farmers</td>
<td>Private</td>
</tr>
<tr>
<td>Marketing</td>
<td>Commercial Seed</td>
<td>Commercial seed</td>
<td>Private markets</td>
<td>Farmers/seed merchants</td>
<td>Private</td>
</tr>
</tbody>
</table>
Annex 3. Planning and Implementation of Seed Programs in Developing Countries

PLANNING

In many developing countries, seed programs are still planned centrally, either by the Ministry of Agriculture or by the National Seed Agency. This annex describes the present process and its drawbacks. The process may vary slightly from country to country but the approach is essentially the same.

The starting point in the process is the planning of the quantities of seed of various types to be produced. The first question generally addressed is: how much seed should be produced, or, in other words, what is the potential quantity of commercial seed (i.e. seed to be sown by the farmers for raising crops) which can be marketed. This quantity (plus x percent for physical contingencies) represents the production target for the seed agency. This target, in turn, will determine the acreage of farmland to be allocated for seed production, the location and the size of the processing plants, the volume of storage, the transportation requirements and the marketing network outlets, facilities, etc.

Therefore, the first step is the assessment of the total acreage of each cultivated species (and varieties) which, multiplied by the seed rate and divided by the acceptable seed replacement rate (once every "x" years) gives a figure which represents the potential quantity of seed which can be sold for that species. The addition of the potential quantity of seed for all species and varieties, would give the total target of seed production for the seed agency across crops and varieties.

1/ This annex is based upon an excellent unpublished paper on the subject by Mr. Alexander Shilo.

2/ This has different titles in the various countries.

3/ In hybrids, farmers have to obtain a fresh stock of seed every year; so the seed replacement rate is 100 percent. In OPVs, farmers can theoretically use the seed obtained from the earlier year's crop and saved for sowing in the following year; seed replacement rate can therefore be theoretically zero. But in practice, due to admixtures and dilution of variety (particularly in cross-pollinated crops like composite maize), it is advisable to obtain a fresh stock of seed after some years; normally it is recommended that farmers replace their seed every five years; in such a case the replacement rate is 20 percent. Replacement is recommended not only because of dilution of variety; plant breeders continually bring out newer varieties with greater pest and disease resistance, and which might fit in better with the prevailing farming systems. Sometimes, newer varieties also bring about new cropping systems; a well-known example is the Punjab (India) where the shorter duration rice varieties led to rice-wheat rotation.
A seed production program is built like a pyramid: at the top is the breeder seed; a very small quantity of breeder seed is produced by a scientist at a research station, with the highest quality as far as genetic purity and health are concerned. The breeder seed is handed over to the seed agency which performs the first sowing the yield of which will be the foundation seed. The foundation seed is the parental seed from which seed will be produced for the market. Depending on the species, the foundation seed has to be multiplied more than once (up to three or four times) in order to yield the quantity of seed required for matching the demand (e.g. for sorghum, one multiplication is more than enough; for groundnuts, up to four multiplications are necessary). This seed will be marketed under the label "certified seed" or "truthfully-labeled" seed as the case may be.

In the planning process, and once the production targets have been set, one proceeds along the pyramid upstream to determine:

(i) The quantity of seed M4 required to produce the commercial seed after the fourth multiplication, and the acreage A4 to be sown accordingly;

(ii) The quantity of seed M3 and the acreage A3 needed to produce M4;

(iii) M2 and A2 needed for A3;

(iv) And so on until one reaches the foundation seed level.

When several multiplications are necessary, the last one/s is/are usually performed by private farmers, on their land, with a contract and under close supervision by the field agents of the seed agency.

Downstream, below the pyramid, the production targets will determine the location and the size of the processing plants, the capacity for the storage facilities, the transport and marketing facilities; in short, all the logistics needed to make sure that the commercial seed would have the required quality, and would be available to every farmer and at the right time.

This pattern involves two elements outside the seed agency.

(i) The seed breeding and variety maintenance, which is a research function, usually performed under the supervision of a scientist working at the seed agency or at a research station.

\* Such straightforward multiplications are possible only in open-pollinated varieties. In hybrids, once commercial seed is produced, further downstream seed multiplication is not desirable.

\*/ The term "commercial seed" is used to denote either of these.
(ii) The seed certification, which is a legal guarantee given to the farmer/customer by an independent government agency, stating that the quality of the seed has reached the standard prescribed by the law and is therefore allowed to be sold under the label "certified seed."

This pattern requires: competent scientists for plant breeding and variety maintenance; sound land and agricultural practices for foundation seed production and initial multiplications on the seed farms under direct management by the seed agency; a highly skilful and reliable contract farmers, and close supervision by the seed agency; an independent and competent seed certification agency; a reliable marketing and supply network; and finally, the confidence of the farmers/customers in the seed agency, that they will get good seed, supplied on time and at an affordable price.

This pattern prevails in many developing countries. It has been borrowed from what prevailed in most industrial countries some years ago, and has been devised for developing countries by so-called "seed experts", and supported by donors.

COMMON SITUATION IN THE FIELD

When "seed experts" design seed programs for developing countries they usually follow the same pattern. They assess the acreage for the major crops, multiply by the seed rates officially recommended in the country, divide by the rate of replacement, and get a figure, which should be the potential market, i.e. the production goals for the local seed agencies.

Then, moving into the planning process, they have to address the following questions.

- Who will produce the seed?
- Who will process, store and transport the seed?
- Who will sell the seed?
- Who will buy the seed?

Often, they realize that these production targets lead to quantities of seed which are not easily manageable, require costly investments in equipment and facilities, as also a major advertisement effort for building a market to sell the seed.

Their next step is usually a proposal: "Let us implement X percent of the program in, say, five to ten years," and programs and projects are built accordingly. But basically, the system remains unchanged.

In practice, in most developing countries, this system does not work for the following reasons.
(i) In many cases, the market for certified seed does not exist because the farmer uses his own seed (which in fact is what has been saved from the previous season), or buys seed from local sources. Sometimes, the farmer does not have faith in the ability of any seed agency (generally a parastatal) to produce seed with a better quality than his own, let alone to provide it on time and at an affordable price. One should not forget that the farmer is generally risk-averse, especially if production is at a subsistence level.

(ii) Overoptimistic planning is partly a by-product of the preceding situation, and partly the tendency of the planning bureaucracies "to play safe." In Malawi, for example, seed requirements are estimated by the Agricultural Development Agencies (ADD), and sent to the Ministry of Agriculture; since ADDs are not held responsible for optimistic estimates resulting in over-production, there is a tendency to err on the higher side. The same has been the case in India for many years, where over-estimation led to over-production by public sector seed companies.

(iii) The land allocated to government farms and seed stations is often of poor quality, which is not suitable for good seed production.

(iv) Government farms are usually operated under a ministry's administration, which does not have the management and financial flexibility needed for running seed production as a business.

(v) Government farms are operated by civil servants, who are mostly good agriculturalists, but follow government hours, have problems of transportation, of income (many hold other jobs simultaneously) and are poorly motivated. Big seed farms thus only have bigger problems.

(vi) For seed multiplication under contract, good farmers are surely to be found, but these farmers might not be reliable and could sell their production to a local dealer (specially if the payment is in cash), and the supervision of these contract farmers by the supervisors of the seed agency is often poor, uneven and sometimes barely exists.

(vii) Often, the seed production model is not sustainable; in Rwanda for example, the seed multiplication is usually done by projects, with expatriate staff, and this activity could stop at the end of the project.

(viii) Big seed plants require, besides heavy investments which can be made available by foreign donors, excellent managerial skills, which are hard to

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*Many parastatals do not pay their contract farmers in time.*

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find in developing countries. Under a project and during the initial years, these seed plants are run under expatriate managers, but when the project is over, it is hard to find skilled local managers to take over.

(ix) The marketing network is often weak. Retailers have poor facilities, through which they sell many commodities and have no special motivation for the sale of seed.

(x) Certification is often done by a unit from within the seed agency; this is a procedure which might create conflicts of interest between the production units and the certification unit, and could lead to a lowering of the standards of quality.

(xi) The areas planted at each stage under various crops are based on assumptions regarding yield. These assumptions often go wrong, resulting in either surpluses or shortages. Shortages in hybrid seeds would push up the prices of certified seeds, and the typical response of most governments is control on seed prices, with all the negative repercussions of such control.

Despite all the practical problems, some of which have been mentioned, of the central planning of seed production and programs, it is surprising that many Bank and donor-assisted projects support such an approach.

The Bank-assisted National Seeds Projects I and II in India illustrate the pitfalls of excessive reliance on parastatals, and central planning of seed production based on demand assessment by government agencies. To quote from the Project Completion Report (p. 37) of these projects by the Bank's Operations Evaluation Department:

"Once the farmer has obtained seed of an HYV, he is often able to produce his own seed, at least for several generations, of near equal quality to certified seed on offer. Such few trials as have been done rarely use a fair comparison, but even so, they show very little difference in yield from farm produced and certified seed of many pulses and only fairly modest gains in cereals. Further, the better farmers will supply their neighbors, and a number of certified seed growers will withhold some seed anyway...."

"...in the light of the above, the government estimates of the purchase of seed for replacement by farmers were too optimistic but there is a further and probably more important influence. Suppose a farmer does wish to meet the objective of replacing self pollinated cereal seed every fifth season (i.e., the 20 percent replacement rate proposal). Rather than replace all his seed every fifth year, he can replace 20 percent of his seed every year (making his seed on an average two years away from being certified), and he is more likely to multiply his seed. For
instance, if seed multiplication rate for wheat is taken as twenty, he could purchase just a percentage of his seed every year, multiply once and plant all his crop to second generation seed in the subsequent year. In practice, this principle is doubtless followed, substantially reducing certified seed requirement."

Actually, this is a healthy trend and needs to be encouraged, as it results in a more efficient use of the available resources, and would benefit the resource-poor farmers. The fear voiced in some countries that such a trend might drive the seed companies, most of them parastatals, out of business is a misplaced one, because once farmers realize the value of good seed, they would feel encouraged to buy seed; the trend would increase farmers’ incomes, and expand the market for the seed companies.

The economics of a seed project are also based upon theoretical farm models. Issues which are seldom raised, but which eventually wreck the projects are:

(i) Given the prevailing risk factors would farmers purchase seeds at the assumed prices?

(ii) Are the assumed grain prices those which farmers actually realize, and are these paid to them promptly by the parastatal grain procurement agencies which function in many SSA countries?

(iii) Are the other services, such as credit, storage and access to markets consistent with the seed system?
Annex 4. Multinational Seed Companies in Africa

Pioneer Hi-Bred International and Cargill are two major multinational seed companies which have been active in the seed industry in Sub-Saharan Africa for a long time. Other companies, such as Lever Brothers have started recently. Pioneer is present in Zambia, Lesotho, Swaziland, Cameroon, Cote d'Ivoire, Ethiopia, Zimbabwe, Kenya, and Sudan, and is currently prospecting the Botswana market. Its activities include variety testing (of varieties bred by them, as well as those bred at the stations belonging to the national research systems and IARCs), with focus on hybrid seeds. Specifically, it is testing varieties of maize and sorghum in Ethiopia; maize in Zimbabwe, Cote d'Ivoire, and Kenya; maize, sorghum and sunflower in Nigeria; maize, and some open-pollinated crops (importantly, groundnut and cowpea) in Cameroon. Cargill is currently active in Malawi, Tanzania and Zimbabwe; and is prospecting the Angola, Kenya, Ethiopia, Zambia and Zaire seed markets. In Malawi, it is involved in the research and multiplication of barley, corn, cotton, peanut, rice, sorghum, soybean, sunflower, vegetables and wheat; in Tanzania, research and multiplication are being carried out on hybrid maize, and only research on sunflower; in Zimbabwe, it conducts research and multiplication of hybrid maize. Their activities are shown in the following tables. Recently Lever Bros, another multi-national has started operations in Malawi.

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1/ The companies have their headquarters in the U.S.A. The details given here are from a personal communication of Messrs. Damm and Garrit respectively with Mr. Jupiter Ndejunga.

2/ Pioneer has recently withdrawn from Nigeria, following changes to macro-economic policies in that country, which have led to a fall in the offtake of hybrid maize seed.
Table A4.1. The Activities of Pioneer Hi-Bred in Sub-Saharan Africa

<table>
<thead>
<tr>
<th>Country</th>
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<td></td>
<td>Sorghum</td>
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</tr>
<tr>
<td></td>
<td>Sunflower</td>
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<tr>
<td></td>
<td>Vegetables</td>
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<td>*</td>
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<tr>
<td>Cote d'Ivoire</td>
<td>Corn</td>
<td>*</td>
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<td>Sorghum</td>
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</table>

* Refers to activities undertaken by Pioneer in various crops.

* The Republic of South Africa is not covered in this report since Bank operations there are still in the early stages. However, the seed-related activities of multinationals in that country are mentioned here, because they support some activities of these companies in other countries in Southern Africa.
Table A4.2. The Activities of Cargill in Sub-Saharan Africa

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<thead>
<tr>
<th>Country</th>
<th>Crop</th>
<th>Sales</th>
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<th>Testing</th>
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<td>Vegetables</td>
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<td>Shade crops</td>
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<td>Angola</td>
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* Refers to activities undertaken by Cargill.
### Annex 5. Roles of Government and Private Sector in the Different Stages of Varietal and Seed Development in Sub-Saharan Africa

<table>
<thead>
<tr>
<th>Country</th>
<th>Research</th>
<th>Multiplication</th>
<th>Marketing</th>
<th>Extension/Promotion</th>
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<tbody>
<tr>
<td>Angola</td>
<td>Gov’t</td>
<td>Angosementes, Contract Farmers State farms</td>
<td>Angosementes</td>
<td>Not well developed</td>
</tr>
<tr>
<td>Benin</td>
<td>Gov’t</td>
<td>CARDER &amp; its farms &amp; contract farmers</td>
<td>CARDER</td>
<td>Carder</td>
</tr>
<tr>
<td>Burkina Faso</td>
<td>Gov’t</td>
<td>Bas. seed: Res &amp; contract seed growers. Cert. seed: Govt. agency, Coops., contract seed growers</td>
<td>No agency</td>
<td>SVA</td>
</tr>
<tr>
<td>Cameroon</td>
<td>Gov’t</td>
<td>Mideviv &amp; contract seed growers</td>
<td>Mideviv</td>
<td>Extension services</td>
</tr>
<tr>
<td>CAR</td>
<td>Gov’t</td>
<td>National seed service</td>
<td>Govt. agency</td>
<td>Extension service</td>
</tr>
<tr>
<td>Congo</td>
<td>Gov’t</td>
<td>CNSA</td>
<td>CNSA</td>
<td>Coop. Extension Serv.</td>
</tr>
<tr>
<td>Cote D’Ivoire</td>
<td>Gov’t</td>
<td>Res. Institute and Govt. agency contract seed growers</td>
<td>No marketing arrangements</td>
<td>Govt. agency</td>
</tr>
<tr>
<td>Ethiopia</td>
<td>Gov’t</td>
<td>Cert. seed: parastatal on state farms and through contract seed growers stat.farms.</td>
<td>ESC/AISCO</td>
<td>Extension department</td>
</tr>
<tr>
<td>Gabon</td>
<td>CIAM</td>
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<td>CIAM</td>
<td>CIAM</td>
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<tr>
<td>Ghana</td>
<td>Gov’t</td>
<td>Foundation seed: Ghana Grain and Legumes Board Cert. seed: Contract seed growers</td>
<td>Private sector</td>
<td>Dev.agencies Ext.service</td>
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<td>Dev.agencies Gha.see.comp.</td>
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<tr>
<td>Country</td>
<td>Government</td>
<td>Basic: Department</td>
<td>Certification Agency</td>
<td>Development Program/Extension Service</td>
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</tr>
<tr>
<td>Guinea-Bissau</td>
<td>Gov't</td>
<td>Department</td>
<td>No agency</td>
<td>poorly developed</td>
</tr>
<tr>
<td>Guinea</td>
<td>Gov't</td>
<td>Found: Public sector;</td>
<td>Public sector</td>
<td>Extension service</td>
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<td></td>
<td></td>
<td>Cert: Public sector through contract seed growers</td>
<td></td>
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<tr>
<td>Kenya</td>
<td>Gov't</td>
<td>Foundation seed: Public Sector</td>
<td>Private agencies</td>
<td>Kenya Seed Company Extension Services</td>
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<td></td>
<td></td>
<td>Cert. seed: Public Sector through contract farmers</td>
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<tr>
<td>Madagascar</td>
<td>Gov't</td>
<td>State farms</td>
<td>Private agencies</td>
<td>Ext.services</td>
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<td>Mali</td>
<td>Gov't</td>
<td>Cert: state farms</td>
<td>No agency</td>
<td>Ext.services</td>
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<tr>
<td></td>
<td></td>
<td>Contract seed growers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Malawi</td>
<td>Gov't</td>
<td>Multi-national seed companies for maize, sunflower and vegetables. Farmers for other corps, especially groundnut</td>
<td>Mainly by ADMARC</td>
<td>Govt. extension service</td>
</tr>
<tr>
<td>Mauritania</td>
<td>Gov't</td>
<td>Basic: Seed project</td>
<td>Devel.proj</td>
<td>Sonader</td>
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<td></td>
<td>Cert: Contract growers</td>
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<tr>
<td>Niger</td>
<td>Gov't</td>
<td>State farms</td>
<td>Ext.services</td>
<td>Ext.serv and Res.institutes.</td>
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<tr>
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<td>Gov't</td>
<td>Govt. and private</td>
<td>Govt. and private and private</td>
<td>Extension agencies</td>
</tr>
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<td>Gov't</td>
<td>Basic seed: Specialized Services.</td>
<td>Trafipro and Oprovia</td>
<td>Ext.services</td>
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<tr>
<td>Sudan</td>
<td>Gov't</td>
<td>Foundation: State farms; Cert: State farms and contract seed growers</td>
<td>PPA</td>
<td>Ext.services</td>
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<tr>
<td>Tanzania</td>
<td>Gov't</td>
<td>Basic: State farms. Cert: Contr.growers</td>
<td>Tanseed</td>
<td>Tanseed and Ext.services.</td>
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<tr>
<td>Chad</td>
<td>Gov't</td>
<td>Farmers</td>
<td>no agency</td>
<td>Ext.services</td>
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<tr>
<td>Togo</td>
<td>Gov't</td>
<td>Basic: seed farms Cert: cont. growers</td>
<td>DRDR</td>
<td>DRDR</td>
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<tr>
<td>Country</td>
<td>Governing Body</td>
<td>Basic: State Farms</td>
<td>Certified: Contract Growers</td>
<td>Uganda Seed</td>
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<tr>
<td>Uganda</td>
<td>Gov’t</td>
<td>State farms</td>
<td>contr. growers</td>
<td>proj. Farmer coop.</td>
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<tr>
<td>Zaire</td>
<td>Gov’t</td>
<td>State farms</td>
<td>Contract growers</td>
<td>Seed farms</td>
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<tr>
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<td>Gov’t</td>
<td>Zamseed and</td>
<td>Con. seed. growers</td>
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<td>Zimbabwe</td>
<td>Gov’t</td>
<td>Farmer coops and Private Coop</td>
<td>Private Agencies</td>
<td>Coop and</td>
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</table>

**Source:** G. E. Delhove 1989.

**Notes:**
(a) Many abbreviations in the above table (e.g. DRDR) refer to specific parastatals.
(b) Where it is stated that a particular activity is carried out by a project, the implication is that it is a public sector activity, carried out by the project management unit, and not by a national institution.
(c) CAR is the Central African Republic.
Annex 6. Seed Systems in Some Selected Countries

This annex contains an account of the seed systems in some developing countries. The countries selected are fairly representative of the various levels of maturity of seed systems, and the levels of agricultural growth. They exemplify the strengths and weaknesses of the methods and strategies followed in varietal and seed development. Zimbabwe represents a relatively mature seed system in SSA; Kenya has a long and successful history of research on hybrid maize; Senegal and Cameroon have complex farming systems; and finally Nigeria, Guinea and Zaire have on-going Bank-supported seed projects. India's seed system is old and is generally believed to have delivered results on the field, albeit at great costs to the exchequer.

Table A6.1. Macroeconomic Indicators, Annual Growth and Basic Agricultural Data

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<tbody>
<tr>
<td>Area (million km²)</td>
<td>475</td>
<td>246</td>
<td>3288</td>
<td>583</td>
<td>118</td>
<td>924</td>
<td>197</td>
<td>2345</td>
<td>753</td>
<td>391</td>
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<tr>
<td>Pop (million)</td>
<td>12</td>
<td>5.9</td>
<td>867</td>
<td>24</td>
<td>9</td>
<td>99</td>
<td>7.6</td>
<td>37</td>
<td>8</td>
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<tr>
<td>GNP/cap (USD)</td>
<td>960</td>
<td>440</td>
<td>350</td>
<td>370</td>
<td>200</td>
<td>290</td>
<td>710</td>
<td>220</td>
<td>420</td>
<td>640</td>
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<tr>
<td>POP. growth (%Y)</td>
<td>3.0</td>
<td>2.5</td>
<td>2.1</td>
<td>3.8</td>
<td>3.4</td>
<td>3.2</td>
<td>2.9</td>
<td>3.2</td>
<td>3.7</td>
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<tr>
<td>GDP growth (%Y)</td>
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<td>3.6</td>
<td>6.8</td>
<td>5.5</td>
<td>6.0</td>
<td>2.3</td>
<td>1.9</td>
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<td>3.6</td>
<td>6.8</td>
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<td>1980-90</td>
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<td>5.3</td>
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<td>2.9</td>
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<td>2.3</td>
<td>0.7</td>
<td>2.4</td>
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<td><strong>Share of Agr.</strong></td>
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<tr>
<td>1965</td>
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<td>1.8</td>
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<tr>
<td>1980-90</td>
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<td>2.9</td>
<td>1.6</td>
<td>0.2</td>
<td>3.4</td>
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<td>n.a.</td>
<td>9.9</td>
<td>12.2</td>
<td>n.a.</td>
<td>8.6</td>
<td>n.a.</td>
<td>n.a.</td>
<td>n.a.</td>
<td>10.1</td>
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<td>Gov/GDP</td>
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<td>n.a.</td>
<td>8.8</td>
<td>8.6</td>
<td>n.a.</td>
<td>n.a.</td>
<td>n.a.</td>
<td>n.a.</td>
<td>n.a.</td>
<td>8.2</td>
</tr>
</tbody>
</table>


Note:
Area in million km².
Population in million inhabitants.
GNP/cap : Gross National Product per capita in $U.S. dollars.
Growth in Pop : Population growth in (percent).
Growth in Agr : Agricultural growth in (percent).
Growth in Ind : Industrial growth in (percent).
Growth in Ser : Service Growth in (percent).
Share of Agr. : Share of Agriculture in GDP (percent).
Pri/GDP : Private Investment as a (percentage) of GDP.
Gov/GDP : Government Investment as a (percentage) of GDP.
n.a. : Not available.
Selected macroeconomic indicators for these countries indicate that only in India and Kenya is economic growth higher than the growth of the population. And, only in India is the growth of the agricultural sector greater than that of the population. Agriculture is still responsible for a large proportion of the GDP in many SSA countries. Private sector share in investment in Nigeria is still lower than that of the public sector.

CAMEROON

Research

Prior to 1975, agricultural research in Cameroon was established in the Center and South-East provinces of Cameroon under the direct supervision of the French and English research centers and was directed at the large-scale holdings of white settlers. Cocoa, coffee, tea and cotton were the primary crops of interest. In 1979, the Government of Cameroon set up the Institute of Agronomic Research (IRA) whose responsibility was enlarged to include research on food crops. IRA now comprises 4 main research centers each covering one agro-climatic zone; more than 12 other research centers, and approximatively 210 researchers (160 national and 50 foreign national).

Every center has the mandate to conduct research on crops relevant to its agro-climatic zone. Thus, the research center at Maroua focuses on maize, sorghum, millet, peanuts and cotton. The Ekona research center in the humid and coastal forest area prioritizes on tuber and fruit crops. The Foumbot center in the highlands focuses on maize, Irish potatoes, cassava, cocoyam and coffee. Finally, the Nkolbisson center, in the sub-humid forest is a multipurpose center. Its activities vary from soil analysis, coffee and cocoa to other food crops.

The Ministry of Research is responsible for the research policy in the country. IRA produces breeder seeds in collaboration with international research centers, mainly IITA and ICRISAT. Currently, the emphasis is on the production of hybrid maize seeds. Due to poor linkage between research and farmers’ needs, there are many varieties of different crops and technologies which have never been adopted, as the research projects were not adapted to farmers’ circumstances.

Testing and Liaison Units (TLUs), set up under a USAID project in 1982, are expected to close the gap between research and extension. Their objectives are to:

- Gather information on farmers’ circumstances (agro-socio-economic data) by conducting informal and formal surveys;

- Feed back the information to research; and
- Participate in researchers' formulation of projects to make sure that they respond to farmers' needs.

**Seed Multiplication and Processing**

MIDEVIV, which is a parastatal agency, is responsible for the multiplication and processing of foundation and commercial seeds, and the marketing of seeds. In the North Cameroon province, MIDEVIV contracts with seed growers. In the Center province of Cameroon, it operates its own seed farms. The crops of interest are maize, peanuts, soybeans, yam, pineapples, banana-plantain, and fruit crops.

The "Project Semencier Nord," under MIDEVIV, funded by USAID was taken over by the Pioneer Seed Corporation in 1989. It is currently involved in adaptive research on hybrid maize.

**Marketing**

The price of seeds is fixed by the MIDEVIV board of which the Minister of Agriculture is the chairman. There are no farmers' representatives. These prices are far above grain prices and might not be affordable by many farmers. Seed distribution and extension are undertaken by many parastatal agencies, such as Société Coopérative de Développement Rurale and Société de Développement du Cacao and the project units of some of the donor assisted projects.

**Main Features**

- Only recently there has been an attempt to direct research towards farmers’ needs.

- There has been an emphasis on teaching farmers the value of their own saved seed.  

- There is no seed policy, spelling out the roles of the different agencies.

- There is no seed law, or protection of breeders' rights.

- Research potential is not fully utilized.

- Multiplication and processing of seeds is the monopoly of MIDEVIV.

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* The results of a study conducted by TLU in three villages (Nkometou, Nkolkoumou, Nkolfep) of the Centre province where on-farm trials are conducted show that, after three years, 90 percent of the farmers have retained improved maize varieties.
- There is a great deal of government intervention in the seed industry, ranging from multiplication, to marketing and distribution.

- The government decides the prices of seeds.

GUINEA

Research

Prior to 1958, agricultural research in Guinea was conducted in four relatively well-managed and financed centers on different food and industrial crops. Several varieties of rice, maize, and rice, groundnuts were selected and disseminated. From 1958 to 1963, research stagnated due to lack of resources, and between 1964 and 1980, little research was conducted. Since 1980, there have been many developments which have contributed to the resurgence of research activities in Guinea. The significant ones have been the creation of the Rice Development agency (ONADER) in 1980, Guinea’s membership in regional research efforts including the West Africa Rice Development Association (WARDA), and its participation in Semi-Arid Food Grain Research and Development (SAFGRAD).

Seed Multiplication

Seed production and multiplication are largely confined to the isolated efforts of IDA and ADB-funded projects. Existing production of improved seeds by the formal sector meets the demand of only a small fraction of the country’s farmers. A 1986 survey and the views expressed by staff and farmers during the preparation and appraisal of the IDA-assisted National Agricultural Research and Extension Project, suggest a strong demand for improved seed. To meet this demand, the government has from time to time imported seed of untested varieties. These imported varieties have not worked very well because their adaptation to local situation was not attempted. Because of Guinea’s many different ecologies, it is unlikely that a foreign supply could provide the needed seed, although some imported varieties might be multiplied and sold commercially after adaptive trials.

The IDA-funded project embraces the "classical" approach, which has been tried in many countries, of a seed parastatal engaged in the production of foundation and certified seeds and which has all the facilities for seed processing. It has been observed that more than 90 percent of processing facilities remain unused and that the production cost is very high.

A major feature of the seed program is its excessive reliance on seed parastatals, and the lesson to be learned is that it is not possible for a centralized unit, especially a public sector one, with all the inevitable high overheads, to produce seed of open-pollinated varieties at affordable prices and yet avoid losses.
INDIA

Research

The Indian Council for Agricultural Research (ICAR) in the Ministry of Agriculture is responsible for agricultural research in India, supported by the State Agricultural Universities (SAU) and research conducted by the agricultural departments in some states. ICAR has organized/coordinated crop improvement projects to speed up agricultural progress in the country. In 1957, ICAR started the All-India Coordinated Maize Improvement Project in close collaboration with the Rockefeller Foundation; and in 1961, the first four maize hybrids were released. In 1960, ICAR also started the All-India Coordinated Sorghum and Pear Millet Improvement Projects, and in 1964 and 1965, the first sorghum hybrid and pear millet hybrid respectively were released. Encouraged by these results, the projects in other crops were initiated, and to-day, there are over 100 All-India Coordinated Projects, covering not only crops but specific disciplines as well, such as dryland farming. The All-India Wheat Improvement Project was one of the most successful and was started in 1965; 114 varieties of wheat have so far been released. Public sector plant breeding has played a dominant role in the development of the seed sector in India. In recent years, private seed companies have also participated in varietal development including hybrids.

At present, about 200 small- and medium-sized private seed enterprises are active in India. A survey on 40 private seed companies reveals that out of 15 companies which provided information on sales, two had annual seed sales of more than Rs.50 million, nine between Rs. 10 and 50 million; and the remaining less than Rs. 10 million. Only a quarter of these companies were established before 1970; 60 percent between 1970 and 1980; and the remainder after 1980. About a quarter started plant breeding between 1948 and 1970, and about half between 1971 and 1985.

Legal and Institutional Framework

Many organizations are involved in the development and release of new varieties. The All-India Coordinated Crop Improvement Projects are responsible for testing and identifying varieties for release. Agricultural universities and ICAR institutes coordinate the plant breeding programs and have major responsibility for basic and applied breeding work.

The Central Seed Committee established under the 1966 Seeds Act is responsible for variety release. A central subcommittee on crop standards, notification and release of varieties was established to make recommendations on the release and notification of cultivars of national importance, minimum standards for the germination and purity of

\[10 \text{ US$} = \text{ Rs.} 17.50 \text{ (during the relevant period)}\]
released and notified cultivars, delimiting the regions for the cultivation of each approved variety, and the particulars of the 'label' in respect of notified varieties. Before release, varieties are tested for three years in All-India Coordinated Research Projects. Based on their field performance, they are identified for release for a specific agroclimatic region, and subsequently tested at the government farms for adaptation to that region. Breeder seed is produced by the agricultural universities and institutes which developed the particular variety.

In 1963, the National Seeds Corporation (NSC) was established by the government. It began as a central agency for the promotion of seed industry in India, to initiate measures for the production of high quality seed and, in particular, to produce, process, and market hybrid seed. Later, the responsibility was expanded to producing and distributing certified seed of various crops. Until the mid-1960s, its also functioned as a certification agency in different states.

In 1969, the government established the State Farm Corporation of India (SFCI) to manage thirteen central state farms. The corporation has been entrusted with the production of breeder, foundation and certified seeds. The company could only produce a small percentage of seed requirements.

In the 1970s, almost all the states established State Seed Corporations (SSC) under IDA-assisted seed projects. It was envisioned at that time that SSCs would meet the intra-state requirements, and that the NSC would take care of inter-state production and marketing. But in practice, this could not work; first, it involved too much central planning which worked very well on paper, but not on the ground; and second, many SSCs started producing seed in other states for marketing in third states, and such free-wheeling could not be stopped; in any case, many competing SSCs would serve the needs of the consumers better than one monopolistic public sector organization such as the NSC. Since the State Agricultural Universities (SAUs) were under the administrative control of the states, the SSCs had a source of breeder and foundation seed independent of the NSC; in fact, for some time in the late 1970s and early 1980s, the NSC (with the approval of the World Bank under the Second National Seed Project) tried to control the foundation seed production and distribution but could not do so for long, as such central production planning resulted in shortages of foundation seed (see Annex 3).

Under the Seeds Act, 1966, it is obligatory to label seeds of notified varieties which are marketed, while seed certification remained voluntary. This has enabled seed producers to sell seed without certification as "truthfully labelled," and has encouraged the growth of private sector seed industry. Most vegetable and flower seed sold is "truthfully labelled," while seed of cereals, pulses, and oilseed is certified.
Seed Production

Breeder seed is produced by a qualified plant breeder and monitored for quality during the production by a joint team comprising the crop breeder, producing breeder, and one representative of each of the crop-coordinated projects. Then, the breeder seed is supplied to the NSC, SFCI, and SSCs and reputed private seed companies for the production of foundation seeds. Certified seed is produced by NSC, SFCI, SSCs, and private seed companies, mostly through contract seed growers.

Marketing and Pricing Policies

The Government of India does not set seed prices; the NSC, SSCs, and private seed companies and other organizations are free to set their prices. Sometimes, the states introduce statutory or "voluntary" control on the price of seed. Due to subsidy on seed of many crops, particularly oil seed and pulses, the parastatals can afford to set their prices at a higher level than the private sector seed companies.

Informal Sector

The legal framework has helped the growth of the informal sector comprising "producer-sellers," who buy foundation seed from the state agencies, and produce commercial seed for sale to farmers as "truthfully labeled." Very often, contract growers, after meeting their obligation to the seed companies, sell the surplus seed to other farmers as uncertified. Since farmers know that the former had obtained genuine parental material, there is always a demand for their seed. This has developed a strong and continuing bond between seed producers and seed consumers. Farmers produce and sell even hybrid seed; the smallness of their holding and the need to maintain isolation are overcome by the formation of seed producers’ groups, and sometimes even "seed villages," where an entire village produces seed of one variety. These initiatives by the informal sector have contributed to the expansion of the formal private sector seed industry.

Main Features

- Well-established and clearly spelled-out national seed policy.
- Legal framework conducive to the growth of private sector, particularly the informal sector.
- No restrictions on the inter-state movement of seed and generally no price control.
- Agencies responsible for enforcing seed law (e.g. Seed Certification Agency) independent of the developmental agencies (e.g. NSC).
• Farmer participation in varietal development.

• Very pronounced presence of government in the seed system.

• Varietal release is slow and bureaucratic, and as yet, many varieties have not passed the stage of release and gone into the seed development stage.

• Plant breeders’ rights are not sufficiently safeguarded. This inhibits the development of private sector plant breeding.

• Both the Centre and the States are finding it very difficult to close down the NSC and the SSCs, many of which make losses.

• Subsidy on seeds of pulses and oilseeds which is administered by the NSC through SSCs, and which inhibits the entry of private sector in these areas.

• There is little evidence of the growing realization that the Indian seed system is moving into an evolved stage and that a long-term perspective needs to be formulated spelling out the roles of the public and the private sectors.

KENYA

Research

Prior to independence in 1963, improved seed production was started in the Central Highlands and was intended to benefit the large-scale holdings of the settlers. After independence, the industry expended rapidly, particularly due to the introduction and diffusion of hybrid maize. Several supporting activities for seed industry development have been created.

Research is almost entirely in the public sector. Government supports research done by the National Seed Quality Control Service (NSQRS) and partly owns the Kenya Seed Company (KSC) and the Agricultural Development Corporation (ADS). It also supports the Kenya Grain Growers’ Cooperative Union (KGGCU) which distributes seeds.

Seed Policy

Before a variety can be released in Kenya, the various procedures set down in the Seed and Plant Variety Act (1977) need to be followed. These include distinctiveness, uniformity and stability trials and national performance trials. The National Variety Release Committee is chaired by the Director of Agriculture; and a variety is released to farmers if the committee approves.
The Seed and Plant Variety Act provides specifically for the granting of plant breeders' rights for plant varieties or species or group specified by the Ministry of Research, Science and Technology (MRST).

Seed certification was started in the 1970s. The NSQCS functions under the Kenya Agricultural Research Institute (KARI) and is classified as a commodity research station. It has the following mandate.

- Production and testing of breeder seed of recommended crop varieties and clones;
- Standardization of techniques for seed testing and production;
- Evolution of procedures for the production of hybrid seeds of crops, such as maize, sorghum and millet;
- Improvement of seed storage methods and physiological studies on seed dormancy; and
- Establishment of standards for seed viability, genetic and physical purity, for each notified crop variety in respect of breeder, foundation and certified seed.

Seed Multiplication and Marketing

The research system provides breeder seed to Kenya Seed Company (KSC) which multiplies them into certified seeds on its farms and on those of the contract farmers, who are members of KGGCU through primary cooperatives.

The KSC Board approves prices paid to farmers (contract growers) for producing seeds, and the wholesale seed price to the KGGCU. The retail price of hybrid maize seed is determined by the KSC board in consultation with the MRST.

The KGGCU is the main outlet for improved variety in Kenya. The union has fifty branches spread throughout the country. It is also a monopoly vehicle for some agricultural inputs such as fertilizers, pesticides, agricultural tools and machinery.

Although the seed industry is dominated by the KSC, private companies are increasingly getting involved, e.g. East African Seed Company (EASC), Jardinage Seed Company, Mount Kenya Agro-Industries, the USA Seed Company, Cargill East Africa Ltd, Pioneer Hi-Bred and Ciba-Geigy.
Main Features

- Presence of a national seed policy.
- Incentives to plant breeders whose rights are recognized by law.
- Strong research base.
- Involvement of farmers' cooperatives in the seed distribution system making seed availability more efficient.
- Presence of a sound certification and quality control agency.
- Seed price-setting by the government.
- Near-monopoly of seed production by the KSC and the KGGCU.
- Heavy government involvement in the seed industry.

MALAWI

Seed Policy

The Malawi Seed Act, which spells out the seed policy, was passed in 1990, but the Regulations under the Act have not yet been prepared. The policy however is well understood by the players in seed network, which, apart from the consumers are public sector agencies. The National Seed Company of Malawi (NSCM) is jointly owned by Cargill, the UK Commonwealth Development Corporation and ADMARC (Agricultural Development and Marketing Corporation, a Malawi parastatal), and till recently, was the monopoly producer of most varieties of seeds, particularly hybrids. Each new variety which is sought to be sold to farmers should be released by a varietal release committee chaired by the Permanent Secretary of the Ministry of Agriculture. Seed quality control is the responsibility of the ministry (Seed Service), but in practice only hybrid maize seeds produced by The National Seed Corporation of Malawi (NSCM) are certified, but not seed produced under the Smallholder Seed Multiplication Scheme (SSMS).

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11 This is partly based upon a study on the Malawi seed industry by Elizabeth Cromwell, Research Fellow, Overseas Development Institute. See Cromwell, E., 1991.
Research

Until the late 1980s, research was entirely the responsibility of the Department of Agricultural Research, and plant breeding work was conducted at the Department's research station. Since 1988, NSCM has its own breeding program, and relies upon parental material from South Africa and Zimbabwe; but this is very small, and the public sector still remains dominant in plant breeding.

Seed Development

NSCM is the sole producer of certified hybrid and composite maize seed marketed in Malawi, and also produces most of the non-maize seeds, such as groundnut, beans and soyabean. Recently, however, the latter are being produced under SSMS. The objective in starting SSMS was to provide farmers with seed of self-pollinated crops such as groundnut, beans, soyabeans and wheat, at a lower cost than NSCM, which did not find the production and marketing of seeds of these crops financially attractive. It is significant that the SSMS is implemented in the smallholder sector, where the seed producers are the smallholder farmers, whereas the contract growers in the seed production program of NSCM are the farmers in the "estate" sector. Under SSMS, seed farmers are not free to sell seed in the market on their own; in other words, they are not seed entrepreneurs. They are obliged to give the seed to the local government — called Agricultural Development Division (ADD) — which also selects farmers who can participate in the scheme. The scheme is thus heavily government-engineered.

Seed Pricing

Seed prices are administered by the government, and are subsidized; it is estimated that the cost of seed subsidy is about 15 million kwachas (about US$ 4 million); the cost of SSMS overhead is not precisely estimated as it is part of the government's operations, and is not included in the above figure.

Marketing

Small farmers can obtain certified seed of hybrid and composite maize from NSCM directly or from its network of registered dealers or from ADMARC which is a

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12 For those readers who are not familiar with the agrarian scene in Malawi, it needs to said here that there is a dualism in Malawi's agrarian sector which is characterized by smallholders and estates, differentiated by regulations concerning production, marketing, pricing and land tenure. Even though there is no clear-cut demarcation between the two in terms of size of holding, the farms in the estate category are generally larger. For reasons of ability to maintain the necessary isolation (which is thought to require large farms), contract seed production for NSCM is done exclusively by estate farmers. This has its implications for seed pricing, as NSCM has to compete with burley tobacco (burley tobacco is the monopoly of the estate farmers) for farmers' business; in other words, seed production should be more remunerative to contract farmers than growing burley tobacco.
marketing parastatal; and quality seed (SSMS-produced, and uncertified, what is referred to in this paper as "truthful") from ADMARC. SSMS seed is solely marketed by ADMARC at pre-announced prices.

Main Features

- Private research subject to government control and direction.
- Till recently, there has been no competition in seed production or distribution; whether the recent entry of one more multinational (Lever Brothers) results in more competition remains to be seen.
- Seed prices are set by the government and are subsidized.
- Certification of OPVs does not seem to obligatory; SSMS seed is not certified, but it is "truthfully labeled". It is not clear whether this means that certification is optional, or whether SSMS seed is simply not certified due to the infeasibility of certifying seed grown in dispersed locations and to the paucity of staff with the certifying agency.

NIGERIA

Research

The various research institutes function directly under the Ministry of Agriculture and have had well-developed plant breeding and varietal development programs in operation for some time, although in recent years the funding of the research system has been erratic and uncertain. Many varieties evolved by research are capable of producing higher yields than local selections of maize, rice, sorghum, cowpea, soybeans and cassava. But till recently there was no practice of testing them under conditions obtaining on farmers' fields; they perform well in mono-cropping situations, but most farmers have mixed cropping systems. Hence the adoption of varieties has generally been slow. The strong presence of IITA in Nigeria has contributed to the availability of many new crop varieties to farmers. WARDA and ICRISAT who have research centers in Nigeria have also supported the Nigerian research system in varietal development.

Seed Multiplication

The key players in seed production are: the National Seed Service (NSS), the Agricultural Development Projects (ADP) and some private sector companies, which are primarily in hybrid maize seed production. The production involves a three-stage process (breeder, foundation and certified seeds). Public agencies, namely, NSS and ADP, supply certified seeds to users through their farms or contractual arrangements with some farmers. Private companies are also involved in seed production, especially hybrid
seeds. These seeds are used mostly by medium and large farmers. The responsibilities assigned to the NSS by the Bank-supported National Seed Project, particularly regarding privatization of seed industry include:

(i) Promotion of the private sector; and

(ii) Assistance in the importation of proven parental material developed by them in other countries for the production of double and triple crosses in Nigeria. In view of the fact that the parent organizations of these companies do not pass on the inbred material for security reasons the parental material made available is only the single crosses for further production of hybrid seed within Nigeria.

Legal status

The seed decree has recently been promulgated. It assigns the following responsibilities to the NSS:

(i) Certification, quality control, development and promotion of seeds;

(ii) Seed technology and seed industry development; and

(iii) Organization and monitoring of production and distribution of breeder, foundation and certified seed.

According to the existing Seed Decree certification is mandatory, and even breeder seed is required to be certified. The decree makes it clear that a person offering agricultural seeds of a "notified variety" for sale should affix a label accurately describing the contents, and minimum limits of germination and purity. It is feared that the provisions of the seed decree will inhibit the emergence of small-scale private sector seed industry. The NSS has recently framed regulations relaxing some of the above provisions, and making certification voluntary; but these regulations are yet to be endorsed by the government and formally gazetted.

Marketing and Prices

ADPs sell seeds either directly or through Farmers' Supply Companies (FASCOM), where they exist; these are wholly-owned by the ADPs; they sometimes operate through distributors who also handle fertilizers and chemicals. The prices of such "public sector" seeds are subsidized by the government.
Development of the private sector

There are quite a few private companies in operation in Nigeria, including Pioneer Hi-Bred, which is a multinational seed company (see Annex 4). These companies are primarily engaged in producing hybrid maize seeds; except Pioneer, they depend entirely upon "public sector varieties." Pioneer imports its own germ plasm from other countries and also has plans to have a research base in Nigeria.

NSS has realized that, in due course, ADPs should give up production of certified seed, which should be taken over by the private sector. At the same time, organized private sector seed companies might not be interested in producing open-pollinated varieties, which would not be commercially attractive. The answer therefore lies in building up a second- "tier" informal private sector, with low overheads, comprising mostly farmers, who would purchase foundation seed from the ADPs, multiply them and market the commercial seed either with or without certification (truthfully labeled). As a first step in this direction, NSS has identified thirty-four dependable quality-conscious seed growers in different regions, and a beginning has been made with open-pollinated varieties (OPVs), e.g. maize composites, rice and soybean and cowpeas in the development of farmer seed-entrepreneurs. The NSS assists them in buying foundation seed, provides them technical support, facilities for custom processing, and marketing intelligence for export as well as inter-state marketing of seed. However, these enterprises are free to fix prices and sell the seed on their own. With the development of these enterprises, the ADP's present role in commercial seed production is expected to further diminish, leaving the private sector seed companies and farmer-seedsmen to cater to the needs of a variety of seed consumers. It remains to be seen, however, how far the seed law encourages such a trend.

Main Features

- Development of the private sector seed industry.
- Assignment of developmental and regulatory roles to the same agency, viz. NSS.
- Seed decree not very clear regarding the varietal release i.e. it is not clear whether every variety, even privately-bred ones, should go through the release mechanism?
- The development of the private sector is too "managed" by the NSS.
- Subsidy on "public sector" seed which inhibits the development of private sector.
SENEGAL

Research

Agricultural research in Senegal started in 1921, and for almost fifty years was the headquarters for agricultural research in the then French West Africa. In 1974, the Institut Sénégalais de Recherches Agricoles (ISRA) was created to bring all research institutions in the country under one umbrella. Today, Senegal has seven agricultural research stations.

The system of Experimental Units, which existed between 1968 and 1980, was the first example of farming systems research in West Africa. However, this system suffers from the "top-down" approach encountered in many other countries in Sub-Saharan Africa.

In 1982, ISRA's "Production Systems Research" was established with the assistance from The World Bank and USAID. This research has led to a better understanding of the traditional farming systems, and of farmers' potential and constraints in adopting technologies developed by ISRA, through increased ties with extension.

Seed Multiplication and Distribution

The National seed system in Senegal consists of four related components.

- A source of new varieties from national and international institutes that ISRA selects and tests.
- Early stages of multiplication carried out by ISRA and the Direction de la Production et du Controle des Semences (DPCS), with contract growers used for the later stages of multiplication.
- A system of seed quality control under the responsibility of the DPCS.
- A system of distribution of seed to consumers (farmers) through the SRDR, Société Nationale de Commercialisation des Oléagineux du Sénégal (SONACOS), and private dealers.

The focus on seed production in Senegal has been on the major cash crop, peanuts. Other crops have received little attention. More than 80 percent of the seeds used by farmers are farmers' saved seeds.

The term "top-down" used in Farming Systems Research refers to situations where researchers undertake their operations without taking into account farmers' needs and assume that the technologies derived by them should be suitable for farmers.
Experience with Non-Governmental Organizations (NGOs)

In Senegal, more than one hundred international and indigenous NGOs are in operation; of these, more than fifty-four are working in agriculture. These NGOs have sufficient financial and staff support to serve rural communities; but often, their areas of operation are rather small.

The main objectives of the NGOs are to support activities that are technically sound and sustainable. The "Farmer-Participatory" approach in Research (FPR) is compatible with the philosophy of the NGOs. One of their experiences in seed production has been with the "On-Farm Seed Project" (OFSP), initiated in 1987; this is a collaborative effort of Winrock International, American NGOs, the US Peace Corps, and the Mississippi State University (MSU).

OFSP

The innovation in the OFSP approach is two-fold. First, specific interventions in the local seed systems are based on information gathered in the field. Second, the project is collaborative in that all operations are accomplished through organizations in the field, such as the PVOs and the Peace Corps, and focuses on meeting farmers' demand for better seeds by improving their systems of selection, production, storage, and distribution. Through training and demonstrations, the OFSP helps farmers learn how to do better than what they have been doing on their own for centuries.

Located in villages, the NGO agents have worked with farmers to become familiar with their farming systems, giving particular attention to seeds. The global objectives of the project are to:

- Gather information on production practices and seed-related problems of the farmers;
- Design and implement trials to ameliorate the identified seed problems;
- Discuss the results of the trials with farmers;
- Carry out additional trials and extension with pilot farmers; and
- Extend the results to more farmers and farmers’ organizations.

A major area of concern is the sustainability of NGO efforts, as farming systems research is expensive.
Main Features

- Research is geared towards farmers' needs.
- The approach is based on the assumption that farmers can easily learn if they are appropriately taught.
- Training farmers in better methods of seed selection based on a recognition that seed selection has for a long time been done by farmers, so that they are aware of the importance of good seed.
- Government sets the price of seeds.
- Parastatal agencies have the monopoly of seed distribution.
- Research is still focused on a few crops only.
- Many seed varieties appear not to have been tested under farmers' condition to ensure that they are compatible with the farmer's production system.

Zaire

Seed System

The seed system in Zaire, as in many countries in SSA, is dominated by the government. The Bank-assisted Seeds Project which started in 198614 aims to support the Government of Zaire in establishing a viable seed industry in Zaire with the increasing participation of the private sector. In practice, however, this has not yet happened, and the present political situation is only one of the reasons. The main reason is that it is not profitable for any private sector to deal in OPVs, particularly when the environment in which farmers operate, which includes marketing of produce, pricing etc. does not favor purchase of seed.

Seed Policy

Research is essentially conducted at the Institutions de la Recherche Agronomique (INERA-SENERAV). Some private sector plant breeding activity is present, and private breeders participate in the multi-location trials of the national research system, before a variety is released. But the private sector is not obliged to reveal all the details relating to a variety at the time of submission of the variety for release and notification. Each variety has to be evaluated for its distinctness, stability and homogeneity before it can

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14 Seeds Project (Cr-1609)
be released. Release and notification (called "cataloguing") are for all varieties. There is no seed law yet; it is being formulated, and the policy is being informally administered at present.

Seed Quality Control

Since the seed law is not yet in force, there is no independent agency for quality control. It is envisioned that certification should be compulsory.

Seed Production and Marketing

Seed production is mostly carried out on government farms. In 1989-90, the eight farms managed or assisted by SENASEM (seed parastatal) produced about 820 tons of seed. According to a recent supervision report by the Bank, the seed produced was not used by farmers for growing crops because:

(i) They were not the varieties preferred by farmers; and

(ii) There was no linkage with extension which did not train farmers on multiplication of OPVs and vegetatively propagated crops.

Main Features

- Farmers do not participate in varietal development.
- Their preferences are not taken into account while producing seed.

ZAMBIA

Seed Policy

The policy and general guidelines are developed by the Ministry of Agriculture and Water Development in consultation with Zambia Seed Company and Lint Company which are parastatal organizations, and cooperatives and farmers’ organizations. The Permanent Secretary of the Ministry is the Controller of Seed and Administrator of the Agricultural Seed Act.

Multiplication

Once a variety is released with the recommendations of plant breeders by the variety release committee, the Zambian Seed Company (Zamseed) would multiply and distribute the variety. The research institute provides Zamseed with breeder seed. This company contracts a few selected farmers to produce pre-basic seeds. Zamseed contracts
with experienced registered seed growers of the Zambian Seed Producers Associations for the production of basic and certified seeds under the supervision of the Seed Control and Certification Institute (SCCI). Zamseed deals with the imports and exports of seeds and ensures a strategic seed reserve of at least 25 percent of annual requirements.

SCCI is the only authority responsible for seed testing and certification. It is completely independent from plant breeding, seed production and marketing activities. This institute performs routine seed testing, such as purity, moisture content and germination. Its laboratory is accredited to ISTA.

Marketing

The marketing of seeds in Zambia is the sole responsibility of Zamseed. This is done through agencies such as provincial cooperative unions, and the price is fixed by the government.

Main Features

- Seed policy is set with the involvement of farmers through their representatives.
- The Seed Control and Certification Unit is independent of research, production and marketing.
- Seed production process involves contract farmers, and they might eventually view seed production as a profitable activity, and might become seed entrepreneurs.
- The Zambia Seed Producers Association has access to many farmers with a very sound knowledge of crop management and with experience and interest in seed production.
- All activities downstream of basic seed are performed by Zamseed which is a parastatal.
- Zamseed has the monopoly on seed marketing.

ZIMBABWE

Seed Policy

Zimbabwe inherited a well-functioning and highly efficient seed industry from the earlier Rhodesian regime. Formal research on varietal improvement started in 1909, at
the "Botanic Experimental Station." Scientific breeding followed in 1933; and in 1949, the first hybrid maize was marketed.

The bulk of varietal improvement is undertaken by various chapters in the Department of Research and Specialist Services (DR&SS) of the Ministry of Lands, Agriculture and Rural Settlement (MLARS). The research effort is mostly funded by government; contributions towards some research programs are received from farmers' union and external donor agencies. Crops research is also undertaken by the private sector, particularly cooperatives.

Zimbabwe has a well-established national seed policy based on studies worked out by specialists in various disciplines including plant breeders, agronomists, agro-economists, financial analysts, and extensionists. It also has a national seed plan defining this policy and describing ways and means to accomplish various tasks relating to varietal and seed development.

**Box A6.1. Private Sector in Zimbabwe**

The Savannah Seed Company, one of the private sector seed companies operating in Zimbabwe, has a good record of enabling farmers to obtain good quality seed of improved varieties. It started as a South African-owned company, initiated by Pioneer SA. Savannah is presently owned 40 percent by the Zimbabweans and 60 percent by Pannar UK. Savannah Seed does not get its varieties tested and certified by any government agency. Its varieties are sold as standard or "truthfully labeled" seed under its own brand name. The seed marketed by the company is the product of its own plant breeding program, with little input from the Department of Research and Specialist Services. The company claims to maintain a high standard of purity and germination.

**Seed Quality Control**

The Seed Act in 1965 (amended in 1971) was a major step towards seed quality control. The Act requires registration of sellers of seed and seed testing laboratories; regulates the importation, exportation and sale of seeds; and provides for testing, certification and inspection of seeds. The Zimbabwe Seed Act places all the responsibilities for seed quality control on the Seed Services Branch, which is an integral part of the DR&SS. Zimbabwe’s seed laboratory is accredited to the International Seed Testing Association (ISTA).

**Multiplication**

In line with international practice, Zimbabwe has adopted the "three generation system," i.e. breeder seed, foundation seed and certified seed. Under this procedure, breeder seed is released to the state-owned seed agency, who, with the approval of the certifying authority, distributes seeds to selected foundation seed growers for
multiplication. The basic seed is thoroughly inspected by the certifying authority during
the season. The basic seed is then distributed to certified seed growers by the certifying
authority after extensive seed analysis at the Government Seed Testing Laboratory. A
minimum of two field inspections of the seed crops are undertaken to ensure the
maintenance of seed crop quality as laid down in the Seed Notice, 1971. Seeds are sent
for testing of their purity and germination. Certification is compulsory and no person
can sell notified seed without obtaining certification.

The marketing of seeds is carried out by private dealers and privately-owned seed
associations of which there are five. The government controls seed prices for the
internal market. Seed which is exported by the private sector is not subject to any price
control.

Main Features

- Well understood seed policy.
- Private sector involvement in research.
- Involvement of farmers in the development of varieties.
- Seed multiplication and processing by private seed companies or cooperatives
  of farmers.
- Seed certification by an independent agency, with no connection with
  research, extension or marketing services.
- Seed marketing almost entirely by private bodies.
- Control on internal seed prices.
- Seed certification mandatory.
Annex 7. Elements of Supply and Demand in the Seed System

<table>
<thead>
<tr>
<th>Components of Supply</th>
<th>Stage 1 Farmer Selection and Supply</th>
<th>Stage 2 Introduction of Improved Varieties</th>
<th>Stage 3 Widespread Use of Improved Public Varieties and Early Spread of Private Varieties</th>
<th>Stage 4 Mature Seed Industry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research &amp; Development (R&amp;D)</td>
<td>Farmers experiment, public R&amp;D occurs near the end</td>
<td>Public R&amp;D produces new varieties; private companies start R&amp;D on hybrids</td>
<td>Both public and private firms produce new varieties and hybrids</td>
<td>Private firms produce most new varieties; public does basic R&amp;D and minor crops</td>
</tr>
<tr>
<td>Seed production Breeders' seed</td>
<td>None</td>
<td>Public R&amp;D institutions</td>
<td>Public and private R&amp;D institutions</td>
<td>Private firms, public firms for cooperatives and minor crops</td>
</tr>
<tr>
<td>Basic and foundation seed</td>
<td>None</td>
<td>Government farms</td>
<td>Government farms; government organized cooperatives of farmers; farms of private companies.</td>
<td>Private companies and farmer cooperatives for public varieties</td>
</tr>
<tr>
<td>Commercial seed</td>
<td>None</td>
<td>New varieties of government farms, contract growers organized by the public or private sectors</td>
<td>Public and private firms, with the share of private firms increasing</td>
<td>Private companies, farmer cooperatives</td>
</tr>
<tr>
<td>Marketing and distribution</td>
<td>Local trading of farmers seed</td>
<td>Distribution by public and private firms</td>
<td>Public and private firms, with the share of private firms increasing</td>
<td>Private companies; farmer cooperatives</td>
</tr>
</tbody>
</table>

Determinants of Demand

<table>
<thead>
<tr>
<th></th>
<th>Stage 1 Farmer Selection and Supply</th>
<th>Stage 2 Introduction of Improved Varieties</th>
<th>Stage 3 Widespread Use of Improved Public Varieties and Early Spread of Private Varieties</th>
<th>Stage 4 Mature Seed Industry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superiority of new varieties</td>
<td>Not applicable</td>
<td>High-yielding varieties superior with fertilizer</td>
<td>Public and private varieties superior</td>
<td>Private superior to public, few public varieties produced</td>
</tr>
<tr>
<td>Availability of complementary inputs</td>
<td>Some fertilizers and irrigation</td>
<td>Fertilizers available but limited because of government supply</td>
<td>Fertilizers and other agricultural chemicals available</td>
<td>Fertilizers and other agricultural chemicals available</td>
</tr>
<tr>
<td>Farmers' ability to produce and save seed</td>
<td>Not applicable</td>
<td>Improved varieties, easy to save</td>
<td>Farmers cannot produce hybrids; more disease accompanies new varieties due to high plant population and fertilizers.</td>
<td>Farmers cannot produce hybrids, better genetic resistance and more processing facilities</td>
</tr>
<tr>
<td>Information about new varieties</td>
<td>Other farmers</td>
<td>Extension</td>
<td>Other farmers; extension; private advertising</td>
<td>Extension provides consumer information, advertising</td>
</tr>
<tr>
<td>Transportation and communication</td>
<td>Poor transportation</td>
<td>Poor transportation</td>
<td>Improved transportation</td>
<td>Developed transportation</td>
</tr>
<tr>
<td>Seed Prices</td>
<td>Not applicable</td>
<td>Close to grain prices</td>
<td>Private hybrids have higher prices</td>
<td>Private hybrids have high prices</td>
</tr>
<tr>
<td>Overall agricultural policy</td>
<td>Agriculture taxed</td>
<td>Agriculture taxed</td>
<td>Transitional stage</td>
<td>Subsidized agriculture</td>
</tr>
</tbody>
</table>

Annex 8. Some Technical Aspects of Seed Systems:

TERMINOLOGY OF SEED CLASSES

The various stages of seed development have different nomenclatives under different systems. These are shown below:

<table>
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<tr>
<th>Organization for Economic Cooperation and Development (Europe)</th>
<th>Association of Official Seed Certifying Agencies (USA)</th>
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</thead>
<tbody>
<tr>
<td>(Pre-basic)</td>
<td>Breeder</td>
</tr>
<tr>
<td>Basic</td>
<td>Foundation</td>
</tr>
<tr>
<td>Certified (1st)</td>
<td>Registered</td>
</tr>
<tr>
<td>Certified (2nd)</td>
<td>Certified</td>
</tr>
<tr>
<td>Certified (3rd)</td>
<td></td>
</tr>
</tbody>
</table>

The generally accepted meanings of the various technical terms used in this paper are given here:

*/ This Annex is mostly based on Cromwell, E. et al., 1993, Appendix 1, and CTA. 1985. p. 304.
**Certification**  
A legally-sanctioned quality control system. Seed is produced under stringent quality control, whereby all stages of seed production are monitored. Seed produced (if approved) is called certified seed and is of a high quality.

**Certified seed**  
Progeny of basic seed and produced according to an officially approved and monitored certification scheme. Certified seed is intended to be used for production of further generations of certified seed or for crop production.

**Commercial seed**  
Seed produced from basic seed outside the framework of a certified scheme and used for crop production. Seed not meeting the standards of the certification scheme (if used for crop production) is also called commercial seed.

**DUS-tests**  
The tests to establish whether or not a new variety is sufficiently distinct, uniform and stable (DUS).

**Hybrid**  
A variety produced by crossing two or more inbred lines. The superior performance is usually attributed to a heterosis effect. Further multiplication of such varieties usually results in a substantial drop in crop performance.

**Improved variety**  
Variety obtained through plant breeding. The improvement is not necessarily a higher yield, but can also be improved disease resistance, better yield stability, drought tolerance, better quality, better storage, etc.

**Multiplication rate**  
The number of times seed used for growing a crop is generally multiplied. For example, if the use of 100 kg of wheat seed per hectare results in a yield of 5 tons/ha i.e. 5,000 kg/ha, the multiplication rate is 5000/100, i.e. 50. Hybrids generally have a high multiplication rate; the seed rate for hybrid maize is 25 kg/ha and under good management conditions the yield could be 5 tons, giving a multiplication rate of 200.

**Roguing**  
The act of removing undesirable individual plants from a plot of field of the variety. This technique is used in seed production to maintain the purity of the variety.
**Seed rate**

The amount of seed recommended by research to be used per unit of land, and is generally given as "x" kg per hectare. For example, the seed rate of wheat is 100 kg/ha implying that the research recommendation is that 100 kg of good quality seed should be used per hectare for raising crops.

*Self-pollinated crops* are easy to maintain because they exist naturally as pure lines and any variability which occurs, for example from mutations or mechanical contamination, is visible and can be eliminated by roguing. They require isolation only to the extent of a physical barrier to avoid confusion with adjacent crops at sowing and harvest time.

*Cross-pollinated crops* are more difficult to manage because they are intrinsically variable as they are prone to contamination by foreign pollen; so seed crops have to be isolated either by space or time from others of the same species. If contamination does occur, it is less easily detected due to the variability which already exists within the variety, which tends to increase with successive multiplications of the crop.

The traditional varieties of cross-pollinated crops are open-pollinated populations, i.e. pollination is not controlled, but the formal sector attempts to restrict variability within cross-pollinated crops by breeding composite or synthetic varieties. The ultimate solution is to produce F1 hybrids by controlled crossing of parent lines, which is a labor and management intensive activity. Hybrid seed has to be bought afresh every year but it can produce higher yield by capitalizing on hybrid vigor.

There are two aspects to seed quality, both of which are required for seed to contribute fully to crop yield. The first is its *genetic potential* (the genetic information contained within the seed itself). This is controlled by inspection in the field of the growing seed crop and removal of off-types by roguing. The second aspect is its *physiological quality*. This is controlled by sampling seed for its germination capacity, purity, health and moisture content. In formal systems, both these aspects of seed quality are assured by seed certification.
The following table gives the important biological features of major crop species.

**Table A8.1: Important Biological Features of Major Crop Species**

<table>
<thead>
<tr>
<th>Breeding system</th>
<th>Hybrid Maize</th>
<th>Open Pollinated Maize</th>
<th>Sorghum/Millet</th>
<th>Wheat</th>
<th>Rice</th>
<th>Beans</th>
<th>Groundnut</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sowing rate per ha</td>
<td>Controlled pollination</td>
<td>Cross pollination</td>
<td>Intermediate</td>
<td>Self pollination</td>
<td>Self pollination</td>
<td>Self pollination</td>
<td>Self pollination</td>
</tr>
<tr>
<td>Sowing rate per ha</td>
<td>Medium (20kg)</td>
<td>Medium (20kg)</td>
<td>Low (10kg)</td>
<td>High (100 kg)</td>
<td>High (50kg)</td>
<td>High (100 Kg)</td>
<td>High (125 Kg)</td>
</tr>
<tr>
<td>Multiplication factor</td>
<td>High (100)</td>
<td>High (100)</td>
<td>High (100)</td>
<td>Low (25)</td>
<td>Medium (50)</td>
<td>Medium (50)</td>
<td>Very low (&lt;10)</td>
</tr>
<tr>
<td>Rate of deterioration</td>
<td>Very rapid</td>
<td>Rapid</td>
<td>Medium</td>
<td>Slow</td>
<td>Slow</td>
<td>Very slow</td>
<td>Very slow</td>
</tr>
<tr>
<td>Recommended frequency of purchase</td>
<td>Annual</td>
<td>2 years</td>
<td>3 years</td>
<td>4 years</td>
<td>4 years</td>
<td>Variable</td>
<td>Variable</td>
</tr>
<tr>
<td>Availability of modern varieties</td>
<td>Many</td>
<td>Many</td>
<td>Few</td>
<td>Many</td>
<td>Many</td>
<td>Few</td>
<td>Few</td>
</tr>
<tr>
<td>Justification for purchase</td>
<td>Essential</td>
<td>Good</td>
<td>Variable</td>
<td>Poor</td>
<td>Poor</td>
<td>Poor</td>
<td>Very poor</td>
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