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# Promoting the Growth and Development of Smallholder Seed Enterprises for Food Security Crops

Case studies from Brazil, Côte d'Ivoire and India

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# Promoting the Growth and Development of Smallholder Seed Enterprises for Food Security Crops

Case studies from Brazil, Côte d'Ivoire and India

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# Contents

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# 1 Preface

Farmers everywhere depend on access to good quality seed, which is fundamental to their crop production systems. Most governments have made significant investments in strengthening national agricultural production capacities, yet farmers in developing countries still face difficulties in accessing the quality seed of the varieties that they require. Guaranteeing farmers' access to quality seed can only be achieved through a viable seed supply system that can multiply and distribute seeds which have been produced or preserved. This is better achieved by the private sector, but medium- to large-scale international seed companies concentrate on high-value crops and avoid dealing in the self-pollinating, open-pollinating and vegetatively-propagated varieties on which most smallholder farmers depend for their food security as the biology of these crops makes it easy for farmers to keep their seeds for several seasons.

However, smallholders are often seen as the driving force of economic growth, poverty reduction and food security. This is also true for smallholder seed enterprises which, in the absence of large companies, provide a valid alternative for the production and distribution of food security crops.

This paper reviews case studies on smallholder seed enterprises in Brazil, Côte d'Ivoire and India, as well as relevant world literature in order to identify key issues that facilitate or constrain the development of the seed sector. The final section provides some guidelines on policy design and implementation to promote the development of sustainable seed enterprises at different stages in the evolution of national seed sectors. It provides examples of good practices and hence seeks to assist governments in identifying ways in which they can support the development of smallholder seed enterprises that will provide the most appropriate varieties to smallholder farmers in their efforts to boost food production.

FAO recognizes the contribution of smallholder seed enterprises in addressing global challenges, such as achieving the Millennium Development Goals (MDGs), adaptation to climate change and the attainment of food and nutrition security. Sustaining the growth of smallholder seed enterprises through the promotion of public and private partnerships and capacity building is an FAO Impact Focus Area. The promotion of policy design, implementation and institution building to facilitate this growth and transition to higher stages of development is an important challenge for FAO.

# 2 Introduction

Over 90% of the crops in developing countries are still planted with farmers' varieties and farm-saved seed (Almekinders et al., 1994; Almekinders and Louwaars, 1999; Maredia et al., 1999; World Bank, 1998). As a result, large international seed companies concentrate on those countries with large commercial seed sectors, often focusing on high-value crops grown by larger farmers in more favourable areas, i.e. targeting those who are best able to pay for their seed. They tend to avoid self-pollinating crops - including many of the crops smallholder farmers grow and on which they depend for their food security - because these are the crops for which farmers save their own seeds, reducing opportunities for commercial seed production of these crops. In the past, the public sector - universities, governmental organizations and international organizations - were major sources of new varieties and quality seeds of food crops for the smallholder farming sector, especially with regards to self-pollinating crops. However, in recent years, many countries have encouraged privatization or commercialization of public-sector seed activities, while international organizations have faced budget constraints, leading to reduced investment in public-sector plant breeding and seed production enterprises. As a consequence, public-sector seed activities have tended to focus on a narrow range of crops grown by larger farmers, in this way, reducing supplies of seed of new varieties of subsistence crops to smallholder farmers even further (Bengtsson, 2007).

Nevertheless, there are a number of examples throughout the world where seeds of cultivars are supplied by successful small- to medium-scale seed enterprises or farmer organizations. Some of them may have succeeded in creating a vibrant seed business able to respond to the demand for quality seeds. Identifying these and determining the key factors leading to their success will contribute to efforts to replicate the innovations in similar areas or conditions.

This paper synthesizes the findings of case studies carried out in small-scale seed enterprises in Brazil, Côte d'Ivoire and India. This is followed by a review of literature concerning the development of such enterprises, with particular reference to developing countries, and compares the findings with those of the case studies. Finally, it draws out lessons that can be learned in an effort to support the development of small-scale seed enterprises in developing countries. The three studies cover a range of crops (soybean and maize in Brazil, rice in Côte d'Ivoire and sorghum, pearl millet and rice in India), markets (primarily smallholder subsistence farmers in Côte d'Ivoire and India, and commercial farms in Brazil) and the stages of development of the seed industry.

# 3 Case studies

## 3.1 BRAZIL

The study of seed enterprise development in Brazil focuses on soybean and maize.

There are marked differences in the stage of development of the seed sectors in the two crops. Soybean is a commercial crop grown by market-oriented farmers, with farm size ranging from 10-100 ha in the south to 500-5000 ha in central Brazil. In contrast, farmers growing non-hybrid maize are mainly small-scale subsistence-oriented producers. As a result, the nature of seed enterprises serving the two crops is quite different.

### 3.1.1 Soybean

The soybean case study looked at a private seed production enterprise (Maua Seed Company) established in Parana State (southern Brazil) in 1975 by three agronomists formerly employed by a local agricultural cooperative.

At the time the company was formed, soybean cropping was a new venture in Parana State and most of the soybean 'seed' available was actually soybean grain imported from Rio Grande do Sul processed using adapted coffee processing equipment. The quality of the seed was poor, with high levels of admixture with other varieties and contamination with weed seed. Thus, there was a growing, unmet demand for quality soybean seed, assessed by the fledgling seed company through its contacts with a local farmers' cooperative and through a team of sales agents it had established.

The company set up operations in the Maua region of Parana State. This area has an average altitude of over 1000 m, giving it the cooler temperatures needed for producing quality soybean seed. The company constructed a soybean seed processing plant using the best technology available at the time. Technical advice was provided by seed specialists from the official Parana State Agriculture R&D Institution, IAPAR.

The capital to start the company was obtained from the National Development Bank of Brazil within a framework of Government financial support to agricultural activities. The financial support for investment and business operations was offered at that time at subsidized interest rates and less strict guarantee requirements for loan approval. In this case, the bank accepted as collateral the founders' technical knowledge and skills, as demonstrated by their prior work in the community, and an industrial project plan developed in conjunction with seed specialists from IAPAR. This was crucial to the early success of the company.

Seed production started through a collaborative project with eight large-scale soybean farmers in the region. Initially, the farmers planted a total of 4000 hectares with varieties obtained under license from Embrapa. Farmers were selected on their technical abilities as well as their interest in diversifying their enterprises. The seed company assisted the farmers in obtaining loans to start up their field activities, including development of production plans (seed and fertilizer rates, pest and disease control, field operations, etc) drawn up by agronomists from Parana State institutions. State government agricultural subsidy programmes were readily available at the time. Now, however, the seed company finances most seed production operations, including the cost of storing seed from harvest in May to planting in August-October.

Farmers are paid a premium for seed lots that meet required quality standards. The company operates its own quality control system, monitoring crops in the field and through processing and storage. Farmers are paid in cash.

Over the years, the number of farmers growing seed for the company has increased. Seed production has increased from 2800 tonnes in the 1970s to about 20 000 tonnes in 2007/08. The company also expanded its marketing to neighbouring regions and States by building linkages with other cooperatives and sales agents.

Since 1999, the company has also been closely involved in a consortium between private seed companies and Embrapa Soybean through which the seed companies partly fund Embrapa's soybean breeding programme in return for exclusive rights to commercialise the resultant cultivars. As a result, consortium members captured some 45% of the soybean seed market in southern Brazil between 2000 and 2005.

From the beginning, the company developed a technical assistance network in collaboration with the local agricultural cooperative, providing solutions to the main agricultural problems facing farmers in the area. By doing so, the company helped develop local farming and enhanced returns to agriculture. This, in turn, helped build demand for the company's seed as farmers gained in financial security and became more market oriented, as well as building the company's reputation as a trusted partner.

#### *3.1.1.1 Key success factors*

##### *Conducive policy environment*

Brazil has had seed legislation in place since 1965 that defines production, processing, storing and marketing regulations, minimum quality standards and inspection and quality control responsibilities. Plant breeders' rights have been in place for more than 10 years, providing an environment conducive to investment in plant breeding and seed enterprises.

The government also provided extensive financial support for the agricultural sector in the 1970s and 1980s, which supported the development of the seed industry and commercialisation of the farming sector. The company was able to obtain funds at government subsidized interest rates to develop the necessary infrastructure as well as to cover its operating costs for the first year. Such support is vital for new enterprises. Farmer seed-growers were also able to access subsidized credit under favourable terms through government support programmes. Credit has been more difficult to obtain in recent years with declining government support in this area and this will be a constraint to further development of the seed sector and a barrier to entry of new enterprises.

##### *Demand for seed*

There is a strong demand for high-quality soybean seed. Banks require farmers to purchase certified seed as part of the conditions of loans. Moreover, farmers recognise the importance

of using high-quality seed to establish good crops; soybean seed splits easily after harvesting if not handled carefully and correctly, markedly reducing germination. Given the strong market orientation of the soybean farmers in Brazil, farmers are willing to purchase seed rather than save their own seed and have the financial resources to do so. However, seed from the informal sector (self-saved seed or pirate seed) accounts for some 40% of the seed market and this is a constraint on commercial seed production.

### *Availability of seed of improved cultivars*

The difference in the scale of farm operations for soybean has resulted in very different patterns of seed source in the two regions. In the south, where farms are smaller, the commercial seed market is dominated by seed enterprises multiplying varieties developed by EMBRAPA (45%) and cooperatives breeding and multiplying seed of their own varieties (40%), with multinational seed companies picking up the remainder of the market (15%). In the central region, where soybean farms are much larger, private seed companies meet 65% of the market, with EMBRAPA varieties meeting 20% and cooperatives 15% of the market.

The Maua company has also pursued an innovative approach in developing and commercializing new soybean cultivars, through a consortium involving private seed companies and Embrapa. This has helped ensure that cultivars developed meet farmers' needs and this has been reflected in a high market share being captured by the consortium's products.

### *Technical expertise/linkages with R&D and extension services*

The Brazilian government has long had a very strong national agricultural research and development programme through the Brazilian Agricultural Research Corporation, Embrapa, through State agricultural bodies and through universities and higher education institutes. This has provided for extensive technical expertise in agriculture, strong extension services to support new agricultural ventures such as soybean cropping, and technical assistance to, for example, seed enterprises.

The company maintained close links with national and state agricultural institutes, particularly Embrapa Soybean and IAPAR, ensuring that it had access to state-of-the-art knowledge and advice.

### *Marketing approach*

The company's approach to marketing, involving a combination of direct on-farm selling and partnerships with cooperatives and agricultural input retailers, helped build market chains for inputs and outputs. The company's sales force ensured extensive contact with farmers and cooperatives, giving the company strong insight into the needs of their client groups.

### *Capacity building*

The company adopted a policy of continual capacity building for company staff and for partners, including staff of cooperatives and farmers. This has helped ensure that participants at all levels in the market chain are well-trained and knowledgeable, able to provide a high-quality service. Moreover, it has had spin-off effects, in increasing awareness of the value of high-quality seed among client farmers, increasing demand for its product.

### *Focus on agricultural development*

The company holistic approach to agricultural development, aimed at helping farmers to improve their livelihoods, which gained strong support from the local communities and strong customer loyalty.

#### 3.1.1.2 Constraints

*High costs of seed production, processing and storage*

Producing and commercializing quality soybean seeds in tropical conditions requires heavy investment in infrastructure and high levels of technology, particularly in terms of specialized harvesting, processing and handling equipment, and drying and storage. Recent declines in government subsidies for investment in agriculture will constrain further development of the seed sector and represent a barrier to entry for prospective new enterprises.

*Competition from agricultural cooperatives*

Agricultural cooperatives have access to government subsidies not available to private companies. Moreover, they have a captive market in the form of their members.

*Informal seed market*

The informal market, particularly farmer seed-saving, accounts for some 40% of the seed market. Farmer seed-saving limits the market for seed, with farmers commonly saving their own seed for several cropping cycles before returning to the market for fresh stocks of seed. The seed industry needs to do more in terms of persuading farmers of the benefits of using quality seed rather than farm-saved seed.

### 3.1.2 Maize

Maize farming in Brazil falls into two broad groups: large-scale farms growing crops from purchased hybrid seed, and smaller, more subsistence-oriented farms (10-30 hectares) growing old, open-pollinated varieties, landraces and populations derived from seed of hybrids, mostly obtained through the informal seed sector, including farm-saved seed. The hybrid seed market is dominated by four multinational companies (Monsanto, Pioneer, Syngenta and Novartis). Breeding and production of seed of open-pollinating varieties is presently limited to a few Federal and State public universities and research institutes that concentrate their focus on disease tolerance and work independently or in partnership with the private seed enterprises or farmer communities.

The maize seed case study examined a collaborative maize seed enterprise established in 1999. The partners involved in the enterprise are an NGO (Assessoria e Serviços aos Projetos de Agricultura Alternativa - AS-APTA), the State University of Londrina (UEL) and several farmer communities from central and southern Parana State. The NGO had been working to improve the standard of living of communities in the region for more than 15 years. The Biology Department of UEL had planned to establish a maize genebank to preserve traditional landraces and to initiate a maize breeding programme aimed at supplying smallholder farmers with affordable quality maize seed.

Following consultations with farmer communities in central-southern Parana State, the partners agreed to start a programme that had three main goals: 1) to preserve maize landrace varieties by assembling a genebank at UEL; 2) to begin a participatory breeding programme, as a means of providing the communities with quality maize seeds and improving the technical level of their crops; 3) to help foster the improvement of the community general education, agricultural practices and economic levels.

The programme started out working with farmers' organizations in 10 towns, representing a total of about 1500 farmers. By 2005/06 the programme had expanded to include some 4000 farmers from 22 towns. Each farmer organization elected two to four representatives to participate in 'forums' to plan activities, set targets and monitor implementation. The forums met every 6 months.

An initial work programme was developed in consultation with community leaders. The programme provided well-defined objectives and targets for each year, which included genetic gains from population breeding and multiplication and availability of seeds for sale or distribution.

Because the participating farmers lacked funds, forum activities were funded by the NGO, largely with support from foreign donors. UEL provided technical expertise to the programme and some investment in equipment for the breeding programme.

Farmers individually sought bank loans to fund their breeding and seed production activities. Funds were available through the government sponsored "National Program of Financial Support to Family Agriculture - Pronaf". The NGO supported these applications by providing technical plans required by banks for loan approval.

Convincing the participating farmers to obtain bank loans at their own risk was a difficult step since several farmers had previously experienced crop failures and financial losses, mostly due to poor technical support from State official extension services.

Seed is produced of promising lines developed by the maize breeding programme. Seed is sold through local agricultural retailers and at local community fairs. It is sold in unmarked bags, as the seed does not meet legal requirements for selling on the formal market, which requires variety propriety documentation and production field registration and inspection by the regulating authorities. The legal procedures are still deemed too expensive for the farmers involved in the enterprise to comply with.

The programme obtained funding from Pronaf to develop basic seed drying facilities and low-cost short-term storage on farms to improve the farmers' seed enterprises. It also has plans for future investments to further improve storage conditions and quality control of the produced maize seeds through the use of better receiving, drying, processing, classification and testing (including germination and vigour testing) by submission of a project of a industrial seed processing plant and quality control laboratory to governmental institutions for financing.

Community participation is a major feature of this programme, and a cornerstone of its achievements. The involvement of the communities in all aspects of the programme, from conceptualization through to planning and delivery of the work programme, raised the perception among community leaders that the technology available from the public institutions, UEL and IAPAR could help improve farmers' cropping techniques and consequently their economic returns and living standards.

UEL staff have recently started a similar programme with family farmer communities located in northern Parana.

#### *3.1.2.1 Key success factors*

*Conducive policy environment*

As already discussed under the soybean case study, Brazil has long had seed legislation and plant breeders' rights in place, providing an environment conducive to investment in plant breeding and seed enterprises.

*Availability of credit*

The government has provided subsidized loans under favourable terms, which contributed to the success of the programme, allowing resource-poor farmers to purchase the inputs and equipment needed to engage in seed production. However, credit has been more difficult to obtain in recent years with declining government support in this area. This has hampered seed production, but has also limited demand for seed itself, making development of seed enterprise less financially viable.

*Technical expertise/linkages with R&D and extension services*

The programme benefits from skilled, knowledgeable and dedicated staff of the NGO and the university, and from links with the State agricultural R&D institute (IAPAR).

*Community participation*

Inclusion and real participation of the communities in the work was a necessary step to ensure the communities' real interests were taken into consideration. It was also necessary

to overcome the communities' general distrust of governmental programmes, which had often failed in the past and caused financial losses and sometimes even rural exodus. The participatory approach has shown clear benefits to the uptake of improved technologies, as well as increasing general awareness among farmers of the value of the technology available from the participating institutes.

*Capacity building*

UEL, IAPAR and AS-APTA maintain a training programme on techniques for maize cropping and seed production including harvesting, drying and seed storage, which ensures that participating farmers are able to gain full benefit from the breeding programme.

*Focus on agricultural development*

As with the soybean seed enterprise, the maize programme focused on supporting broad-based agricultural development, not just seed production, with extensive farmer involvement and demonstration of new techniques and approaches.

#### *3.1.2.2 Constraints*

*High cost of complying with legal requirements for seed marketing*

The resource-poor farmers involved in the programme cannot afford the cost of complying with seed certification regulations, both from their operational costs and the costs that would have to be passed on to their customers (other resource-poor farmers).

*Ongoing dependency on NGO and university support*

The programme is still dependent on support and intervention from the NGO (with donor funding) and the University, and hence is not self-sustaining. This reflects the low income from seed production activities under this model.

*Difficulty obtaining subsidized loans*

Credit has been more difficult to obtain in recent years with declining government support in this area. This is restricting further development of the seed enterprise and restricted demand for seed.

## 3.2 CÔTE D'IVOIRE

The case study in Côte d'Ivoire focused on the rice seed sector, and examined the operations of three farmer cooperatives involved in seed production and marketing.

Rice is the major subsistence crop in Côte d'Ivoire, but only about 10% of the crop is planted to improved cultivars. The main reasons cited for this are: lack of a seed policy; dominance of farm-saved seeds; lack of information about farmers' seed needs; lack of linkages between the different stakeholders in the seed sector; lack of seed production approaches adapted to the needs of smallholder farmers.

Farm sizes are small, averaging 0.8 hectares in rainfed systems and 0.3 hectares in irrigated areas. Yields are generally low because of the prevalence of traditional cropping systems, the preponderance of rainfed cropping and the low levels of use of both improved seed and other inputs.

Production of rice seed in Côte d'Ivoire started in the 1960s with multiplication and distribution of varieties bred by government institutes or introduced from other countries. During the 1970s the government established a seed certification laboratory, a foundation seed farm, introduced a seed multiplication agreement with farmers with a multiplication premium, and established three seed processing and storage centres. Seeds were distributed to farmers free of charge.

In 1985 the government established the Plants and Seeds Office to manage the seed production, processing and marketing. Seeds continued to be distributed free of charge.

A national decree on plant varieties Release and protection, and seed production and distribution was promulgated in 1992 and a national seed plan and technical regulations for certified seeds were developed. However, the national seed plan has yet to be approved or implemented, leaving a policy vacuum.

The government adopted a policy of privatization of seed production in 1989 and seeds were no longer distributed free of charge. The Commonwealth Development Corporation was in charge of managing a seed processing and storage unit until 1994, when it withdrew following several years of losses.

This 'history' is similar to that in other West African countries, including Ghana (Lyon and Afikorah-Danquah, 1998).

Seed production has since declined, as have average crop yields as farmers have reverted to saving their own seeds or buying uncertified seeds on local markets.

The National Rice Programme (PNR) produces first and second generation seed from parental material bred by the national agricultural research centre (CNRA) and the Africa Rice Center (WARDA). Seeds are certified by the National Laboratory for Agricultural Services Support (LANADA). The National Agency for Support to Rural Development (ANADER) ensures the dissemination of new technologies. Seed is produced commercially by a wide range of actors, including small businesses, various interest groups, associations and NGOs. Some international organizations have also initiated seed multiplication in rural areas through emergency programmes managed by NGOs. Seed is also produced at the village community level through Community Based Seed Systems (CBSS). These activities are now meant to be coordinated by the National Rice Producers' Association (ANARIZ-CI).

Under the CBSS approach, which supports informal farmer seed systems, the public sector plays a facilitation role. Key roles include producing and maintaining basic seed, certifying seed and providing information about seed and available varieties at the national level. Farmer organizations provide practical training for farmers, participate in variety testing, produce seed, provide information on varieties at the community level, monitor

and control seed quality, and disseminate seed. Farmer organizations have a lead role in developing seed enterprises and in stimulating demand for quality seed.

Cooperatives have been seen as a means of filling the gap between nascent demand for improved seed and the lack of seed provision by the public or private sector. Many development projects have supported development of farmer cooperatives producing and marketing rice seed and grain.

### 3.2.1 Seed production cooperatives in Côte d'Ivoire

The study examined three cooperatives involved in producing rice seed: The Central Region Rice farmers Cooperative (CORICENTRE), The Food Crops Production and Marketing Cooperative of Daloa (COCOPROVIDA) and the Cooperative of Food Producers and Livestock Breeders (WALESSE).

CORICENTRE arose from a development project aimed at increasing production and marketing of rice. The cooperative was established to coordinate activities by member farmers, linking production of quality-controlled seed to seed needs for rice production within the cooperative (but also selling seeds to the National Rice Programme and other farmers). The cooperative ensures members receive the seed and inputs they need to produce their crops and assists in marketing of the grain produced. The cooperative has provided extensive training in rice production and seed production for participating farmers and has coordinated participation in several seed production projects, including one supported by the European Union and FAO. Operating costs of the cooperative are meant to be covered by levies paid by members, but these are not always paid. The main strengths cited for the cooperative are the enthusiasm of the members, their experience in rice production, the availability of land, and local demand for seed.

COCOPROVIDA was set up to fight poverty by helping women in the Daloa region increase their self-reliance. About 2000 women from 58 villages are members of the cooperative. The main activities were cassava and rice production, but the cooperative later decided to produce seed of both irrigated and rainfed rice varieties. Seed for growing on was obtained from CNRA, WARDA and PNR. Seed of local varieties is also produced. In 2005/06 the cooperative sold seed to five main clients, including PNR, Caritas and FAO. Extension services and support, including training, are provided by an NGO, a voluntary agency, and several national and regional organizations that support small-scale agricultural development. The main strengths cited for the cooperative are the enthusiasm of the participating farmers, their experience in rice farming, and the availability of land to allocate to seed production.

The WALESSE cooperative was established in 2004 with assistance from an NGO and currently has some 2500 members, mostly women. Two members have been trained in seed quality control but the cooperative does not have any quality control equipment. It is planned to start seed production in 2009.

#### *3.2.1.1 Key success factors*

The importance of sustained demand for seed is evident from the experience of both CORICENTRE and COCOPROVIDA cooperatives.

CORICENTRE is an integrated rice operation, in which seed production is closely linked to grain production. Rice produced is marketed as grain or milled to add to its value. The cooperative also organizes supplies of other inputs for grain production, including fertilizer and herbicides. Thus, the operation is producing seed to meet well-established and known seed demand, but also benefits from a broader operational base, being an end-to-end market chain for rice. It represents a potentially sustainable model for the stage of development of the seed sector in Côte d'Ivoire.

COCOPROVIDA was set up to meet demand for seed from the National Rice Programme, PNR, a parastatal organization. However, with declining government support for free distribution of seed, PNR is likely to purchase less seed in future. Other major clients are organizations running emergency food operations in the country, which again is not a

long-term sustainable client base. In an effort to broaden its client base, COCOPROVIDA is participating in an internet-based seed-market information system, Cyber Semences (www.semences-ci.com). The objective of the Cyber Semences system is to promote awareness of the characteristics of rice varieties available in Côte d'Ivoire and from where seed can be sourced, putting consumers - farmers or retailers - in contact with producers. By giving participating organizations - farmer organizations or cooperatives - the opportunity to promote awareness of themselves and their activities, the system hopes to help the seed producers to build their 'brand' and a loyal client base. Web pages on varieties supplied by the organizations - both improved and traditional varieties - aim at promoting awareness of the characteristics of varieties and their benefits to farmers. Pages on seed stocks include details of prices, promoting a transparent market.

It is hoped that these models for seed enterprise development will lead to the establishment of a flourishing seed industry in Côte d'Ivoire.

#### *3.2.1.2 Constraints*

*Lack of a conducive environment*

Seed production in Côte d'Ivoire changed from government-led provision of seed free of charge to farmers to privatization and commercialization of seed production, without creation of market structures or support for creation of new seed enterprises.

*Lack of access to credit*

Smallholder farmers do not have the resources to fund seed production activities, and banks are reluctant to lend them money to pay for inputs and equipment because of the risk involved in farming.

*Inadequate seed processing and storage facilities*

None of the cooperatives had adequate seed processing and storage facilities, and the storage capacity of PNR is limited.

*Increasing cost of inputs*

Costs of fertilizers more than doubled recently, and many farmers are unable to afford the increased price. This reduces yields of both seed and grain crops, bringing into question the profitability of production.

### *Lack of mechanisation*

All farm operations in all the cooperatives are manual, greatly restricting the areas that can be planted.

### *Low seed price*

The price that smallholder farmers are willing and able to pay is low, which provides little incentive for seed production enterprises.

## 3.3 INDIA

The seed industry in India evolved from a single parastatal company, to decentralized state or provincial parastatals, to a mixed private-public system, where the public sector supplies predominantly self-pollinated varieties (SPVs), and the private sector supplies hybrids and specialized varieties. In addition to the state seed corporations, there are now over 500 private seed companies, 24 of them with links to multinational seed companies, and many of them with their own breeding programmes. The Indian seed industry now stretches all the way from genetic research, through varietal development, bulking up, certification, registration and production to marketing.

### 3.3.1 Seed production enterprises in India

The case study examined two enterprises involved in seed production in India: the Mulukanoor Cooperative Society, producing rice seed, and the University of Agricultural Science, Dharwad, which has focused on high-volume low-value crops such as groundnut, soybean, chickpea and wheat.

The **Mulukanoor Cooperative Society** was established in 1957 with 373 members. In 2005 it had over 6000 members from 14 villages. Almost all villagers are members. The cooperative produces eight rice varieties for both grain and seed. It started producing seed in 1991, producing over 750 tonnes of seed in that year. By 2005 seed production had grown to over 8000 tonnes. The cooperative provides all the necessary inputs to the growers, including seed, fertilizer, credit and farm implements. Three agricultural officers employed by the cooperative monitor seed crops in the field to ensure they meet quality standards. They have also trained a number of farmers in quality control and monitoring. The cooperative buys back all seed produced, after deducting the cost of inputs and credit advanced to the grower. Seed is processed in the cooperative's own seed processing facilities and is then sold on to private seed companies operating in Andhra Pradesh, Karnataka and Maharashtra states, as well as to some public sector organizations.

The **University of Agricultural Science, Dharwad** (UAS-Dharwad) produces seed on 12 research stations, providing all the infrastructure facilities for seed production, processing and storage, as well as contracting seed production and distribution through 'seed villages'. It has combined promotion of improved varieties with demonstration of other technologies, including integrated nutrient management and integrated pest management, with the aim of improving the agricultural systems of smallholder farmers. The University employs graduates and post-graduate students to supervise seed production in the villages, ensuring the quality of the seed produced. After one year the students are encouraged to develop their own seed enterprises or seek employment in the public or private seed sectors. Training is offered to farmers in seed production and farmers field days are used to promote awareness of improved varieties and production practices. The University buys back all seed that meets quality standards and sells it on through public and private seed enterprises.

#### *3.3.1.1 Key success factors*

*Conducive policy environment*

National seed policy in India promotes seed trade, provides incentives for private sector plant breeding and strong support for public sector institutes, and sets standards for seed production, quality assurance, distribution and marketing, and supports development of seed industry infrastructure, inter alia. Intellectual property rights provide a balance between protecting the interests of conventional plant breeders and the rights of farmers to save their own seed and to register their varieties.

*Availability of credit*

India's national seed policy provides for many subsidies for seed-sector development. Financial support for agricultural development is also available through the National Bank for Agriculture and Rural Development, as well as from commercial and cooperative banks. The Mulukanoor Cooperative also provides credit to members to help them obtain the inputs and equipment needed to produce quality seeds.

*Guaranteed market for seed*

Farmers contracted to grow seed are guaranteed a market for their produce, as long as it meets quality standards.

*Quality control*

Seed quality is ensured through careful monitoring by qualified staff, and through training of farmers in quality control and monitoring.

*Infrastructure*

In both cases examined, the seed enterprise had established its own seed processing and storage facilities, providing an important service to growers and ensuring the delivery of quality seed.

*Availability of seed of improved cultivars*

Seed of improved varieties is readily available for multiplication from both public sector organizations and private sector breeders.

*Capacity building*

Emphasis on continual capacity building ensures that people involved in the seed enterprises have the necessary skills to ensure efficient operations and production of quality seed.

*Marketing approach*

Input and output market channels are well-developed, in both the public and private sectors, and include cooperatives, farmer organizations, state and national agricultural and development agencies, local and regional farmers' markets, seed traders and retail outlets, as well as seed companies.

*Focus on agricultural development*

Both enterprises examined emphasised efforts to promote awareness of both improved varieties and improved cultural practices, encouraging uptake of both.

## 3.4 SUMMARY OF CASE STUDIES - COMMON FACTORS INFLUENCING DEVELOPMENT OF SMALL-SCALE SEED ENTERPRISES

The three country case studies demonstrated a number of common factors contributing to or constraining the success of small-scale seed enterprises:

| Factor | Brazil - soybean | Brazil - maize | Côte d'Ivoire | India |
|---|---|---|---|---|
| Conducive policy environment | + | + | - | + |
| Demand for seed | + | + | + | + |
| Availability of seed of improved cultivars | + | + | + | + |
| Availability of credit | + | + | - | + |
| Technical expertise | + | + | + | + |
| Linkages with R&D and extension services | + | + | | |
| Community participation | + | - | + | - |
| Marketing/market chain | + | - | + | + |
| Capacity building | + | + | | + |
| Broad-based agricultural development | + | + | | + |
| High cost of complying with seed certification regulation | - | - | - | - |
| High cost of storage or lack of storage | - | | - | - |
| Informal seed market | - | - | - | - |
| Increasing cost of inputs | - | - | - | - |

# 4 Case studies in context

The case studies presented above represent a considerable range of experiences, in terms of the type of enterprise described and the stage of development of the seed sectors in the various countries and for the different crops covered.

Many authors have described 'life-cycles', or growth stages, for the development of national seed industries (e.g. Pray and Ramaswami, 1991; Morris et al., 1998; Maredia et al., 1999; Tripp, 2003). These commonly describe four stages of development (Kosarek et al., 1999):

**Pre-industrial stage**: subsistence agriculture, traditional varieties or landraces grown from farm-saved seed or seed obtained through exchange with other farmers. Varietal improvement is in the hands of farmers. Information about varieties is obtained through direct observation or personal contact with those growing them. No formal varietal registration or quality control standards. No seed legislation, seed policies or intellectual property laws applying to seed.

**Emergence stage**: Farming is still primarily subsistence, but surpluses may be sold on fledgling markets. Some farmers adopt improved open-pollinated varieties, fewer still experiment with hybrids. Public sector organizations begin plant breeding and producing seed. Most seed is still farm-saved, but increasing numbers of farmers buy commercial seed. Public extension services play a key role in informing farmers of characteristics and benefits of new varieties and connecting farmers with sources of seed. Legal framework for control of seed industry begins to take shape, often by adopting standards from more developed countries and international organizations, but need for IPRs is still weak, as primary source of seed is still public sector.

**Expansion stage**: Increasingly commercial crop production, with more of the crop sold rather than for home consumption. Many farmers have adopted hybrid seeds of major crops, with very little farm-saved seed of these crops. OPVs still dominate less commercial crops and 'orphan' crops, and farm-saved seed continues to dominate in this sector. Private sector becomes involved in plant breeding and seed production, and increasingly involved in providing technical information and 'extension'. Quality control strengthens, but plant variety protection is still weak.

**Maturity stage**: Agriculture is largely commercial, with hybrids dominating in high-value crops. Most farmers purchase seed annually. Plant breeding increasingly in the private sector, although low-value, high-volume OPVs are still largely the domain of public sector breeding and small- to medium-scale seed enterprises. Seed production is entirely in the private sector, and the private sector is increasingly the source of technical information for farmers. Quality control standards are strongly enforced, and plant variety protection is in place and effectively implemented.

The rice seed system described for Côte d'Ivoire falls within the Emergence stage, while the maize seed industry in Brazil appears to be transitional between Emergence and Expansion. The India case study and soybean case in Brazil represent a mature seed sector.

# 5 Key factors influencing development of small-scale seed enterprises

The following section highlights some of the literature dealing with small-scale seed enterprise development, reinforcing the key lessons learned from the three country case studies.

## 5.1 CONDUCIVE POLICY ENVIRONMENT

Many studies, including the current case studies, have demonstrated that seed enterprises cannot develop in the absence of comprehensive national seed policies. Scowcroft and Polak Scowcroft (1998) provide a clear description of the key elements of a national seed policy to guide the development of a country's seed sector, stressing the role of this national policy in providing a framework for the rational development of the seed sector. These include:

- Plant improvement and variety development
- Variety evaluation, registration and release
- Plant variety rights
- Seed certification
- Production, storage and marketing
- Strengthening seed supply systems
- Farm and community seed production
- Developing capacity in seed multiplication
- Establish sensible seed quality protocols
- Promotion of production and marketing of high-quality seed
- These are discussed in more detail below.

The policy environment must be supportive of the nature and scale of seed enterprise planned. This ranges from recognition of farmers' privilege (the right to save, exchange and sell seed even of commercial varieties) for small-scale, farmer-based seed enterprises through support for privatization and commercialization of agricultural services. Examples of successful privatization of the seed sector in developing countries commonly highlight the involvement of NGOs, CSOs, international organizations or donors in supporting the fledgling private sector enterprises (Lyon and Afikorah-Danquah, 1998; Bengtsson, 2007). This was particularly the case in the Côte d'Ivoire case study.

As found in all three case studies, there is often a need for continued state involvement in ensuring access to credit facilities for farmers and agricultural entrepreneurs, in providing extension and advisory services to both farmers and entrepreneurs, and in setting and monitoring seed quality standards (Jaffee and Srivastava, 1994; Lyon and Afikorah-Danquah, 1998; World Bank, 1998; Maredia et al., 1999; Kugbei et al., 2001; Kugbei and Zewdie Bishaw, 2002).

The objective of the policy environment should be to promote the development of diverse sources of supply of seed through encouraging a variety of different types of enterprise to participate in delivering the seed farmers need (World Bank, 1998, Kugbei and Zewdie Bishaw, 2002; Louwaars, 2009). However, very few countries have policies that support

farmer seed systems, which hampers the operation of these systems (Louwaars, 2009). The exception among the three case studies is that of India, which has in place policies that support farmer seed systems.

Plant breeders' rights, for example, are important to private-sector involvement in breeding open-pollinating/self-pollinating crops (Manap et al., 2007; World Bank, 2006; Gerpacio, 2003; Loch and Boyce, 2003; Lyon and Afikorah-Danquah, 1998; Jaffee and Srivastava, 1994; Tripp, 1993; Pray and Ramaswami, 1991). Indeed, multinational companies commonly require that IPRs be in place as a precondition of their investment in research and development activities. Many authors recommend implementing plant breeders' rights consistent with UPOV 1978 or 1991 (e.g. World Bank, 1998; Louwaars, 2009).

The policy environment needs to be adapted to the stage of development of the seed sector and even to different crops within the seed sector. Rigid application of seed regulations can hamper the development of seed enterprises, as shown in Ethiopia (McGuire, 2005). Certification of seed is valuable, ensuring that seed is of a specified variety and meets quality standards (Tripp, 2003), but excessively strict certification schemes can constrain development of the seed sector (Maredia et al., 1999; Kugbei and Zewdie Bishaw, 2002; Loch and Boyce, 2003; David, 2004; Minot, 2008; Smale et al., 2009b), as was noted in the case of maize in the Brazil case study. FAO's 'Quality Declared Seed' approach is one possible viable alternative to more restrictive, formal quality control policies (FAO, 2006). India allows seed to be marketed as 'truthfully labelled', a form of self-certification (Smale et al., 2009a; Tripp, 2003). Smale et al. (2009b) recommend that government legislation allow production and sale of "truthfully-labeled and quality-declared seed in village markets" to increase the supply of well-adapted varieties from either the formal or informal seed sector, as do Loch and Boyce (2003). The World Bank (1998) and Tripp (2006) recommend voluntary seed certification based on government-set certification standards, with the public sector helping to develop the certification and seed testing capabilities of seed enterprises.

Varietal registration is similar area. Registration or approval of new varieties helps ensure that varieties introduced to the market are useful and distinct from each other, and helps overcome problems of the same variety being known by different names - or the opposite case, whereby many different varieties are known by the same name (Tripp, 2003). However, compulsory registration of varieties slows introduction of new varieties and restricts market access for landraces and farmer-developed varieties. The World Bank (1998) recommends allowing breeders to introduce new varieties to the market without formal registration during the early stages of development of a country's seed industry, while Tripp (2006) recommends simplifying variety registration.

Tripp (2003) recommends reducing the emphasis on 'upstream' regulation - seed certification and variety registration - and allocating more resources to increasing the quality-control capacities of seed producers and helping farmers recognise the varieties that best meet their needs and to appreciate the value of quality seed. He states that "Regulation should be seen as a set of policies that encourage the evolution of a diverse collection of seed enterprises rather than as an institution whose purpose is to limit access to seed market participation" (Tripp, 2003).

## 5.2 DEMAND

First issue for development of seed enterprises - is there a demand that will ensure the long-term commercial survival of the enterprise? This will occur only where farmers are selling a significant proportion of their output, and hence generating the cash income needed to purchase inputs on a formal market. Even in this case, commercial seed production is viable only if purchased seed offers farmers real benefits over saving their own seed (Maredia et al., 1999; Tripp, 2006). This is likely to occur where seed of a particular crop is difficult to save on-farm, for hybrids, or where premiums are paid for particular varieties, such as in the case for rice in Andhra Pradesh, India (Tripp, 2003; Tripp and Pal, 2001). The importance of sustained demand was evident in the case studies of soybean in Brazil and both case studies in India. The weakness of demand for seed was highlighted as a constraint in the Côte d'Ivoire case study.

In many cases, development of hybrid varieties has been the stimulus for the development of commercial seed enterprises (Jaffee and Srivastava, 1994), with hybrid maize in the USA and many other countries, and hybrid sorghum and pearl millet in India (Pray et al., 1991). Vegetable seed has commonly been an early feature of formal seed systems. In many cases, producing seed of vegetable crops requires growing the plants beyond the stage at which they are normally harvested for human consumption, which complicates on-farm production of seed. This provides an entry-point for specialist seed producers. The same is true for forage crops that are usually harvested before they produce seed (Fowler, 1994). Once producing seed of high-value crops, it is relatively straightforward for a seed enterprise to expand into other crops, even those that are less profitable, as the enterprise has already developed its skill and resource base. However, there is a growing recognition that the private sector is unlikely to be able to meet the needs of all farmers or provide seed of all crops in the near future, if at all (Louwaars, 2009).

In subsistence-oriented agricultural systems farmers tend to use farm-saved seed for self-pollinating crops, rarely purchasing seed. This was noted as a particular constraint for soybean in the Brazil case study, but was recognized as a feature of seed systems in all three country case studies. Even if farmers do purchase seed of a new variety that meets their needs, they then start keeping their own seed, leading to few repeat purchases. Major efforts will be needed to raise the awareness of farmers of the benefits of using high-quality seed (Maredia et al., 1999; Kugbei and Zewdie Bishaw, 2002; David, 2004; RIU, n.d.). This was mentioned as a key requirement for the development of successful seed enterprises in all three country case studies.

For seed enterprises to be successful in these circumstances, there is a need to have a steady stream of new varieties coming on the market, either through conventional breeding programmes or through participatory approaches. However, it is questionable whether this can support development of a sustainable seed enterprise (Tripp, 2003; Tripp, 2006). Alternatively, seed enterprises must diversify, producing seed of a wide range of crops or providing other inputs and services to fund their activities (Kugbei and Zewdie Bishaw, 2002). This was highlighted as important in the case studies of seed enterprises based on farmers' cooperatives in both Côte d'Ivoire and India.

Where the seed sector is at the 'pre-industrial' stage of development, a better approach may be to strengthen local seed systems, particularly through promoting awareness of new varieties, linking farmer seed producers with sources of seed of improved varieties, making seed available through extension agents and key farmers, and supporting appropriate systems for marketing farmer-produced seed (Bengtsson, 2007; Ndjeunga et al., 2006; Tripp, 2006;

McGuire, 2005; Tripp, 2003; Tripp and Rohrbach, 2001; Bay, 1998; World Bank, 1998; Jaffee and Srivastava, 1994). This will encourage the uptake of improved varieties and provide the foundation for future demand. Many different approaches have been tried to improve farmers' awareness of the value of improved varieties and their availability, including farmer participatory assessment trials, farmers' field days, diversity fairs and even mass media campaigns (Smale et al., 2009b; Rubyogo et al., 2007; Nagarajan et al., 2007; McGuire, 2005; Thiele, 1999; Pray and Ramaswami, 1991).

### 5.2.1 Seed quality

Seed quality was mentioned as a key consideration in all country case studies, and quality control was given as a key success factor in the India case study. Seed quality is a major determinant of seed acquisition behaviour (Zewdie Bishaw and van Gastel, 2008), but is difficult for farmers to determine until the seed has been planted and is growing in their field (Minot, 2008). Thus it is vital that quality standards and control are implemented in seed enterprises to ensure they meet farmers' demands. It is also essential that these are relevant to farmers' concerns and communicated to them (Tripp, 2003).

There are strong arguments for a continuing role for governments in setting and monitoring seed quality standards (Lyon and Afikorah-Danquah, 1998; World Bank, 1998; Kugbei et al., 2001; Minot, 2008), but implementation can increasingly be shared with seed producers themselves (Tripp and Louwaars, 1997). This implies a need for government investment in training in seed quality control and monitoring, as well as capacity to oversee and enforce standards.

Excessively strict seed quality controls hamper the diffusion of new varieties to farmers. Small-scale, local seed enterprises need the freedom to operate without having to comply with the regulatory and quality assurance requirements of the formal seed sector (David, 2004; Zewdie Bishaw and van Gastel, 2008).

### 5.2.2 Price

Price is a major determinant of demand, and resource-poor farmers are unable to pay high prices for seed. This was mentioned as a particular constraint in the Côte d'Ivoire case study. The high costs of seed production, processing and storage were mentioned as constraints in the Brazil soybean case study, while the high costs of complying with seed certification requirements were mentioned as a constraint to maize seed enterprise development in Brazil. The informal sector can adopt simplified quality control schemes and standards that are relevant to small-scale farmers, reducing costs of operation (Thiele, 1999).

Generally, prices paid for seed in informal seed markets are only slightly higher than those paid for grain of the same crop (Smale et al., 2009a; Bengtsson, 2007; McGuire, 2004). Some authors assert that only small enterprises with low overheads can produce good-quality seed at a price that smallholder farmers can afford (e.g. Kugbei and Zewdie Bishaw, 2002).

### 5.2.3 Markets and market information

#### *5.2.3.1 Markets*

Development of markets for smallholders' produce is possibly the single most effective measure that can be taken to stimulate development of seed enterprises (Tripp, 2006). Without markets for their produce, farmers will not be able to purchase inputs such as seed and fertilizers and hence will not provide a market for seed enterprises' produce. The importance of market-oriented production was evident in the success of the soybean and maize seed enterprises studied in Brazil and of both systems studied in India. The lack of such markets was seen as a constraint in Côte d'Ivoire.

Market chains will need to be identified and developed, depending on the scale of operations, and marketing approaches developed and implemented. Networks of stockists may be needed to ensure seeds reach farmers, but these are commonly lacking for self-pollinated or open-pollinated crops (Tripp, 2006). In Niger, poor integration of input and

output markets was shown to contribute to the limited uptake of improved varieties of pearl millet and groundnut, while the well-integrated input-output markets for groundnut in Senegal contributed to uptake of improved seed (Ndjeunga et al., 2006).

Governments may need to provide incentives to encourage development of seed marketing channels in less-favourable areas (Tripp and Rohrbach, 2001). Inadequacies of marketing skills and infrastructure are primary constraints to seed enterprise development in many countries (Tripp, 2006; Trejo Hernández et al., 2004).

Seed enterprises need to pursue a range of marketing approaches, from on-farm demonstrations and farmer field days at the local level and provision of small packets of seed, through to networks of agents in large-scale operations. Many of these market chains will involve linkages with operations providing inputs and outlets for both seed and food products. This is well illustrated by the case studies. For example, the marketing channels used for soybean in Brazil, employed a mixture of direct marketing to farmers combined with partnerships with cooperatives and agricultural input retailers to build marketing chains and extend the company's markets.

Emergency seed distribution during times of crisis, such as droughts or displacement of people, funded by governments or donors, has often harmed fledgling seed enterprise development. The seed distributed is often of varieties that do not meet local conditions or farmers needs, and is commonly of poor quality (Tripp and Rohrbach, 2001). This tends to discredit the formal seed sector in farmers' eyes, making them even more reluctant to obtain seed from such sources in future (Tripp, 2003).

Free distribution of seed is a constraint to the development of commercial seed enterprises and should be avoided as much as possible (Bey, 1998; Tripp and Rohrbach, 2001; Tripp, 2003; World Bank, 1998; Nagarajan et al., 2007). It also discourages the development of wholesale and retail marketing channels for seed (Tripp and Rohrbach, 2001). This was apparent from the Côte d'Ivoire case study, and discussed in the India case study as a feature of the earlier stages of development of the seed industry in India.

Development of marketing skills among farmers and others involved in seed enterprises has also been identified as a key need for supporting sustainable seed enterprises (RIU, n.d.).

#### *5.2.3.2 Market information*

Information is crucial to efficient functioning of seed systems (Jaffee and Srivastava, 1994; Lyon, 1999; Tripp and Pal, 2000; Tripp and Pal, 2001; Amegbeto and van Gastel, 2005). Plant breeders need to know what it is that farmers want. Seed enterprises need to be able to assess accurately likely demand for seed. Farmers need to be able to find information about varieties that meet their needs and from where they can obtain them, on quality of different sources, and on technical issues such as fertilizer requirements and other agronomic factors (Maredia et al., 1999; Tripp and Pal, 2001; Tripp and Rohrbach, 2001; Tripp, 2003; Smale et al., 2009a; RIU, n.d.). Market traders are key sources of both information and seed in many remote areas (e.g. Nagarajan et al., 2006 for India) and need to be linked with seed sources and information providers (Smale et al., 2009b). Lack of information and poor extension services are noted by many authors as constraining uptake of improved varieties in developing countries (e.g. Rusike et al., 1997; Bay, 1998) and was specifically mentioned as a constraint in the Côte d'Ivoire case study.

### 5.3 AVAILABILITY OF IMPROVED VARIETIES AND SEED

Many authors have referred to demand and availability of seed as 'chicken and egg' - demand will not grow in the absence of available improved seed, but efforts to develop improved varieties depend on demand for the finished product.

Availability of improved varieties from public sector breeding programmes was mentioned as a key success factor in the Brazil and India case studies. It is apparent from the Côte d'Ivoire case study that weaknesses in availability of seed from the public sector constrains uptake of improved varieties. It is common for small- and even medium-scale enterprises to depend on the public sector - government institutes and universities - for new

varieties and even source seed, and continuing public sector investment in these activities may be required for self-pollinated crops, at least in early phases of development of the seed sector (Pray and Ramaswami, 1991; Jaffee and Srivastava, 1994; Tripp and Rohrbach, 2001; Kugbei and Zewdie Bishaw, 2002; Tripp, 2006; Smale et al., 2009b).

Private-sector breeding tends to be a feature of more mature seed industries and large-scale seed enterprises.

An efficient system of distributing source seed is also essential - those wanting to commercialize varieties must be able to readily access sufficient quantities of source seed for growing on. Inadequate production of source seed by public institutions has been shown to be a constraint to diffusion of new varieties in sub-Saharan Africa (Tripp, 2000; Tripp, 2006).

Increasingly, participatory breeding and on-farm testing programmes are being recommended as mechanisms of generating new varieties of low-value crops and encouraging their adoption by smallholder farmers (Witcombe et al., 1999; Rubyogo et al., 2007; Diakité et al., 2008; Minot, 2008; Smale et al., 2009b). This approach is illustrated in the case study on maize in Brazil. However, the possibility of commercialising farmer-bred varieties depends on the policy environment. Seed policy in Vietnam, for example, does not provide for registration of farmer-bred varieties (Anon, 2007), whereas the seed policy in Nepal was changed recently to facilitate registration of farmer varieties (Halewood et al., 2007).

### 5.4 ENTREPRENEURSHIP, TECHNICAL SKILLS AND CAPACITY BUILDING

Producing quality seed requires a range of skills at various levels, from planning and management of seed production through skilled farm operations. This requires cadres of skilled, knowledgeable people at all levels of the seed 'chain', which requires training at all levels, from farmer to PhD scientist (Kugbei and Zewdie Bishaw, 2002). Technical support for seed production from extension services is essential during early stages of development of seed enterprises (David, 2004; Amegbeto and van Gastel, 2005) and in less favoured areas (Gerpacio, 2003).

All of the case studies examined contributed to developing farmers' skills in seed production and post-harvest handling and quality control, and on general skills in improving agricultural production. Improving farmers' skills and knowledge in seed storage, seed quality management and accessing new varieties could do much to enhance uptake and spread of new varieties and improved practices (Maredia et al., 1999; David, 2004; McGuire, 2005; Rubyogo et al., 2007; Zewdie Bishaw and van Gastel, 2008).

Seed enterprises have commonly been started by farmers, merchants and agricultural scientists, although farm cooperatives have played a considerable role in some countries (Tripp, 2003). In recent years NGOs have also put considerable efforts into developing local seed production projects (Bengtsson, 2007). However, RIU (n.d.) notes that seed production should be viewed as a business rather than a technical or development activity if it is to succeed, highlighting the need for business and entrepreneurial skills from the outset, and not just technical skills.

The Brazil soybean case study provides an example of a seed enterprise established by agricultural scientists, in this case agronomists formerly employed by an agricultural cooperative. Similarly the Brazil maize case study involves agricultural scientists from a university providing the technical backstopping for a new seed enterprise, with management skills and training being provided initially by an NGO. One of the case studies from India involves a seed enterprise established by a university department, building on its research and training facilities. However, agricultural scientists do not necessarily have the business skills needed to set up an run commercial enterprises, and business support may be necessary (David, 2004).

However, it should be noted that public seed production and distribution are often expensive and ineffective because parastatal seed organizations commonly produce a narrow range of varieties that do not match farmers' needs and are of variable quality, harming farmers' trust in the seed system (Maredia et al., 1999). This has been demonstrated in the

case of maize in Ghana, where only three varieties developed by the national agricultural research system over the past 25 years have been adopted by farmers (Derwisch et al., 2008), and was mentioned as a constraint in the Côte d'Ivoire case study.

The Côte d'Ivoire case studies are all examples of cooperatives providing the basis for seed enterprises, albeit in these cases arising out of development projects or stimulated by NGOs and other outside organizations. Similarly, the India case studies involve one seed enterprise that grew out of a farmers' cooperative that initially focused on producing rice grain as a means of diversifying income generation options. Tripp (2003) notes that most successful seed enterprises developed by cooperatives were based on cooperatives established for other purposes, such as input or output trading. There are almost no cases of successful, sustainable community-based seed enterprises that have been set up with outside support from NGOs or donors where these are not linked to previous commercial enterprises (Nagaraja et al., 2007; Tripp, 2003). Zewdie Bishaw and van Gastel (2008) stress the need for village-based seed enterprises to be based on marketing and profitability to ensure sustainability.

There are other instances of seed enterprises in India, Kenya and Uganda, among others, that have been started by traders in agricultural inputs and outputs that expanded into seed production (Tripp, 2003). Similar examples are found throughout the developing world. In the USA, grain traders have also expanded into seed production.

### 5.5 ACCESS TO CREDIT

Availability of credit, particularly at government-subsidized rates of interest, was mentioned as a key success factor in the Brazil and India case studies, while lack of credit was mentioned as a key constraint to seed enterprise development in Côte d'Ivoire.

Access to credit is vital to the development of seed enterprises, especially small-scale enterprises, for purchase of inputs, field equipment and seed-handling equipment (RIU, n.d.). Dealers also need access to credit to finance purchase of seeds, especially until they have generated sufficient profits to finance their own operations (Lyon and Afikorah-Danquah, 1998).

### 5.6 ENTERPRISE OWNERSHIP AND PROFITABILITY

Seed enterprises must be based on local ownership and profitability (in either monetary terms or by other socio-economic measure) if they are to develop and grow sustainably (Zewdie Bishaw and van Gastel, 2008). This was the case in the case study of maize seed production in Brazil (see above).

Many small-scale seed enterprises have been developed with external support, either from donor agencies or from NGOs and the like. While these have proved successful in

delivering improved seeds to subsistence farmers and those in remote areas, this approach is not sustainable and encourages 'aid dependency' (Tripp, 2003; Tripp, 2006; Rubyogo et al., 2007; Zewdie Bishaw and van Gastel, 2008).

### 5.7 INFRASTRUCTURE

Cost of infrastructure, particularly processing and storage facilities, was mentioned as a constraint in all country case studies, although in India policies are in place to subsidize the cost of such infrastructure

Storage facilities are a crucial element of any seed enterprise (Kugbei and Zewdie Bishaw, 2002). ICARDA recommends establishing village-level storage facilities for small-scale, farmer seed systems, rather than individual farm-level storage (Zewdie Bishaw and van Gastel, 2008).

### 5.8 LINKAGES BETWEEN FORMAL AND INFORMAL SEED SECTORS

All three country case studies demonstrate the benefits of linkages between the formal and informal seed sectors, with the seed enterprises benefitting from expertise available in public sector institutes and NGOs in particular. Small-scale enterprises would be unable to support the full range of skills and knowledge needed to function effectively.

Functional linkages between the formal and informal seed sectors improve the functioning of both and promote evolution of the seed sector (Smale et al., 2009b; Rubyogo et al., 2007; SEARICE, 2003; Tripp, 2003; World Bank, 1998; Maredia et al., 1999). The formal seed sector is the primary source of new crop varieties, and is home to most of the capacity in 'scientific' plant breeding, extension services, credit and the like. The informal sector is the primary link to farmers' and traditional knowledge, especially requirements for new varieties, inputs and services.

# 6 Key lessons

The stage of development of a seed sector is a primary consideration for any planned interventions. The following section describes possible interventions for each stage of the evolution of a seed sector.

## 6.1 PRE-INDUSTRIAL STAGE

At the very earliest stages, government efforts must be two-pronged:

1. Create awareness of improved agricultural practices, including the benefits of using quality seed and improved cultivars;
2. Produce and supply quality seed of the best local landraces or improved varieties that are available elsewhere and are suited to local agroclimatic conditions.

The second of these should be allied with efforts to strengthen traditional seed systems, particularly through promoting awareness of new varieties, linking farmer seed producers with sources of seed of improved varieties, making seed available through extension agents and key farmers, and supporting appropriate systems for marketing farmer-produced seed. This will contribute to increasing productivity and food security in the subsistence sector, generating surpluses for sale and encouraging a move towards more market-oriented production. Farmers should be engaged in participatory evaluation of cultivars and landraces. This will require investment in collecting and characterizing traditional landraces and potentially suitable modern cultivars, and in training for all aspects of seed production, health and storage.

These activities should be accompanied by parallel efforts to develop a national seed policy, seed plan and seed legislation to provide the framework of institutional mechanisms for seed production, quality control and trade (see section 3.1 Conducive policy environment). Countries should develop policies based on their own circumstances and interests, and avoid the common practice of 'importing' policies from developed countries. These latter policies are based on mature seed industries, including a strongly commercial agricultural sector, and are thus not necessarily suited to the circumstances of developing seed sectors.

## 6.2 EMERGENCE STAGE

During the emergence phase, the focus is on building on the foundations established during the pre-industrial phase.

Efforts to promote the demand for improved seed should include multilocation variety testing and demonstration trials, combined with continuing efforts to popularize new high-yielding varieties. Extension services should be strengthened to ensure that farmers are aware of new varieties and their characteristics. Providing seed in small packets may be used to encourage farmers to test new varieties under their own conditions. Participatory plant breeding and selection should be strengthened to improve existing local varieties.

Public sector seed production, certification and quality-control agencies as well as seed testing laboratories should be established to provide the foundations for the fledgling seed sector. This should be combined with government support for credit to establish seed processing and quality control facilities, in order to facilitate the establishment of small-scale seed enterprises.

Training should be strengthened through support to agricultural universities and public-sector research centres working on aspects of the seed sector, including plant breeding. Training should include business management for agricultural enterprises.

The above recommendations should be allied with continued efforts to strengthen informal seed systems through activities such as establishing village seed banks and provision of training on production, quality control and seed production. The policy environment

should be supportive of the informal seed sector, for example through recognition of farmer-bred varieties and seed certification models such as the FAO 'Quality Declared Seed' approach or India's 'truthfully labelled seed' policy. Plant breeders' rights may need to be introduced as a foundation for private-sector involvement in the seed sector, however, policy should provide for "farmers' privilege" - the right to save, exchange and sell seed - to support the contribution of the informal seed sector to uptake new varieties.

### 6.3 EXPANSION STAGE

The major focus of the expansion phase is to continue to build demand for seed, and to provide a policy environment that encourages private-sector involvement in seed production and marketing, in particular.

During this phase, the public sector should withdraw from activities such as seed production, quality control and certification and seed supply systems, allowing these to be taken up by the private sector. However, the public sector will still be the primary locus for breeding and improvement of open- and self-pollinated crops, even in mature seed sectors.

Governments should provide support for infrastructure development, particularly in support of marketing. Mechanisms might include either direct investment, such as in the transport network, or subsidies for private investment, particularly in seed processing and storage facilities.

Availability of credit has been shown to be a major factor in determining progress in the establishment of small-scale seed enterprises. Government policies should aim to ensure availability of credit both to seed enterprises (and contract growers) and to farmers for purchase of seed.

### 6.4 MATURITY STAGE

At the maturity stage, the focus should be on providing a policy environment that encourages a balance of public and private investments in the seed sector. IPRs will need to be provided to stimulate private-sector investment in plant breeding and extension activity. However, it must be recognised that there will be a continued need for public-sector involvement in low-value open- or self-pollinated crops which do not offer adequate returns for private sector investment.

Seed certification and variety registration policies can be applied more strictly at this stage, with many associated activities privatized, albeit with standards set and monitored by government agencies.

Governments should continue their investment in fundamental research and education, but training in technical skills for seed production and processing can be taken on increasingly by the private sector.

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