

# Seed System Innovations in the Semi-Arid Tropics of Andhra Pradesh



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Project*  
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## **Abstract**

An effective seed supply system is necessary to make good quality seed available to farmers at the right time and at low cost. Given the critical role played by improved varieties in increasing production of grain and quantity and quality of stover for livestock fodder in conventional cropping systems, agriculture decision-makers have the challenge of developing an integrated and cost-effective seed system that is capable of generating and delivering improved seed varieties to farmers. Such a system would be an important step toward ensuring seed security and enhancing livelihoods, particularly of dryland farmers.

Issues related to seed multiplication and delivery systems in India are discussed in this publication. The book outlines the development of the seed industry in India and highlights the changes made to seed policies over the years. It records the experience from an attempt to improve the local seed systems in four dryland agricultural districts that are typically representative of the semi-arid areas of Andhra Pradesh state. Using specific seed delivery models, it presents ways of strengthening seed systems to address the needs and vulnerabilities of smallholder farmers including those associated with livestock and fodder security in these areas.

This book is not an all-encompassing summary of the seed systems in Andhra Pradesh, nor does it try to provide magical solutions to constraints encountered by poor farmers. It does, however, attempt to illustrate alternative approaches to strengthen the seed systems by employing new approaches as well as implementing tested approaches in new ways constituting innovation. Given the ever rapid changes taking place in the technological, socioeconomic and policy environments, understanding some of the processes and mechanisms involved in these changes as has been presented in this document will help in continuous development of an appropriate seed system and contribute to enhancing the livelihoods of poor farmers in the semi-arid areas of India.

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# Seed System Innovations in the Semi-Arid Tropics of Andhra Pradesh

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## Foreword

The power of a seed is unlimited. As a powerful agent of change, seeds can be a means of overcoming production constraints, thereby making a difference in the lives of the poor and hungry. This requires seed demand and supply to be balanced by way of a secure seed supply system. This would give farmers access to adequate quantities of good quality seed of the desired type at the required time and at affordable cost.

Seeds are key components in the conservation and ownership of biodiversity. Accordingly, sustainable seed supply and implementation of seed security are among the major activities outlined in the Global Plan of Action for the Conservation and Sustainable Utilization of Plant Genetic Resources for Food and Agriculture. Seeds therefore represent hope for the future of mankind.

Throughout our history, farmers' informal seed systems have had a great influence on the evolution of modern agriculture, by practising conservation of agrobiodiversity at the gene, farmer and ecosystem levels. Within this framework, women in particular have played a crucial role, as has been identified by a recent analysis, in sustaining the informal seed sector, and more widely, in ensuring food security. However, informal seed systems are heavily dependent on local resources and inputs, and highly vulnerable to natural disasters and sociopolitical disruptions. Therefore, investing in a range of approaches in order to strengthen local seed systems assumes great urgency.

While the formal hybrid seed industry led by the private sector has tended to focus on profit-making species and crops, the informal sector has concentrated on crops – mainly self- or open-pollinated varieties – that are crucial to local food production systems. Given such a scenario, national seed policies concludes helping to strengthen the informal sector. International support too continues to be mainly engaged with the formal sector. Perhaps matching support is required to encourage continued development of informal seed systems.

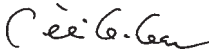
In this context, the concept of 'seed villages', which advocates self-sufficiency in production and distribution of good quality seed, is fast gaining ground. Seed villages, or village seed banks, operate under supervision and utmost transparency, inculcating mutual trust and social responsibility among farmers, thereby reducing their dependence on external inputs.

Several initiatives have been launched to revive this traditional concept, such as those initiated by the Indian Council of Agricultural Research (ICAR), the National Research Centre for Sorghum (NRCS) and state agricultural universities (SAUs). Similarly, the seed bank concept is part of ICRISAT's projects in collaboration with the Asian Development Bank (ADB), Tata-ICRISAT project in Vidisha and Guna districts of Madhya Pradesh and the Andhra Pradesh Rural Livelihoods Project (APRLP) in Kurnool district in Andhra Pradesh and other ongoing efforts in the states of Maharashtra and Karnataka.

In low-rainfall, dryland agricultural areas, cereals and legumes serve the dual purpose of providing food and income for poor farmers and fodder for their cattle. Given the critical role played by improved varieties in increasing conventional crop production, a key question arises: how do we facilitate the development of an integrated and cost-effective seed system that is capable of generating, producing and distributing improved seed varieties that meet the needs of resource-poor farmers?

This book is an attempt to review and document the existing seed multiplication and delivery systems in four dryland agricultural districts of Andhra Pradesh: Anantapur, Kurnool, Mahbubnagar and Nalgonda. While analyzing the problems associated with different seed systems in these districts, the book makes a strong case for strengthening alternative seed systems and seed delivery models that address the needs of small farmers in the context of constantly changing dynamics on the national, international, political and socioeconomic fronts.

I am sure this book will be a valuable reference source for those engaged in strengthening local seed systems as a step toward food security in the semi-arid tropics of India.

  
**William D Dar**  
Director General  
ICRISAT

# Part I: Introduction

CHAPTER 1: Preamble-The Need for Change



# The Need for Change

*A little-known, under-appreciated and pressing concern in the global supply of crop seed is a dearth of systems providing seed for crops of import mainly to poor households in developing countries. Seed for such crops cannot be supplied economically by the formal and centralized seed sector. The resulting bottleneck in seed supply primarily affects self-pollinating crops, such as groundnut, chickpea, pigeon pea, black gram, and green gram which are served largely, if largely ineffectively, by local seed provision systems. This chapter touches on the interfaces between crop and livestock production systems and provision of seed and feed in a developing-country context, where smallholder mixed crop-and-livestock farming remains the backbone of agricultural enterprise and such interfaces are common. We look at this crop-livestock-seed-feed 'quadrangle' under Indian circumstances and scenarios, particularly the barriers and socioeconomic constraints relating to improved seed dissemination on the sub-continent and interventions most likely to improve seed supply by, among and to the poor.*

## Introduction

Whereas the formal seed sector dominates supply of seed to farmers in industrialized countries, the informal sector is the main actor in developing countries, where despite large investments over the past three decades to build formal seed systems, 90–95% of the world's smallholder farmers still obtain seed from informal sources, largely from other farmers. The formal seed sector of developing countries is controlled either by the state or private industry, which monitors the entire process of seed production—from breeding to multiplication to processing to storage—to ensure high-quality. In the informal sector, on the other hand, seed may be manually cleaned but is otherwise generally left untreated, which exposes the resulting crop to the risk of seed-borne pests.



The reason almost all smallholder farmers continue to take recourse in farmer-obtained seed (including their own) is not only because of their inadequate access to the formal sector (and to the credit systems that would allow them to exploit it) but also because the few cultivars and varieties on offer in the formal seed sector do not meet their needs. The informal sector provides a dynamic and flexible supply of seed wanted by smallholder farmers. Furthermore, on-farm production of locally adapted landraces, cultivars and wild species helps farmers cope with specific tropical production problems caused by drought, flooding, heat, cold, pests and diseases.

The repeated use of untested seed by smallholders, however, can lead to seed degeneration. And the risk of transmitting disease through seed is real, if usually ignored, while disease control measures are often unknown by smallholders, unavailable to them, or inadequate for their needs. The common result of hundreds of millions of farmers repeatedly sourcing seed informally is inferior seed quality, dissemination and build-up of seed-borne diseases, and crop yields far below their potential.

What would help these smallholder farmers is to know the quality of seed before they buy and sow it. Knowledge of which supplies of seeds are healthy would allow farmers to choose seed that could increase their crop yields significantly. Although smallholders often inspect seed before purchasing it from a neighbouring farmer or the local market, the health and quality of seed is not always apparent to the naked eye. Seed supply from both formal and informal systems suffers from these and other problems caused largely by lack of investments in education, research and quality control programs.

## The 'crop-livestock-seed-feed quadrangle' in an Indian scenario

Every country needs a robust seed supply to sustain its agriculture and to ensure that the products of modern plant breeding, as well as local farmer ingenuity, are widely available. A commercial seed sector is needed to ensure an efficient and healthy national seed supply. Compared to other developing nations, India has well-developed seed supply systems in both the public and private sectors; hence, the possibilities of delivering plant-breeding innovations to smallholder farmers are better here than in many other developing countries. But even in India's relatively mature seed supply systems, information moves slowly between smallholders and seed

providers, and much of the information is incorrect, incomplete or inadequate for farmers and suppliers alike. Large opportunities exist to improve this information flow as well as farmer access to reliable supplies of good-quality seed of improved varieties at prices affordable by resource-poor cultivators.

In the traditional farming communities of India, the richer or more successful farmers tend to make themselves 'seed-secure' simply by maintaining their own stocks, while poorer farmers need to buy or borrow seed every year. The influx of new varieties is limited to various degrees in these traditional communities, and systems for raising awareness of variety selection are typically either poorly developed or lacking entirely. Varieties grown in traditional communities are limited because the genetic material grown on one farm is typically available on neighbouring plots (farmers who obtain material from their neighbours obviate both the risk and cost of procuring seed from formal sources). In addition, those farmers who source their seed from other cultivators often obtain it from just a few farmers identified by the community as reliable sources of good-quality seed. It has not yet been established if most of these few local seed suppliers adopt special practices to produce high-quality seed or if they are simply well-endowed farmers with surplus grain to sell as seed.

India's smallholder rain-fed farmers experience erratic rainfall and recurring droughts, which lower their incomes as well as grain yields. But fodder crops are less susceptible to drought than grain crops; indeed, some fodder plants can be harvested for fodder even in years when grain production fails entirely. This drought-hardiness trait of many fodder plants influences which crops and varieties farmers choose to grow. The only crop options for many small-scale rain-fed farmers in the semi-arid tropics of Andhra Pradesh, India are sorghum and pearl millet intercropped with pigeon pea, groundnut and chickpea in dryer Rabi season. In recent years, sorghum and pearl millet are increasingly grown in marginal farming areas where other crop options are severely limited. The steep decline in acreage planted to these crops puts both human and livestock nutrition at risk since sorghum and millet feed both people (the grain) and livestock (the stover). In many regions, dry stover from these crops is the only feed available to animals over the long months of the dry season.

## Barriers to seed security

The barriers to development of community-based seed production systems include the generally poor roads and related infrastructure in India's rural hinterlands, which constrain the distribution of seed along with other farm inputs and produce. Farmers need a broad range of modern varieties to choose from, detailed information on those varieties, and training to help them produce seed efficiently themselves with modern technologies. Linking small-scale farmers to institutions offering credit would support the more than 60% of Indian farmers who purchase seed. An inventory of varietal traits would be useful to many farmers, as would production of varieties with preferred traits for their evaluation and selection. Also needed is production of Breeder seed (produced in the first generation by the plant breeder) and Foundation seed (the next step to increasing the amount of seed) of newly released varieties and those in advanced stages of testing. This is then followed by production of Certified seed which is usually monitored by a government agency for quality, and is then sold commercially and purchased by farmers. Field days demonstrating to local communities the utility of certain varieties grown under certain production systems and circumstances would help widen use of improved varieties. Those improved varieties adopted by communities should be monitored to assess their effectiveness and, later, to determine the factors constraining their broad adoption.

None of the above diminishes the importance of traditional coping strategies based on local ways of exchanging seed. Any intervention aimed at increasing the resilience of India's seed distribution systems should take into account traditional seed exchange practices. For example, rather than focusing solely on getting more improved seed to more local communities, local seed exchange networks could also be enhanced by increasing local production and multiplication of seeds and by facilitating farmer access to formal as well as informal seed supply systems. Key to all these strategies is providing small-scale farmers with greater access to credit and other support systems.

## Interventions needed

Although the type and success of any intervention will depend very much on the context within which it is implemented – bio-physical suitability, present institutional arrangements and related policies - the following have

been identified as possible intervention strategies that would help provide India's smallholder farmers with the best quality seed at the right time, place and price.

- Implementing Farmer seed self-reliance programs through community or village seed bank program or 'Beej Swavlamban Yojana' facilitating decentralized seed production and distribution system.
- Developing contractual agreements with farmers to grow seed and establishment of parastatal seed cooperatives.
- Improving supplies of seed for forages, medicinal plants, flowers and underused crops that could benefit resource-poor farmers.
- Promoting community-based evaluation, characterization and multiplication of "at-risk" varieties. Collection and characterization of indigenous grain varieties and establishment of *in situ* seed conservation centres to reduce the risk of local varieties disappearing.
- Building capacity of self-help groups to facilitate community seed banks and provide incentives for farmers to grow indigenous varieties and seed conservation efforts.
- Facilitating community-devised and generated marketing and credit support systems.
- Introduction of controlled conditions to effectively produce nuclei seed; facilities for seed storage, processing, and packaging and establishment of public-private sector partnerships for seed distribution.
- Practicing of Farmer participatory varietal selection, seed production and monitoring. On-farm demonstration trials, on-station seed selection, and distribution of seed to private suppliers.
- Continual identification of opportunities for mutual learning by farmers and scientists to help improve the effectiveness of seed supply to local communities.
- Designing, developing and testing site specific alternative seed system models for improving and sustaining local seed supply based on geographic and ethnic as well as administrative boundaries.
- Taking into consideration and utilizing aspects of the lesser known traditional seed management systems.



# Part II: Seeds for Livelihood Security

## CHAPTER II: The Role of Seeds in Achieving Livelihood Security



# The Role of Seeds in Achieving Food and Feed Security

*Seed is the basic input in agriculture. Availability of good quality seed at the right time, the right place and the right price plays a major role in the food security of a nation. In this chapter we analyze the basic issues related to the role of seed quality in the sustainability of seed programs in the semi-arid regions of India.*

## Introduction

Agriculture contributes nearly 30% of India's gross domestic product (GDP). On the strength of concerted efforts by agriculture scientists, planners and farmers, the annual foodgrain production has reached 200 million tons. At the same time, in spite of the many population control schemes, the human population of India has crossed the one billion mark, and is projected to reach 1.3 billion by 2030. The country will need 260–264 million t of foodgrain, excluding the requirement for seed and export. This is a formidable challenge for agriculture scientists.

To meet the projected demand, foodgrain productivity would have to increase by about 1 t ha<sup>-1</sup> between now and 2030. The demand-production gap can be bridged by (i) increasing the acreage under cultivation; and (ii) increasing productivity. The first option is not really feasible due to the increasing demand for land for roads, housing and industry. Moreover, large tracts of arable land have been deteriorating and shrinking as a result of soil erosion, salinization and acidification. It is, however, possible to increase the gross sown area to some extent by increasing cropping intensity. The second option, increasing productivity, is possible to achieve by (i) ensuring availability and efficient use of water, fertilizer and plant protection measures; (ii) timely sowing of good quality seeds and attaining the recommended plant population; and (iii) development and release of more productive varieties.



## Improved Varieties

In 1960, when modernization of Indian agriculture was initiated, India's attention was focused on high-yielding varieties which would help increase production in high-potential areas, ie, irrigated and more fertile regions, so that the serious food shortage that prevailed then could be wiped out. The challenge was successfully met, and the situation continues to be positive. More than 2300 high-yielding varieties and hybrids of various crops have been released for commercial cultivation, of which about 600 are in the active seed production chain. However, due to many reasons, use of high-yielding varieties has not spread to the desired extent. To increase adoption and spread of high-yielding varieties, mechanisms for making seed available need to be strengthened.

## Seed Quality Parameters

Four parameters determine the quality of seed:

1. Physical purity
2. Germinability and vigor
3. Health
4. Genetic purity (being true to type)

To ensure physical purity of a batch of seed, farmers must remove contamination of the seed of other crops, weeds and inert matter. If a farmer sows the right kind of quality seed at the recommended seed rate, the optimum plant population can be achieved. Germinability and vigor too help in attaining this, giving the farmer more vigorous plants per unit area. Seed health is related to the proportion of healthy and productive plants in the field as nonhealthy seed either will not germinate or die before flowering or produce plants with poor vigor. These seed quality parameters help farmers achieve an optimum plant population with full vigor.

The true-to-type characteristics of seed indicate that they are of the desired variety. In fact, each variety is developed for specific agroclimatic zones and agricultural practices; so a mixture of two different varieties recommended for different agroclimatic zones is unlikely to perform to full potential in a given environment. Moreover, the quality of produce may also suffer, affecting the market price.

## Seed Quality and Productivity

What role can quality seed play in achieving the projected foodgrain production target in 2030, and how can seed technologists help? The productivity (yield ha<sup>-1</sup>) of any crop is the combined result of the yield per plant and the plant population per ha. Yield per plant is an outcome of the genetic potential of the variety/genotype and plant vigor. Seed technology plays a crucial role in the maintenance of plant vigor and achieving the required plant population per unit area. Seed technology can be defined as the methods by which the genetic and physical characteristics of seed can be improved. It involves such activities as understanding the genetic mechanism of the variety, maintenance of the variety, seed production, processing, storage, testing, seed quality enhancement and enhancing seed production and certification programs.

### Seed: Basic Input for Higher Productivity

Improved seed is a catalyst for making other inputs cost-effective. Inputs such as fertilizer, irrigation, insecticide and weedicide can target effectively only if quality seed has been used. The demand for seed in India increased from 2,00,000 t in 1970–71 to 6,50,000 t in 1994–95 as farmers became convinced of the role of quality seed in realizing the full potential of modern high-yielding varieties. In the early years of India's seed supply system, the National Seeds Corporation (NSC) was the lone entity engaged in disseminating scientific seed production technology and supplying quality seed to farmers. Subsequently, almost all states in the country set up their own seed corporations and certification agencies. About 36 breeder seed production units were also established.

However, not all these efforts have made a substantial difference to seed supply, particularly with reference to foodgrain crops. It is reported that more than 85% of the total seed sown in India is produced by farmers themselves (Groosman et al., 1991) of which quality seed constituted only 12% of the total seed sown each year. Large areas of the country are still sown with farmer-saved seed. Studies show that cereal crops give 10–20% less yield ha<sup>-1</sup> when farmers use their own saved seed. By that measure, India's total food grain production could be enhanced by about 20–30 million t by using quality seed of improved varieties and hybrids.

Although India was the first country in the world to develop hybrids in several crops, the acreage under hybrid cultivation is quite low. The

proportion of hybrids in the total seed used is not very satisfactory, being 23% in cotton, 60% in maize, 78% in sorghum, 75% in castor, 60% in pearl millet and 30% in sunflower. Ideally, in crops where hybrids are available, we would need to bring all area under hybrid cultivation. In nonhybrid crops, the replacement rate of quality seed should ideally be 33% for self-pollinated and 50% for cross-pollinated crops. Research findings indicate that seed quality deteriorates in 2–3 years if farmers continuously use their own saved seed.

As per the Indian Seeds Act, seed production should pass through the three-generations system, ie, breeder seed, foundation seed and certified seed. (Sometimes, the process is condensed to either foundation or certified seed.) Therefore, the seed that reaches the farmer would have passed through four multiplication cycles. Deterioration occurs with repeated multiplication, as a result of mixture, unwanted pollination, and occasionally, if rarely, mutation and genetic drift. This affects varietal performance in specific zones, subzones or specific locations. In fact, in spite of applying the recommended operational farming systems, farmers cannot exploit the full potential of a variety selected for their area unless the seed sown is true-to-type and has the specific genetic constitution necessary to respond to physical inputs. Therefore, there is a need to strengthen the seed production program.

## Seed Program: A New Outlook

A seed program can be defined as “an outline of measures to be implemented and activities to be carried out to secure the timely production and supply of seed of a prescribed quality in the required quantity”. Seed production and testing techniques for each crop variety and hybrid should be developed and popularized as soon as they are released. In India, the seed production program is in the hands of the organized and non-organized (farmers) sectors. In the non-organized sector, most farmers are resource-poor and do not have access to the necessary expertise. They need technical and financial support to produce quality seed, and also to store it until the next sowing season. It would be practically possible and financially viable to identify a group of farmers in each district with access to the necessary resources like land and water, and provide them seed and technical support so that they can produce quality seed.

Some might support a more participatory approach to seed production. If examined critically, we find that seed production is only one part of the solution: the real issue is to make quality seed available in the required quantities at the right time to resource-poor farmers. If we can do this, the

seed production program will reach a few smallholder farmers and seed produced by them will spread from farmer to farmer, perhaps through a barter type system<sup>1</sup>.

## Seed: New Varieties for Farmers

A breeder releases a new variety after confirming its suitability in repeated multilocation trials. New varieties can realize their potential in an adopted area under recommended operational farming systems. The point to note here is that it does not help farmers to have good quality seed of poor varieties or poor quality seed of superior varieties. Both the variety used and the quality of seed are equally important.

The success of a new variety depends on timely supply of quality seed. If the production and supply a new variety is faulty, the variety could well die before it spreads. This has happened in the past due to nonavailability of quality seed of the newly released variety. More importantly, experiences with poor quality or spurious seed can discourage farmers from trying out a new variety. Sufficient quantities of quality seed should reach farmers at the right time. A seed production program therefore must be designed. To make available of good quality seed and stop the sale of spurious seed.

## Quality Seed in Non-favorable Conditions

Quality seeds perform well even under non-favorable conditions such as low moisture, rainfed cultivation and high soil salinity or alkalinity. Some varieties are better resistant/tolerant of abiotic stresses, but will perform to potential only if the seed is of good vigor. For instance, when it rains soon after sowing, it leads to the formation of a hard crust of soil, which restricts the growth of emerging seedling. Vigorous seeds stand a better chance of emergence in such cases. Aged seeds with poor vigor often fail farmers. Adoption of new technologies such as seed hardening, pelleting and priming can help in such situations by establishing optimum plant stands.

In recent years, with the commercial introduction of transgenic crops, particularly in highly insect-infested areas, the role of seed technologists has become important. In fact, the release of transgenic crops is not the end of

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<sup>1</sup> The barter system was traditionally popular in India, particularly at sowing time. Farmers used to borrow seed from other farmers, which they repaid with grain 1-1.5 times the quantity of seed borrowed from the harvest produced by that seed.

the story. Many more scientific methods of commercial multiplication of sowing material with high genetic purity and vigor are likely to emerge. For instance, testing of the transgenes in a crop is essential. In some cases the transgene(s) have become either silent or lost in the subsequent cycles of multiplication. This is one area that needs careful monitoring, for farmers might unknowingly grow transgenic crops with a mixture of nontransgenic plants, and pathogens may infect these stands even more vigorously. Evidence reports that heavy multiplication of pathogens on susceptible plants results in attacks on resistant plants (in the absence of a susceptible host plant in the vicinity). If the plant has high resistance, the pathogen is generally forced to develop a new biotype as a natural survival response. To avoid such disastrous situations, transgenic crops must be grown with high genetic purity, which must be maintained during seed multiplication.

## Seed: Damage Control During Disasters

Before 1917, the United Kingdom was dependent on other countries for food. It was a cheaper option than growing its own food. After World War I, however, regular supplies of food from other countries became difficult, and the UK started to give more attention to its own agriculture. Consequently, it started to realize the importance of seed, and the Government of UK decreed an emergency Seeds Order in 1917 to monitor seed quality. The National Institute of Agricultural Botany (NIAB) was established in 1919. Lessons from the UK experience underline the need to improve quality seed production and develop a national seed reserve stock. Dependence on other countries and multinational corporations (MNCs) has its drawbacks on a long-term basis. Unpredictable circumstances such as war and natural calamities might cause a country's crops to fail and MNCs may not always be available.

India needs to strengthen its seed program in view of possible contingencies that could disrupt seed systems. The establishment of a national reserve stock of seed could provide a safety net and therefore should be given more consideration than it is at present.

# Part III: Seed Industry Development in India

**CHAPTER III: Developments in the Seed Industry in India**

**CHAPTER IV: Overall Policy Framework for Seeds in India**

**CHAPTER V: Issues Relating to Plant Variety Protection and Seed Industry in India**



# Developments in the Seed Industry in India

*This chapter traces the history of the Indian seed industry along the various milestones passed since 1957 up to the current scenario. It sketches the contours of India's formal and informal seed systems, and examines the respective roles of the private and public sector seed industries.*

## Introduction

India is served by both formal and informal seed systems. The formal component consists of public and private sector companies, which have divergent objectives and financial arrangements. Within the informal sector one can differentiate between seed saved on-farm and that obtained from the trading and exchange subsystems within the community, this considered a distinct market

## Main Milestones

Efforts to give shape to India's formal seed system began during the Second Five Year Plan period (1956–61) when special emphasis was laid on multiplication of nucleus and foundation seed, which acted as the basis for further multiplication and distribution of seed. The All-India Coordinated Maize Improvement Project was launched in 1957 as a result of collaboration between the Indian Council of Agricultural Research (ICAR) and the Rockefeller Foundation. Other All India Coordinated Crop Improvement Schemes followed and several agricultural universities initiated efforts to develop new crop varieties and hybrids. This enabled chain multiplication of certified/quality seed – from breeder to foundation seed and from foundation to certified seed – and making it available to the farming community. The Maharashtra Hybrid Seeds Company Limited (MAHYCO), a private sector seed enterprise, was established in 1961, and the National Seeds Corporation (NSC) was established in 1963 to produce foundation seed. In 1964, state variety release committees (SVRCs) were established to monitor the timely release of new varieties to farmers The



Seed Act came into existence in 1968–69 and at the same time the Central Seed Committee (CSC) was constituted under the Seed Act. It took over the functions of the Central Variety Release Committee (CVRC). The National Seeds Project (NSP) was formulated in 1975 to establish the State Farms Corporation of India (SFCI), four state seeds development corporations (SSDCs) and breeder seed production units in state agricultural universities (SAUs). These were mandated to provide support to NSC. In 1985, during the second phase of NSP, 13 additional SSDCs were established to promote seed quality standards. Nineteen state seed certification agencies were also established under the NSP. In 1988, NSP's third phase focused on encouraging expert-oriented horticulture industry. The Seed Act, decreed by Parliament in 1966 to regulate the quality of seed production and marketing in the country, was amended in 1972. It was only in 1983 that the Seed Control Order was issued, but was not implemented by various states until 1994. Liberalization of the Indian economy paved the way for the entry of multinational corporations (MNCs) into the Indian seed sector.

## Sources of Seed Production

The seed production process consists of a sequence of stages in which seed of a new variety is multiplied to obtain sufficient quantities of commercial seed. With regard to millets and groundnut seed, the earlier stages are referred to as breeder seed and the intermediate stages as foundation seed. Together, these precursors of commercial seed are known as source seed. Source seed production is beset by serious bottlenecks in many national seed systems, but India has taken major steps to improve access to the seed.

Prior to 1994, breeder seed production was coordinated at the national level in India but now much of the breeder seed production of state-released varieties is managed at the state level, although some states still depend on the centralized system. The National Seed Project (NSP) meets many of the requests from these states, as well as providing breeder seed of centrally released varieties. Public sector seed corporations, private seed companies and cooperatives that wish to obtain breeder seed submit a request ('indent') to the state agricultural university or the ICAR institute producing the breeder seed along with a prepayment. The Indian Council of Agricultural Research (ICAR) establishes the price of breeder seed. The indents are submitted once a year, and the university then distributes them among its

## Important Events in India's Seed Industry

1957	First All India Coordinated Maize Improvement Project established
1960	Similar projects on sorghum and pearl millet started
1961	First four maize hybrids released
1963	National Seeds Corporation established
1965	First hybrid in pearl millet released; 250 tons of seed of dwarf varieties of wheat imported from Centro Internacional de Mejoramiento de Maíz y Trigo (CIMMYT); All India Coordinated Project on wheat established
1966	Seed Act passed
1968	Report of Seed Review Team submitted; Seed Act operational
1969	State Farms Corporation of India created, UP Seeds & Terai Development Corporation established
1971	National Commission on Agriculture constituted; Indian Society of Seed Technology established; minimum seed certification standards adopted
1975	National Commission on Agriculture's report submitted; report of National Seeds Project (NSP) submitted
1977–78	NSP phase I launched with World Bank assistance of US\$52.7 million
1978–79	NSP phase II launched with World Bank assistance of US\$34.9 million
1979–80	All India Coordinated National Seed Project (Crops) launched; All India Coordinated Project on Seedborne Diseases launched
1981	First workshop on seed technology held under NSP
1988	Separate section on seed created in ICAR; new seed policy implemented
1989–90	Special project on hybrids in nine selected crops and seed, National Technology Research Project started by ICAR
1990–91	NSP phase III launched
1991	All India Coordinated Research Project (AICRP) on Seedborne Diseases merged with NSP (Crops)
1994	Government of India signs the General Agreement on Tariffs and Trade (GATT)
2001	Protection of Plant Variety and Farmers' Rights Act passed
2003	National Seed Policy formulated
2004	Directorate of Seed Research established
2005	New seed bill introduced in Parliament

research stations to increase the supplies. Ideally, breeder seed production of a variety should be managed by the station that developed the variety, but in some cases (particularly for very popular varieties) several other stations are assigned the task. For the breeder seed produced, the plant breeder is responsible for the quality, as its production does not undergo the seed certification process (breeder seed production is monitored by a group nominated by the respective All India Crop Improvement Projects). Upon receiving the required supplies of breeder seed, the companies multiply them to produce foundation seed. It takes approximately two years from the time an indent is made for breeder seed until the resulting commercial seed is ready for the market; so seed producers need to carefully plan their inventories. They also need to know which varieties are likely to be in demand. University research stations also produce some foundation seed, which is used mostly for demonstrations or for distribution to farmers to promote new varieties. Some stations also produce foundation seed for use in the Seed Village Programme of the DOA.

## Formal Seed Supply Systems

Seed supplied in the formal, or organized (Camargo et al. 1989) seed sector is characterized by planned production, some form of (mechanized) processing, inclusion of only identified/notified varieties and a system of quality control. Large quantities of seed are transacted in the formal seed system.

Formal seed supply systems (Figure 5.1) consist of seed production by

National government agencies

- (i) State government agencies
- (ii) Government-assisted and other cooperatives
- (iii) Multinational corporations (MNCs) or transnational corporations (TNCs)
- (iv) Domestic private sector companies
  - a) with their own research and development (R&D)
  - b) without their own R&D
- (v) Joint venture companies
  - a) between MNC and domestic private company
  - b) between two domestic companies, etc.

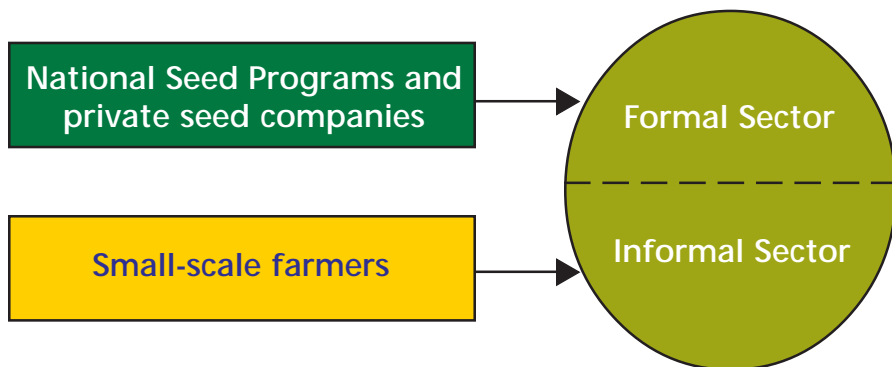
However, the formal seed sector – through its involvement in variety development, evaluation and release; seed production, marketing and

distribution; and quality control operations – can offer only a limited range of varieties and operates within specified quality standards. In practice, these may constrain its ability to meet the diverse needs of farmers. There are serious concerns over the appropriateness of the varieties available in the formal seed sector, the quantity and quality of seed delivered, seed production costs and prices and timeliness of supply. More importantly, rigid government policies and regulations, poor organizational linkages and inadequate infrastructure contribute to the problems of the formal system in developing countries.

Moreover, the existence of even a relatively developed formal sector at the national level certainly cannot yet guarantee small-farmer seed security at the community and household levels. Private seed companies are reluctant to produce and market varieties of sorghum, pearl millet, pigeonpea and groundnut because of low returns. Even if they did, they might not reach smallholder farmers in remote areas due to lack of infrastructure. Moreover, once seed of a variety has been sold to a farmer, he/she is likely to save his/her own seed for the next season and not buy again. This adds up to a disincentive for private seed companies to get involved.

## Informal Seed Supply Systems

Informal seed supply systems (Figure 5.1) are characterized by a lack of functional specialization; they are heterogenous in space and flexible in time. These systems are traditional and informal, operating mainly at the community level through exchange mechanisms. They involve limited quantities per transaction (Cromwell et al. 1992).



*Figure 5.1. Components of formal and informal seed systems.*

Informal seed supply systems broadly include:

- (i) Farm-saved seed and farmer-to-farmer exchange
- (ii) Farmers' cooperatives
- (iii) Community groups
- (iv) Seed growers' associations
- (v) Nongovernmental organizations

More than 80% of the food crops in India are sown from seed stocks selected and saved by farmers. These systems have been variously called farmer-managed seed systems (Ball and Douglas 1992), informal seed systems (Cromwell et al. 1992), traditional systems (Linnemann and de Bruijn 1987) or local seed systems (Almekinders et al. 1994). They are semistructured, and may depend on indigenous knowledge of plant and seed selection, sourcing, retaining and management as well as local diffusion mechanisms. These systems play an important role in the seed security of local landraces at the household and community levels and can be linked to germplasm conservation, enhancement and utilization. Infact a clear distinction between grain and seed may not exist in the informal system. Good quality grain may be offered as seed as the next sowing season approaches.

## Integrated Seed Supply Systems

Integrated seed supply systems, in the context of this presentation, are mechanisms to supply seed of new varieties to farmers which combine methods from both the formal and informal sectors including local seed supply systems. Variety use and development, seed production and storage by farmers under local conditions, and seed exchange mechanisms are the three principal components of a dynamic system that forms the most important seed source of food crops for small farmers in the semi-arid tropics. In fact, the strengths and weaknesses of local seed systems indicate that local seed systems and the formal system are complementary. Integrated approaches in breeding and seed production and distribution have been shown to have promising potential for improving seed supply to small farmers. Organizations facilitating seed industry development in developing countries is depicted in Figure 5.2.

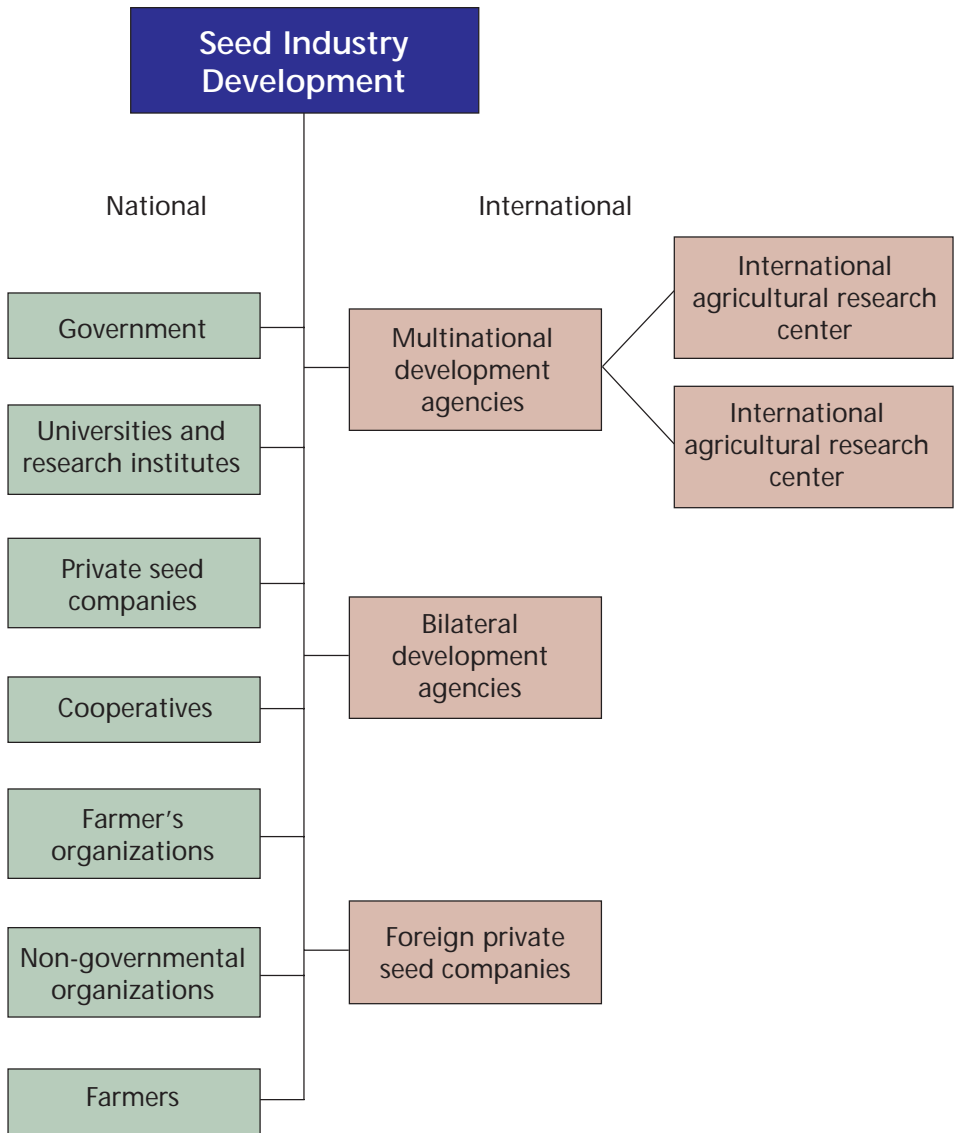


Figure 5.2. Institutions facilitating seed industry development in developing countries.

## Seed System Development

Domestication of wild species probably started with the collection, storage and utilization of seeds not only for food but also for sowing. This was a major step in the evolution of settled agriculture. For centuries, farmers relied entirely on their own seed supply, and these highly adapted populations became recognized as landraces. For much of agricultural history, crop improvement and seed supply remained farmer-based activities. With the development of commercial agriculture, plant breeding and seed production evolved into different disciplines: one engaged in the development of new varieties and the other in multiplying and delivering seed to farmers. As this process of specialization continued in seed production, it brought about significant changes in seed supply systems, giving birth to the modern seed industry.

Definitions of seed systems (Feistritzer and Kelly 1978; Cromwell 1990) have tended to emphasize seed production by the formal sector, but now include the role of the informal sector too in their ambit. The seed system therefore has been defined as the sum total of the physical, organizational and institutional components, their actions and interactions that determine seed supply and use, in quantitative and qualitative terms (van Amstel et al. 1996). Thus, two distinctive but interacting types of seed delivery systems, formal and informal are now recognized.

The organized seed sector in India developed rapidly during the 1960s with the release of hybrid varieties of maize, sorghum and pearl millet, and dwarf high-yielding varieties of wheat and rice. Another important development was the enactment of the Seed Act in 1966. Until the early 1980s, the public sector dominated production and sale of certified cereal seed, with a market share exceeding 70%. In 1988, a new seed policy introduced significant deregulation and attracted several national and multinational companies into the seed business. Incentives encouraged private companies to undertake seed production and conduct research on hybrids and high-yielding varieties. This has had a significant impact in recent years; private-bred hybrids now play a key role in seed production. Between 1993 and 1997, the value of private sector seed sale rose from Rs 6000 million to Rs 15,000 million while the corresponding increase for the public sector was from Rs 4,000 million to Rs 6,000 million. At present, the public sector comprises the National Seed Corporation and 13 state seed development corporations, which produce and market seed of state-bred varieties.

The private sector consists of several multinational corporations, joint-venture companies and domestic research-based seed companies, which are all involved in producing, processing and marketing both public and private varieties. In addition, there are about 50 small- and medium-sized seed companies engaged in the production and marketing of improved seed through both public and private channels. These companies produce seed on contract for larger companies, but also supply seed to small dealers and key farmers within their localities. A lot of these companies are owned by progressive and influential farmers who have experience in seed production and jointly taking advantage of the potential synergies by hands with technically competent persons such as experts in postharvest technology, storage and processing, marketing and financial management.

## Conclusion

Total seed consumption worldwide is estimated at 120 million t per year (Kelly and George 1998). Seed systems in most countries in the Asia-Pacific region consist of public, private and civil sectors. Even though the private sector is increasing its share of the market, it is the civil sector (farmer-saved seed and exchange systems) which produces much of the seed for the majority of staple food crops. In India, the formal (public and private) seed sector holds a market share greater than 10% in only a limited number of major crops (Turner 1994). In developing countries, over 80% of the seed used for sowing is farmer-saved (Jaffee and srivastava 1991).

The private sector responds to commercial incentives, and it is not surprising that India's private seed industry (like that of most other countries) has concentrated on hybrids – seeds of which normally have to be purchased every year – and other high-value seeds. But many of India's most important crops (such as rice, wheat, groundnut and pulses) are based on nonhybrid seed, which farmers can save from year to year. Private sector participation in this type of seed has been more modest, and there are questions about their potential role in such crops. In addition, the highest demand for formal sector seed comes from the more commercially orientated farmers. There are concerns that without proper incentives the private sector may ignore the seed requirements of farmers in marginal areas. In theory, the public sector alternative should be able to address the needs of those farmers who cannot participate in the commercial sector, but the record to date has been uneven. The efficiency of public enterprises is increasingly being called into question.



Although a number of India's public seed enterprises have managed to perform effectively, others are beginning to drop by the wayside. As a dynamic private input marketing system takes hold in the country, many observers are advocating a facilitating role for the public sector in seed production (Jaffee and Srivastava 1994).

The option of decentralization of seed provision is also part of the debate. Seed provision at the local level may be able to respond to farmers' needs more effectively than large public or private enterprises. Cooperative seed production is a possible alternative. In addition, there are a number of initiatives that can be taken by government agencies and nongovernmental organizations to stimulate village-level seed production. No matter how the debate over seed production is resolved, there are a number of key supporting roles for the public sector in seed system development. Although private sector plant breeding has experienced rapid growth in recent years, the greater part of seed sold in India is still based on public owned germplasm. Public sector plant breeding will certainly maintain an important role, but how it should interact with private and local seed production? In addition, any seed system requires a regulatory framework, and seed policy must identify the appropriate public contribution to the regulation of an expanding and diversifying seed sector. Finally, what should be the public sector's role in providing information to farmers about the growing number of seed options should be better defined.

# Overall Policy Framework for Seeds in India

*For any seed system to be viable and sustainable, the right kind of policy framework and interventions are essential prerequisites. This chapter deals with the national seed policy of India and its implications. It also outlines the country's efforts to promote seed trade, variety development, seed production, quality assurance, distribution and marketing, infrastructure facilities, seed import and export, promotion of domestic seed industry and strengthening of monitoring mechanisms for the implementation of the policy.*

## Introduction

As part of the wide-ranging Seeds Policy 2003, a series of initiatives have been planned by the Government of India including plant variety protection protocols, a National Gene Fund, acceleration of seed production and export, and seed quality enforcement through a National Seed Board (NSB). Seed sales, imports and exports would be regulated by a new Seeds Act under which all seeds would have to be compulsorily registered with NSB, which will replace the Central Seed Committee and the Central Seed Certification Board.

The seed policy envisages an increase in India's share of the global seed export market from 1% to 10% and import of the best planting material. It also concedes that genetically modified seeds would increase productivity and improve quality, but would have to adhere to environmental, health and biodiversity safety norms set up under the Environment Protection Act. Transgenic seed varieties would be released only after clearance by the Genetic Engineering Approval Committee (GEAC) and testing by ICAR to assess their agronomic value. The export initiative includes encouraging custom production of seeds, strengthening of seed export promotion zones, quality promotion programs and creation of a data bank on international market potential. When all these measures are in place, India's seed industry is likely to get a great boost. While agriculture will continue to be a subject delegated to the state governments, the central government will complement the efforts of the states in ensuring progress and minimising regional imbalances.

## National Seeds Policy and Its Implications

Agricultural development, in its comprehensive definition, is central to all strategies for planned socioeconomic development in India. Agrarian reforms instituted in the first three Five-Year Plans (1951–56, 1956–61, 1961–66) provided the first surge of momentum for the growth of agriculture in the Indian economy. This period saw investments in irrigation and agricultural education stepped up in tandem. This was followed by the introduction of a succession of high-yielding varieties. A well-designed extension network for spreading knowledge and skills was also created. The spread of high-yielding variety technology, particularly in wheat and rice, in the mid 1960s in conjunction with associated inputs and efficient delivery systems brought about a dramatic change in India's agriculture, which has come to be known as the Green Revolution. As a result of it, foodgrain production has almost quadrupled in the last five decades. Impressive growth has been achieved in commercial crops like oilseeds, sugarcane and cotton. Fruits and vegetables, particularly potatoes, too have shown spectacular growth.

The increase in agricultural production, however, has brought in its wake uneven development across regions, crops and also across different sections of the farming community. In the 1990s, there was a marked slackening of the pace of growth, pointing to the need for infusion of fresh vitality. Of the various agricultural inputs such as fertiliser, nutrients, agrochemicals and seed, the latter is perhaps the most important determinant of agricultural production on which the efficacy of other inputs depends. Seeds with appropriate characteristics are necessary to meet the demands of diverse agroclimatic conditions and cropping systems. Sustained increase in agricultural production and productivity enhancement is dependent to a large extent on development of new and improved varieties and an efficient system through which timely supply of quality seed in adequate quantities can be made to farmers. The progress of the seed sector has been impressive enough over the last three decades. The area under certified seed production has increased from less than 500 hectares in 1962–64 to over 500 000 hectares in 1999–2000. The quantum of quality seeds produced has crossed 10 million tons. The Seeds Act, 1966, and the Seed Control Order and the New Policy on Seeds Development 2003 in India form the basis for promotion and regulation of the seed industry. However, far-reaching changes have taken place in the national economic and agricultural scenario and in the international environment since the enactment of these legislations and policies. There is now considerable need for seed sector

reforms with a framework covering seed production and distribution, quality control and seed legislation, import and export of seeds, plant quarantine and plant breeders' and farmers' rights.

## Promotion of Seed Industry

It is evident that in order to achieve food production targets, major efforts will have to be made to enhance the seed replacement rates of various crops. This would require a substantial increase in the production of quality seed, in which the private sector is expected to play a major role. The creation of a facilitative climate for the growth of the seed industry, encouragement of import of useful germplasm and boosting of exports are core elements of the agricultural strategy for the future.

## Biotechnology and Seed Development

Biotechnology is likely to be a key factor in agricultural development in the coming decades. Genetic engineering/modification techniques hold enormous promise in developing crop varieties with higher tolerance of biotic and abiotic stresses. There is an urgent need for a conducive atmosphere for the application of frontier sciences in varietal development and for enhanced investment in research and development. At the same time, concerns relating to possible harm to human and animal health and biosafety as well as the interests of farmers must be borne in mind.

## Economic Liberalisation and Seed Trade

Globalisation and economic liberalisation have brought new opportunities as well as challenges. While providing the appropriate climate for the seed industry to utilize available and prospective opportunities, safeguarding the interests of Indian farmers, protecting and conserving agrobiodiversity and traditional knowledge are also central concerns. While unnecessary regulation must be avoided, there is a need to ensure that farmers' interests are protected. There is need for a new regulatory system that will encompass quality assurance mechanisms coupled with facilitation of a vibrant and responsible seed industry.

## Varietal Development and Plant Variety Protection

Development of new and improved varieties and their availability to farmers are of crucial importance in the attainment of sustained productivity enhancement. An appropriate policy framework and programmatic interventions are necessary to stimulate varietal development in tune with market trends, scientific-technological advances and suitability for various biotic and abiotic stresses, as well as farmers' needs. Accordingly, an effective *sui generis* system of intellectual property protection is to be instituted to encourage investment in research and development of new plant varieties and to facilitate the growth of the seed industry. A Plant Varieties & Farmers' Rights Protection (PVP) Authority will be established to undertake registration of extant and new varieties in a Plant Varieties Registry to accord intellectual property protection to them. Registration of new plant varieties will be based on the criteria of novelty, distinctiveness, uniformity and stability. The criteria of distinctiveness, uniformity and stability (DUS) will be relaxed for registration of extant varieties, which will be done within a specified period to be decided by the Authority. All plant genera or species notified by the Authority will be registered in a phased manner.

The PVP Authority will develop characterization and documentation of plant varieties registered under the PVP Act and compulsory cataloguing facilities for all varieties of plants. The policy promises to safeguard the rights of farmers to save, use, exchange, share or sell farm produce of protected varieties with the proviso that they shall not be entitled to sell branded seed of a protected variety. Researchers will continue to have the right to use the seed/planting material of protected varieties for bona fide research and breeding. Similarly, benefits that may accrue to a breeder from commercialisation of seeds/planting materials of a new variety will be protected. This proposed initiative also includes a system of rewards for farmers/group of farmers/village communities for any significant contribution they may make to the development of a new variety. The National Gene Fund will implement the benefit-sharing arrangement and pay compensation to village communities for their contribution to the development and conservation of plant genetic resources. Access to plant genetic resources in public collections will be allowed to seed companies as per the provisions of the 'Material Transfer Agreement' under Biological Diversity Bill. Regular interaction will be fostered among private and public researchers, seed firms/organizations and development agencies to promote the growth of a healthy seed industry in the country. To keep abreast of global

developments in the field of plant variety protection and for technical collaboration, India may consider joining various regional and international organizations.

## Seed Production

The Indian seed program adheres to the limited three-generations system of seed multiplication, the three generations being breeder, foundation and certified seed. Breeder seed is the progeny of nucleus seed, which is the seed produced by the breeder to develop a particular variety. Breeder seed is directly controlled by the originating or sponsoring breeder/institution for the initial and recurring multiplication of foundation seed. As per the policy framework envisaged in India, public sector seed production agencies will continue to have free access to breeder seed under the national agricultural research system. Private seed production agencies too will have access to breeder seed, subject to terms and conditions to be decided by the Government of India. State agricultural universities will have the primary responsibility for production of breeder seed as per the requirement of the respective states.

Foundation seed is the progeny of breeder seed; it may also be produced from foundation seed. Production of foundation seed stage-1 and stage-2 may be permitted, if supervised and approved by the certification agency and if the production process is so handled as to maintain specific genetic purity and identity. Certified seed is the progeny of foundation seed, or of certified seed itself. In the latter case, reproduction will not be allowed to exceed three generations beyond foundation stage-1 and subject to assessment by the certification agency that the genetic identity and purity of the variety was not significantly altered.

A number of other initiatives are also envisaged to promote seed production and boost the use of quality seeds, especially at the local level. With the latter objective in view, it is planned to progressively raise the seed replacement rates (SRR) and upgrade the quality of farmer-saved seed. Preparatory to a major thrust on seed production and distribution, the Department of Agricultural Cooperation (DAC), in consultation with ICAR and the state governments, will draw up a National Seed Map to identify potential areas for seed production of specific crops. Each state will prepare a perspective plan for seed production and distribution over a rolling ten-year period. One of the aims of this program is to extend seed production to areas which are

outside the traditional seed-growing areas. In addition, the Seed Village Scheme will be promoted to facilitate production and timely availability of seed of the desired crops/varieties at the local level. Foundation seed will be provided to farmers to build up adequate stocks of certified/quality seed. Also, they will be supplied seed kits to popularise newly developed varieties. To cut the lag time between varietal development and seed delivery, seed producing agencies will be encouraged to enter into agreements with research institutions for commercialization and promotion of new varieties. Support will be provided for production of hybrid seed.

Seed Banks will be established for stocking seed of required crops/varieties as a contingency during natural calamities, production shortages, etc. Seed storage facilities at the village level will be encouraged to take seed crop insurance, which covers the risk of unforeseen situations.

## Quality Assurance

The new seed bill, which is in the parliamentary process, governs the sale, import and export of all seeds and planting materials of agricultural crops throughout India. This includes horticulture, forestry, medicinal and aromatic plants and fodder and green manure. The mandate for executing the provisions of this law and advising the Government on all matters relating to seed planning and development will pass to the National Seed Board (NSB) when it is established in place of the existing Central Seed Committee (CSC) and the Central Seed Certification Board (CSCB). The NSB will be the country's apex body in the seed sector.

Under the new regime, all seeds offered for sale and distribution in the market would have to be registered with NSB. The registration protocol would require new varieties to be put through multilocation trials over a minimum of three seasons to determine their value for cultivation and usage (VCU). The VCU trials would be conducted by ICAR, SAUs and private organizations accredited by NSB, and registration would be granted for a fixed period. Varieties that were already in the market before the seed law was enacted will have to get registered within a time period to be fixed by the Government. Varieties that are submitted for registration after just one season of trials rather than three will be granted only provisional registration. The Government will have the power to exclude certain kinds of varieties from registration to protect public order or public morality or human, animal and plant life and health, or to avoid serious prejudice to the environment.

Similarly, NSB can cancel the registration granted to a variety if it was obtained by misrepresentation or concealment of essential data; if the variety is obsolete and has outlived its utility; and if the prevention of commercial exploitation of such a variety is necessary in the public interest.

It would be mandatory for seed processing units to be registered too. For this, their processing standards would have to meet NSB's minimum benchmarks. Seed certification would continue to be voluntary although the certification tag/label provides an assurance of quality to the farmer. To meet quality assurance requirements for seed exports, seed testing facilities would be established in conformity with guidelines and standards specified by NSB. The Board will accredit individuals or organizations to carry out seed certification including self-certification on fulfilment of prescribed criteria.

Under this new regulatory regime, farmers will retain their right to save, use, exchange, share or sell their farm seeds and planting materials without any restriction. They will be free to sell their seed on their own premises or in the local market without any hindrance provided the seed is not branded. The sale of spurious or misbranded seed will carry a major penalty. Minor infringements committed by dealers and seed producers will attract minor penalties to obviate an opportunity for harassment by enforcement staff.

Apart from maintaining the National Seed Register and other regulatory functions, NSB is mandated to coordinate and assist the states in their efforts to provide quality seed to farmers. It will prescribe minimum standards for parameters including germination, genetic purity, physical purity, and seed health.

## Seed Distribution and Marketing

India's seed policy plans to put in place an improved distribution system and efficient marketing set-up to ensure timely availability of quality seed to farmers throughout the country. As part of this objective, it hopes to encourage the private seed sector to expand its role and restructure and reorientate its activities to cater to nontraditional areas. Seed distribution and marketing facilities will be aided in securing access to term finance from commercial banks.

## Infrastructure Facilities

New infrastructure facilities would have to be created and existing ones strengthened to meet the enhanced requirement of quality/certified seeds.



The National Seed Training Centre being set up at Varanasi in Uttar Pradesh is vested with the task of building capacity in various disciplines of the seed sector. A Central Seed Testing Laboratory is being set up at this center to perform referral and other functions as required under the Seed bill 2004 (Annexure I). Seed processing capacity will have to be augmented in view of the anticipated increase in seed production. Accordingly, modernization of seed processing facilities will be supported in terms of modern equipment and techniques such as seed treatment for enhanced seed performance. Conditioned storage for breeder and foundation seed and aerated storage for certified seed would be created in different states.

A computerised National Seed Grid will be established to provide information on the seed inventories available with various production agencies, their location and quality. This will facilitate optimum utilisation of available seed during any given season. Initially, public sector seed production agencies would be connected with the grid, but progressively the private sector will be encouraged to join it.

The state governments, or the National Seed Board in consultation with them, may establish one or more seed certification agency in the states. The states will establish appropriate systems for effective implementation of the objectives and provisions of the Seed bill 2004 (Annexure I), to promote seed growers, seed associations and cooperatives.

## Transgenic Plant Varieties

Before their commercial release, all genetically engineered crops/varieties would have to be tested for adherence to environmental and biosafety norms as per the regulations and guidelines of the Environment Protection Act (EPA), 1986. Seeds of transgenic plant varieties needed for research purposes can be imported through the National Bureau of Plant Genetic Resources (NBPGR). But before commercial release, transgenic crops/varieties would have to prove their agronomic value for at least two seasons under the All India Coordinated Project Trials of ICAR.

Once a transgenic plant variety is commercially released, its seed can be marketed subject to the seed laws. They would be required to bear a label indicating their transgenic character. The performance of a transgenic plant variety in the field will be monitored for 3-5 years by the Ministry of Agriculture and the department of agriculture of the relevant state.

Transgenic varieties would be protected under PVP legislation in the same manner as nontransgenic varieties. All such seeds imported into the country will be required to carry a declaration and a certificate from the competent authority of the exporting country, certifying their transgenic character. If the seed or planting material is a product of transgenic manipulation, its import will be allowed only with the approval of the Genetic Engineering Approval Committee (GEAC).

## Import of Seeds and Planting Material

The objectives of the import policy are to provide the best planting material available in the world to Indian farmers, and to increase productivity, farm income and export earnings, while ensuring that there is no adverse effect on the environment, human and animal health and biosafety. Therefore, while imports of seeds and planting materials will be allowed freely subject to requirements, they will be subjected to stringent plant quarantine procedures to prevent entry of exotic pests, diseases and weeds detrimental to Indian agriculture. .

According to the Fruits and Seeds Order (Regulation of Import into India), 1989, and its subsequent amendments, seeds and planting materials imported for sale in India have to meet the prescribed standards of seed health, germination, and genetic and physical purity. All seed imports will require a permit granted by the Plant Protection Advisor to the Government of India. Importers are required to make available a specified quantity of imported seeds for accession to the gene bank maintained by NBPGR. The existing policy, which permits free import of seeds of vegetables, flowers and ornamental plants, cuttings, saplings of flowers, tubers and bulbs of flowers by certain specified categories of importers, will continue. Tubers and bulbs of flowers will be subjected to postentry quarantine. After the arrival of consignments at the port of entry, quarantine checks would be undertaken which may include visual inspection, laboratory inspection, fumigation and grow-out tests. For the purpose of these checks, samples will be drawn and tests conducted concurrently.

## Export of Seeds

Given its diverse agroclimatic conditions, strong seed production infrastructure and market opportunities, India has significant seed export

prospects. The Government is planning to evolve a long-term policy for export of seeds with a view to raising the country's share of the global seed export market from less than 1% at present to 10% by 2015. Specifically, custom production of seeds for export is one point of emphasis in this policy, which will be based on a long-term perspective rather than a case-by-case consideration. To give momentum to this policy, seed export promotion zones will be set up and strengthened with special incentives. A data bank will be created to provide information on international markets and the export potential of Indian varieties in different parts of the world. At the same time, the database will keep an inventory check to assess the impact of exports on domestic availability of seeds. Various promotional programs will be taken up to improve the quality of Indian seeds to enhance their acceptability in the international market.

## Promotion of Domestic Seed Industry

While encouraging exports, India's seed policy will provide incentives to the domestic seed industry to step up production of seeds of high-yielding varieties and hybrids. A liberal climate will be created to facilitate the seed industry's marketing efforts, both domestic and international. Membership of international organisations and seed associations such as the International Seed Testing Association (ISTA), Organization for Economic Cooperation and Development (OECD), International Union for the Protection of New Varieties of Plants (UPOV), International Association of Plant Breeders for the Protection of Plant Varieties (ASSINSEL) and World Intellectual Property Organization (WIPO) will be encouraged at the national and individual levels.

Special efforts will be directed toward increasing the quality of farmers' saved seeds. Financial support for capital investment, working capital and infrastructure strengthening will be facilitated through the National Bank for Agriculture and Rural Development (NABARD), commercial and cooperative banks. Tax rebates and concessions will be considered on expenditure incurred on in-house research and development for development of new varieties and other seed-related research aspects. Special incentives such as a transport subsidy will be provided to seed-producing agencies operating in these marginal. Reduction of import duty will be considered on machinery and equipment used in seed production and processing.

## Strengthening the Monitoring System

The Seeds Division of the DAC will supervise the overall implementation of the National Seeds Policy. Adequate infrastructure support would be required for undertaking, monitoring and servicing the National Seed Board and its activities. Human resource development in the seed sector is another area that requires attention.

# Issues Relating to Plant Variety Protection and Seed Industry in India

Legislation relating to plant variety protection and farmers' rights in India are aimed at strengthening local seed systems and giving freedom to farmers to save, exchange and sow their own seed. We discuss in this chapter the salient features of the Protection of Plant Varieties and Farmers' Rights (PPV&FR) Act, 2001 (Annexure II), and the draft Seed Bill, 2004 (Annexure I), and their implications for research, the seed industry, seed exchange, plant variety protection and farmers' rights.

## Introduction

After India became a signatory to the Trade-Related Aspects of Intellectual Property Rights (TRIPS) agreement in 1994, a legislation was required to be formulated to give effect to its provisions. Article 27.3 (b) of this agreement requires member countries to mandate protection of plant varieties either through patents or an effective *sui generis* system of intellectual property rights (IPR) protection, or by any combination thereof. Thus, TRIPS signatory countries had the choice of framing legislations that suit their own system. India exercised this option.

The existing Indian Patent Act, 1970 (Tonapi et al., 2004), had excluded agriculture and horticulture from patentability. While bringing these activities into the purview of IPR legislation, India opted for a *sui generis* system of plant variety protection, providing for the rights and equity concerns of farmers, breeders and researchers in a single legislation. These provisions were the outcome of an intense public debate involving all interest groups and an elaborate exercise by a Joint Convention on Biological Diversity and the FAO Declaration on Farmers' Rights, to which India is a party.

- The PPV&FR Act seeks to establish an independent Plant Varieties and Farmers' Rights Protection Authority comprising a chairperson appointed by the Government of India, and 15 members. It will also set up a Plant Varieties Registry headed by a registrar-general headquartered in New Delhi and supervising registrars in Bangalore, Pune, Bhopal, Patna and Guwahati. The legislation also mandates a Plant Variety Tribunal with the status of a district court to settle disputes connected with this Act.

# Salient Features of Protection of Plant Varieties and Farmers' Rights Act

## *1. Protection of Plant Varieties and Farmers' Rights Authority*

This authority will have a chairperson and 15 members including eight ex-officio representatives from various departments and institutions of the Government of India and seven others representing farmers' associations, tribal organizations, industry, agricultural universities, national-level women's organizations and state governments. The registrar-general of the Plant Varieties Registry will be its member secretary. The authority will be assisted by committees and officers such as the registrars.

## *2. Functions of the authority*

1. The authority will promote the development of new varieties and protect the rights of farmers and breeders;
2. In particular, it will provide for
  - a. Registration of extant and new plant varieties and essentially derived varieties subject to the relevant terms and conditions;
  - b. Characterization and documentation of varieties registered under the Act;
  - c. Documentation, indexing and cataloguing of farmers' varieties;
  - d. Compulsory cataloguing facilities for all plant varieties;
  - e. Ensuring that seeds of varieties registered under this Act are available to farmers, and providing for compulsory licensing of such varieties if the breeder does not arrange for production and sale of seeds in the manner prescribed;
  - f. Collecting data and information on plant varieties, including the contribution of any person at any time to their evolution or development in India or abroad, for compilation and publication;
  - g. Ensuring the maintenance of the National Register of Plant Varieties.

## *3. Powers of the authority*

1. The Plant Varieties and Farmers' Rights Protection Authority will have all the powers of a civil court to receive evidence, administer oaths, enforce

the attendance of witnesses, compel the discovery and production of documents and issue commissions for the examination of witnesses.

2. Its orders would be executable as the decrees of a civil court.

#### **4. Registration of varieties**

1. A National Register of Plant Varieties will be kept at the head office and branch offices of the Plant Varieties Registry in which the particulars of all varieties will be registered. The register will be maintained under the direction of the Central Government. It will be kept under the control and management of the Plant Varieties and Farmers' Rights Protection Authority.

#### **5. Criteria for registration**

A variety will be registered if it fulfils the criteria of novelty, distinctiveness, uniformity and stability.

#### **6. Persons who can apply**

An application for registration can be made by

- a) The breeder of a variety;
- b) A successor of the breeder;
- c) An assignee of the breeder;
- d) A farmer or a group or community of farmers claiming to be breeders of a variety;
- e) A person authorised by any of those specified above to make an application on their behalf;
- f) A university or publicly funded agricultural institution claiming to be the breeder of a variety.

#### **7. Duration of registration**

Registration of a variety will be valid for a period of

- a) Nine years for trees and vines;
- b) Six years for other crops.

This can be renewed further for the remaining period of

- a) 18 years in respect of trees and vines;
- b) In the case of extant varieties, 15 years from the date of notification of the variety under section 5 of the Seeds Act, 1966;

- c) In other cases, 15 years from the date of registration. It would be mandatory for the breeder to deposit the seeds or propagating material in the National Seed Bank.

### ***8. Rights of breeder or his successor***

Registration of a variety confers an exclusive right on the breeder or his successor, agent or licensee to

- a) Produce, sell, market, distribute, import or export the variety;
- b) A breeder may also authorise any person to produce, sell, market, or otherwise deal with the registered variety subject to the relevant conditions.

### ***9. Exclusion of some varieties***

Registration will not be granted to some varieties if it is necessary to prevent their commercial exploitation in order to protect public order or public morality or human, animal and plant life and health or to avoid serious prejudice to the environment.

### ***10. Researchers' rights***

For the purpose of research, any person can use a registered variety as an initial source in an experiment to create other varieties. For further repeated use of the variety as a parental line, the breeder's permission would be required.

### ***11. Farmers' rights***

- a) A farmer who has bred or developed a new variety would be entitled to registration and other protection extended to a breeder;
- b) A farmer's variety shall be entitled for registration if the application contains a declaration as specified in clause (h) or subsection (1) of section 18 of the Act;
- c) Farmers who conserve landraces and wild relatives of plants of economic importance and work on their improvement through selection and preservation would be entitled to recognition and reward from the National Gene Fund if their material is used as gene donors to varieties registered under this Act;



- d) Farmers would continue to be entitled to save, sow, resow, exchange and share or sell their farm produce including the seed of a protected variety. However, they would not be entitled to sell branded seed of a protected variety.

### **12. Right to claim compensation and exemption from payment of fees**

If the propagating material fails to provide the expected performance under the prescribed conditions, farmers can petition the Plant Varieties and Farmers' Rights Protection Authority for compensation. Moreover, farmers are protected from innocent infringement of the provisions of the PPV&FR Act. The Act exempts farmers from having to pay a fee in any relevant proceedings before the authority or registrar or tribunal or the High Court.

### **13. Constitution of National Gene Fund**

The National Gene Fund, to be established by the Central Government, will receive funds from

- a) The proceeds of benefit sharing received from breeders;
- b) The annual fee payable to the authority by way of royalty under subsection (1) of section 35;
- c) The compensation deposited in the National Gene Fund under subsection (4) of section 41;
- d) Contributions from national and international organizations and other sources.

The fund will be used to meet the following expenses:

- a) Payouts by way of benefit sharing under subsection (5) of section 26;
- b) Compensation payments under subsection (3) of section 41;
- c) Expenditure for supporting conservation and sustainable use of genetic resources including *in situ* and *ex situ* collections and for strengthening the capabilities of village administrations to carry out such activities;
- d) Expenditure on schemes relating to benefit sharing framed under section 46.

### **14. Compulsory licensing**

Breeders, having got a compulsory license for a variety from the Plant Varieties and Farmers' Rights Protection Authority, can license an individual or company for the production, distribution and sharing activity.

## *15. Plant Variety Protection Appellate Tribunal*

The Central Government will constitute an appellate tribunal to hear grievances arising out of the decisions of the authority regarding registration, claims, benefits, licenses and compensation.

The PPV&FR Act, 2001, is yet to be enforced since rules have not been framed and notified. Any administrative problems can be visualized only after the issue of rules and regulations.

## **Implications of PPV&FR Act**

### *1. Agricultural research*

Implementation of the PPV&FR Act promises to bring monetary returns to institutions and individuals on their investment in research. By granting plant breeders' rights (PBRs), the legislation is likely to encourage plant breeding activity and stimulate research. Henceforth, researchers in the public and private sector would not only compete with each other but also with farmers in developing location-specific varietal and sustainable crop management technologies and innovations. There would be increased interest in realizing the commercial potential of research.

However, there is concern that projects with commercial potential may dominate the research agenda at the cost of basic research with little direct income potential. There is likely to be increased pressure to seek new sources of funding, and public-private or private-private collaborative programs on mutually agreed conditions may become the order of the day.

### *2. DUS and multilocation testing*

With the enactment of the PPV&FR Act, India is gearing up to give effect to plant breeders' rights (PBRs) to recognize and protect the rights of farmers and breeders. These rights can be granted for a variety that is new, distinctive, uniform and stable in other words, one that measures up to a test of distinctiveness, uniformity and stability (DUS). Farmers' varieties need not comply with the novelty provision but all other types of varieties claiming PBR have to do so. The DAC of the Ministry of Agriculture and the Indian Council of Agricultural Research (ICAR) have initiated the process for DUS testing. The department has been allocating funds since 2000 to

various ICAR institutes to strengthen their DUS test facilities. The council has identified 35 crops for finalizing the DUS test guidelines and 43 centers for undertaking the tests. Many of these centers are project-coordinating units already engaged in the all-India coordinated multilocation tests of elite lines. One of the formidable tasks for the DUS testing units would be to characterize the extant (national releases) varieties to develop a database for the reference collection of varieties (RCV). Though strictly only the latest varieties would be tested for DUS, the manpower and finances required for a precise and total characterization would be a limiting factor. As DUS tests would be done on a cost recovery basis, the onus is on the ICAR institutes to maintain the test plots in an excellent condition to prove the distinctiveness of varieties, maintain the database and the relevant records in order.

### *3. Plant breeders' rights*

In order to claim PBR, a variety must be clearly distinguishable for at least one essential character from the varieties commonly known in India and abroad. Such distinctiveness has to be bred into the variety while incorporating other economically important traits. Establishing such distinctive features is likely to be increasingly difficult in future. Initially there may be a rush of varieties for DUS testing, but this is expected to slow down eventually for want of distinctiveness. Further, distinctiveness does not guarantee commercial viability; breeders have to combine both qualities. Unless this is achieved through planned breeding activity, the genotypes developed cannot be commercially exploited fully through PBR.

### *4. Sharing germplasm*

The most important ingredient for a crop improvement program is the availability of genetic diversity. Until recently, germplasm worldwide was considered the heritage of mankind to be shared and used by all. With the new world order that is emerging in the post-WTO era, the availability of germplasm may be restricted. Any breeder trying to develop new varieties should obtain explicit permission to use germplasm or landraces from the region from where they were originally collected. Although Prior Informed Consent (PIC) and Material Transfer Agreements (MTAs) do assure benefit-sharing, the willingness to share germplasm rests with the breeder/farmer and/or the community. Unless the material is available in the National Gene Bank (NGB), from where it can be accessed by signing an MTA, there is no way of getting the material if the party is not willing to share it.

Further, the second step in the development of new varieties is to test elite lines in the All India coordinated research projects (AIC RPs). Breeders nominate the materials in good faith, and further selection would depend on the performance of cultures in the program. Simultaneously, other breeders also nominate the material and are free to use available material in the trial if they wish to do so. Now, in the PPV&FR regime, if a particular line is doing extraordinarily well in station- or state-level testing, the breeder may not be as readily agreeable as in earlier days to part with the line for multilocation trials because his peers may want to identify it for their use or select and modify as an essentially derived variety (EDV). Unless divulged, benefit sharing becomes a bone of contention between breeders and organizations. Thus, the free exchange of germplasm and breeding lines may become the casualty of the PPV&FR Act unless some innovative practices are devised.

### *5. Transgenics and EDVs*

The increasing use of biotechnology in producing transgenic crop varieties and genetically modified organisms (GMOs) also requires the development of biosafety norms to regulate trade in such crops, animals and products. The trade in GMOs will have to be strictly regulated, and that capacity needs to be created urgently. A responsible regulatory system will ensure that we attract investment in this sector. The prior informed consent of farmers must be taken while pursuing on-farm trials of transgenics. Public notice must be given of all such trials and an informed debate generated on the issues involved rather than allow populist propaganda to be disseminated. It must, however, be remembered that much greater environmental damage takes place due to the chemical pesticides currently in use than might possibly be caused by a transgenic pest-tolerant crop.

The concept of EDV was developed to prevent biotechnologically produced varieties from taking away the benefits of conventionally bred varieties by transferring one or a few genes into or from them. However, EDV does not deal with the incorporation of genes from a protected variety into a nonprotected variety. It has to be recognized that it was conventional breeding by farmers or plant breeders that made the expression of a particular critical gene possible. Therefore, the claimant for plant variety protection for a biotechnologically produced variety should disclose the source parents and must agree to contribute part of the gain to the breeders of the source variety.

## 6. Farmers' rights

Provisions of the PPV&FR Act would encourage conservers, farmers and farmer-breeders. Farmers are the custodians of local germplasm. Through pure line selection many of them have developed very important landraces with unique biotic/abiotic stress tolerance or quality attributes or medicinal value. As a result of the PPV&FR Act, such farmers as individuals or as members of a community or through an NGO will be able to claim PBRs or benefits accruable as per clause 26(2) of the Act in respect of any new variety in the development of which local germplasm or a landrace was used.

Other explicit provisions in the Act safeguard the farmers' right to grow seed and preserve produce to grow the next crop and also to share, exchange and sell it without the risk of infringement of PPV&FR. What has been taking place as a traditional practice until now has been codified as a right. Such steps to strengthen local and community seed supply systems are likely to result in stiff competition for public and private seed companies. While public seed companies have so far largely focused on high-volume, low-value crops, private firms have tended to operate the other way round. Although public sector seed corporations played a historic role in the spread of high-yielding varieties (HYVs) during the Green Revolution, they have since then yielded dominance to the private sector. At present, of the total seed business of Rs 4000 crore in India, the private sector garners more than 75%. When farmers take up quality seed production at the community level, or if seed village programs get a shot in the arm, public seed agencies are likely to face a further threat. Perhaps it is time they became more competitive. In this context, the National Seeds Board has a vital role to play in seed program planning, production, supply and quality assurance. Managerial aspects and the freedom to operate need greater attention and not merely technical or regulatory matters for the success of the public sector seed industry.

## Response of Seed Industry to PPV&FR Act

The seed industry feels that the Act is a step in the right direction and strikes a satisfactory equilibrium between plant breeders' rights (PBRs), farmers' rights (FRs) and researchers' rights (RRs). However, its impact will be felt only after its effective implementation. We present here the summary of the seed industry's views and reservations on some specific provisions of the PPV and FR Act 2001.

### *1. Plant breeders' rights*

The process of plant breeding is long and expensive, and requires time, money, skill and labor. Recovery of those expenses is enabled by way of PBRs guaranteed in the PPV&FR Act. However, the farmer too is treated as a breeder, conservator and cultivator. The equal role given to the farmer may in some cases act as a limitation on PBRs.

Apart from this, the farmer is protected against innocent infringement of the Act. It is a well-intended provision, but needs to be drafted so as to be more specific. For instance, nothing is said in the Act about what might constitute a violation of breeders' rights. This is of critical significance since the Act does allow a farmer to sell generic seed of a protected variety. Should a farmer be sued for breach of the breeder's rights, what would constitute proof in a court of law that he was unaware of the existence of such a right? Breeders' rights have been strengthened to the extent that the onus of proving innocence is placed on the alleged violator. However, apart from these limitations in the law, the penalties and offences section of the law is satisfactory.

### *2. Farmer-to-farmer exchange of seeds*

The farmer has the right to sell, sow and exchange seeds of a protected variety, but not under a brand name. This may result in unfair competition between seed traders and farmers and may inflict losses on the seed market. In addition, the farmer is protected against the supply of spurious seed and he has a right to claim compensation in case of crop failure. This provision on farmer-to-farmer exchange of seed can be misused for commercial gains in the guise of seed exchange by corporate farmers. .

### *3. VCU trials*

The Act requires seed producers to state on the seed bag the expected performance of the seed under a set of conditions. The VCU trials are conducted by designated research institutes and state agricultural universities through multilocation testing for a specified number of years or seasons. As per this clause, farmers have to be compensated for the nonperformance of a hybrid or variety. This may give rise to litigation. Nonperformance of a variety may not always be related to the innate potential of a genotype, but may be due to nonstandard cultivation conditions and practices including climatic vagaries.

#### *4. Biodiversity and germplasm exchange*

Breeders wanting to use farmers' varieties for creating EDVs would need the explicit permission of the farmers involved in their conservation. The farmers may not be satisfied with the proceeds due to them and may demand more. Protracted negotiations between farmers and breeders over the use of a particular landrace as an initial variety may hamper research and development.

#### *5. Registration of farmers' varieties*

The PPV&FR Act allows the registration of farmers' varieties and includes them in the ambit of benefit sharing. However, those farmers who lack formal education may find it difficult to get their varieties registered in the National Register of Plant Varieties. While NGOs and communities may help in this matter, it remains to be seen how many farmers' varieties will actually pass the DUS trials. Benefit-sharing might yet remain a mirage for the farmer after all. There is a need for more clarity on the definition of proprietary material to claim ownership/proprietorship.

#### *6. Infrastructure and security for deposited material*

Since it is necessary to generate sufficient resources for the Plant Varieties and Farmers' Rights Protection Authority, the fee for registration and other processes as well as the annual fee for maintenance of plant variety protection should be reasonably fixed, keeping in view the possible commercial value of the crop and the national interest. Resources are needed to equip the Authority with appropriate infrastructure such as a secure system for the storage of reference samples. As things stand, there is no security system in place for the genetic material deposited, especially parental lines. The private sector advocates some kind of a message transfer agent or black box arrangement with a dual lock and key system to prevent misuse of genetic material. The facilities and technical expertise available at the National Bureau of Plant Genetic Resources (NBPGR) need to be strengthened.

It is no mean task to maintain sufficient quantities of material of all the reference varieties across crops. The infrastructure required and the transparency, accountability and efficiency needed for carrying out DUS trials are a bit of a concern at present. User-friendly software tools for statistical analysis of DUS trials are still being worked on.

## Draft Seed Bill and Response of Seed Industry

Based on the recommendations of the Seed Policy Group headed by Dr MV Rao, former vice-chancellor of Acharya NG Ranga Agricultural University (ANGRAU), Rajendranagar, Hyderabad, the Government of India has drafted a new Seed Bill, to regulate the seed business, particularly the registration of seeds of all kinds and varieties, their production, processing, quality control and law enforcement. The bill is aimed at amalgamating the provisions of the Seeds Act, 1966, and the Seeds Control Order, 1983. It will regulate the sale, import and export of seeds, facilitate supply of quality seed to farmers throughout the country, and establish a National Seeds Board to advise the Government on all relevant matters. The detailed provisions of the bill are presented in Appendix I. The response of the seed industry to some of its provisions is summarized below.

### *1. Definitions*

Seed industry representatives feel that the word 'hybrid' should have been included in the definitions section of the draft Seed Bill. Similarly, misbranding, or wrongful sale of seed under the label of popular registered varieties or hybrids, should have been defined as a major offence.

### *2. National Seeds Board*

Seeds being a highly specialized subject, industry spokesmen believe that formulation of policy on important issues such as minimum standards and procedures requires adequate participation by industry experts in the National Seeds Board. At least five experienced and qualified representatives (from different regions of the country) from the seed industry should be involved in this process. This would strengthen the National Seed Programme.

### *3. Constitution of committees*

Similarly, the committees to be constituted under the proposed Seeds Act ought to have 33% representation from seed industry experts. In any of the developed countries, the majority of members of such advisory or regulatory committees are from the industry. This would give a practical orientation to such activities.



#### *4. Central seed testing laboratories*

Industry representatives feel that there should be at least four Central Seed Testing Laboratories (CSTLs) to monitor the working of the notified seed testing laboratories in the country. At present, there is no audit of their working. It has often been observed that seed lots certified as substandard by the notified state seed testing laboratories (SSTLs) have in fact recorded excellent performance in farmers' fields. Therefore, adherence of standard practices and maintenance of the required conditions for germination in the SSTLs needs to be closely monitored. This calls for more central seed testing laboratories.

#### *5. Labelling*

As per the Seeds Act, 1966, the expected performance of seeds (varieties/hybrids) in the given conditions is required to be stated on the labels of seed bags along with other particulars. However, working out a format for giving these particulars has proved to be very difficult. Seed performance depends not only on genetic purity but also on environmental factors such as soil fertility, soil reaction and managerial practices including pest and disease management, as well as climatic factors such as rainfall and temperature, which vary from year to year even within a specific geographical region. This could create miscommunication between seed producers and farmers, and lead to litigation. Therefore, seed industry representatives feel that mandatory statement of the agronomic performance of seed on the labels should be reconsidered and deleted from the Seed Bill.

#### *6. Multilocation testing and value for cultivation and use*

The Seed Bill requires multilocation testing (MLT) data to be submitted for registration of a seed variety. However, data generated by private companies on their own may not have any validity for assessment of agronomic performance. Therefore, ICAR testing for all the varieties to be registered should be made mandatory.

#### *7. Compensation to farmers*

Seed industry spokesmen argue that the compensation system provided for in the Seed Bill can lead to unforeseen and negative consequences. In most cases, the cost of seed supplied by a company varies from 3% to 10% of the

cost of cultivation of a crop. The seed alone could contribute to 20-30% of the yield. Returns on investment, therefore, are high and attractive. The prices of seed of most crops in India are much lower than in neighbouring countries. Given the stiff but healthy competition in the Indian seed industry, placing the burden of compensating farmers on seed companies could result in

- a. Companies increasing prices to hedge for probable compensation payouts;
- b. Companies closing shop to escape the compensation burden; and
- c. Differences over compensation may lead to protracted litigation between farmers and seed producers.

This could culminate in reduced competition, narrowing of options for farmers and high cost of seed. The seed industry wants compensation to be limited to the actual value of the seeds or two times that at most.

Moreover, the seed industry argues that the question of compensation has already been addressed by other legislations such as

- i) Consumer Protection Act, 1986 (Tonapi et al., 2004); and
- ii) Protection of Plant Varieties and Farmers' Rights Act, 2001.

With the proposed Draft seed bill 2004, joining this list, there would be a multiplicity of seed compensation stipulations. This situation calls for vesting powers in a single seeds enactment overriding all others.

## 8. *Transgenic varieties*

The environmental safety of a particular gene or a particular transgenic event involving a gene in a specific crop is thoroughly examined by the regulatory system before it is released (or deregulated) into the environment. Once the specific gene with a specific transformation event is deregulated, there is no real need for the concurrence of the Environment Protection Act (EPA) when releasing subsequent varieties or hybrids carrying the same gene. Therefore, it should be explicitly stated in the Seed Bill that "No seed of any transgenic kind or variety shall be registered unless the (*alien*) gene which it is carrying has been approved by the Environment Protection Act, 1986 (Tonapi et al., 2004)".

There need not be compulsory registration for transgenic varieties as they would be cleared or deregulated by EPA. Registration may only delay the

process of release of transgenic varieties. The environment protection agencies of the USA, Australia and other countries where transgenics are commercially grown have similar provisions. For example, in the USA, the Bt gene Cry 1AC is deregulated, and any seed company can introgress it into their variety by the simple breeding technique of backcrossing and release for commercial cultivation without going to the Environment Protection Agency again.

### **9. Provisional registration**

Provisional registration should be granted to seed companies till the final decision is made rather than for three years as proposed, since the final registration may take longer than three years.

### **10. Powers of the seed inspector**

Since the seed sales of a particular crop take place in a very short period (sometimes ranging from 7 to 15 days in a year), the power to issue a stop sale order for a period of 30 days is too long and can ruin a seed producer. Therefore, this power should be made conditional. The following sentence should be added to the relevant section of the Seed Bill, stating that: *“When the producer has furnished information clarifying objections raised by the Seed Inspector, the detention order should be revoked within 24 hours”*

or,

*“If the reasons are inadequate, notices calling for further information should be served within 24 hours.”*

### **11. Offences and punishments**

The proposed penalties for minor infringements are too high. Seed is a biological product, and germination may at times deteriorate very fast due to the harsh climatic conditions that prevail in India particularly during the kharif (rainy) season. Therefore, the penalties should be minimized. Minor offences should be compoundable by the seed inspector himself to save time and resources for all concerned.

## Integrated and Effective Implementation of PPV&FR Act and New Seed Bill

Various new legislations concerning seed, biodiversity and environment share interfaces in the implementation of certain provisions of each law. The common entity addressed in all of them is seed, and there is a need for their effective and integrated implementation.

Some overlapping issues have been sorted out to bring about harmony between the Seed Bill and the PPV&FR Act. However, much more remains to be done. For example,

- The Seed Bill requires mandatory registration of varieties/seeds, but registration is under the purview of the PPV&FR Act.
- Key differences exist between the Seed Bill and the PPV&FR Act relating to declaring the origin/pedigree (parentage) of a variety, the conditions for multilocation testing, the agency that will conduct these tests, the level of transparency maintained on grant of registration, price control and treatment of farmers' varieties. While the PPV&FR Act requires the declaration of the origin of the variety with pedigree details, the Seed Bill does not.
- As regards testing of new varieties, the PPV&FR Act lays down that the Plant Varieties and Farmers' Rights Protection Authority will conduct the DUS tests. The Seed Bill does not specify who will conduct the tests for establishing the usefulness of the new variety.

Such lacunae can be misused unless the discrepancies are resolved. Farmers have an opportunity to raise objections if they have reason to think that a variety is not what it is claimed to be under the PPV&FR Act. In the case of the Seed Bill, however, the registered varieties will be made known only through periodic notifications. The public has no opportunity to object to a new variety for any reason. This lack of transparency could mean that varieties of poor performance could get registered without giving people a chance to oppose it.

There is every need to look into each and every aspect of the Seed Bill, the PPV&FR Act and the Biodiversity Act, 2002, and harmonize the discrepancies. In the PPV&FR Act, for instance, the breeder applies for registration for a PBR. This right is valid for 15 years for crop varieties and 18 years for tree species. The Seed Bill allows the period of protection to be doubled so that the seed variety can be protected by the seed producer for

30 years for crop species and 36 years for trees. This extension of the seed owner's right, however, is a positive sign for the seed industry.

There are other lacunae too that need to be addressed. The compulsory VCU trials required for registration may delay the release of new hybrids and varieties with superior pedigrees. Any new hybrid or variety is identified after several years of breeding and testing. To impose additional testing would mean that the benefits of the value-added cultivars would not reach farmers for another two or three years. This is a loss not only to the seed industry, but also to farmers and the nation as a whole. It is not clear how the proposed National Seeds Board will manage the testing of several thousand new varieties and hybrids at loosely networked institutes and research centers. The existing manpower and infrastructure might not be equal to the mammoth task. The mandatory VCU trials could be reduced to one year, which would reduce the lock-in period for new hybrids and varieties.

On the positive side for the seed industry, accreditation of organisations for certification and private organizations for conducting agronomic trials would be welcomed. It is also indirectly stated in the Seed Bill that dealers cannot sell seed of local nonregistered varieties. This is good for the seed industry because of the proprietary nature of their products. The stipulated stock display system by dealers and distributors is a new measure to ensure good quality seed. Involving representatives from the seed industry in the National Seeds Board (NSB) too is another encouraging development.

## Benefits from PPV&FR Act and Seed Bill

The Plant Variety Protection and Farmers' Rights (PPV&FR) Act is unique in the sense that it is the first time anywhere in the world that the rights of both breeders and farmers have received integrated attention. Farmers and breeders are allies in the struggle for sustainable food security and hence their rights should be mutually reinforcing and not antagonistic. The Act adopts this approach. Under the legislation, plant breeders will have the right "to produce, sell, market, distribute, import, or export a variety; in short, full control over production and commercialisation of seeds". Genetically modified (GM) varieties are encouraged by a provision in the Act for creating a separate fast track for approving "essentially derived varieties that are identical to the parent variety except for change in a single character." Most GM varieties belong to this category, and any variety can be registered if it is "novel, distinctive, uniform and stable." The only stipulation that breeders

are required to declare is that the parental material used for breeding was lawfully acquired and their new variety “does not contain any gene or gene sequence involving terminator technology.” Violation of breeders’ rights and using a similar name or packaging to that of the breeder will invite fines up to Rs 1 million and a stringent jail term. Simultaneously, the Act recognizes the right of India’s 50 million farmers to save and sell seeds produced in their farms “including seeds of a variety protected under this Act,” provided they are not sold under brand names (the breeder’s registered name). India is heavily reliant on localized farming; about 87% of the seeds sown are currently produced and sold by farmers themselves. The breeder is rewarded for his innovation by having control of the commercial market place, but without being able to threaten farmers’ livelihoods.

Farmers and local communities also stand to gain from a National Gene Fund, whose proceeds would go toward farmers’ welfare, maintenance of community gene banks or compensation for crop failure, etc. Breeders must pay a royalty into the fund when farmers’ varieties (germplasm) or landraces (original traditional varieties that have not undergone changes) are used for breeding new varieties. The industry seems positive about the legislation. There was a long-standing demand from the seed industry for a law that would safeguard the gains made through the creative efforts of its plant breeders. The PPV&FR Act will therefore encourage higher investment in research and development in India and transfer of advanced technologies from abroad. Companies need not worry unnecessarily over the right given to farmers to sell seed of protected varieties. What is intended under the Act is the freedom of farmers to keep seeds of such varieties and enter into limited sale in their neighbourhood, and this will be possible only in the case of self-pollinated crops. In the case of hybrids, farmers will have to buy seeds every year like they do already.

In the PPV&FR Act and the draft Seed Bill, there is a recognition that farmers who want to propagate their own seed should be allowed to do so. Through the payment of royalties from breeders into a National Gene Fund, there is acknowledgment of the debt owed by those who improve plants in the modern age to their predecessors who developed indigenous and farmers’ varieties. These legislations recognize that companies that spend money making beneficial improvements to crops need some reward. The Indian Plant Variety Protection and Farmers’ Rights Act could be a model solution, one that other developing nations might follow.

## Scope and Future Challenges

### *1. R&D investment*

By introducing the PPV&FR Act, India is fulfilling its obligations as a member of the World Trade Organisation (WTO) to provide protection to new varieties developed by breeders. The Indian Government opted for this legislation, rather than protecting new plant varieties by patents, after a sustained antipatent campaign by NGOs, which fear that a patent regime would end up making farmers prisoners of multinational companies. India has framed the law so as to protect the rights of farmers. The next step for India is to decide how it will interact with other nations; at present, the only international forum set up to globally recognize plant breeders' rights is the intergovernmental organization, the Union for the Protection of New Plant Varieties (UPOV), Geneva. Since it was strengthened in 1991, it does not allow farmers to save seed and is therefore incompatible with the Indian legislation. But UPOV should not have objections since the responsibility of recognizing farmers' rights has been left to national governments.

It is generally agreed that IPR promotes innovation, increases return from investment and boosts investment in R&D. In the Indian scenario, varietal improvement was hitherto largely undertaken by the public sector research system with very little involvement from the private sector. The impact of the PPV&FR Act on public sector research and private research could possibly be different. The liberal farmers' and researchers' rights provided in the Act may restrict research investment from the private sector in self-pollinated and vegetatively propagated crop plants, but the public sector is expected to continue its predominant role and the interests of farmers are expected to be protected as per the policy of the Government of India. Also, the private sector's interest in those self-pollinated crops with high-volume seed trade is likely to continue to supplement public sector efforts. Thus, private investment in varietal improvement under this legislative regime is expected to increase in selective sectors, such as hybrid varieties of commercially attractive crop species and self- or vegetatively propagated crop species offering high-volume annual seed sale. Consequently, public sector research is expected to face stiff competition in these sectors from the private sector.

It is estimated that currently more than 400 private firms are involved in the Indian seed sector. Out of these, only a very few have their own R&D

capability on varietal improvement. In other words, these firms have been staying in the seed business with the help of varieties and hybrids freely available from the public sector. Under the emerging regime, the viability of such firms with little R&D backup may become increasingly difficult. Accordingly, the Indian private seed industry has also been changing with its lead players acquiring foreign tie-ups. Such tie-ups are likely to lead to acquisitions and mergers to eventually create a few private majors with increased compatibility and monopolistic control on varietal improvement and seed trade.

## *2. Biodiversity, material transfer and varietal protection*

Indian agriculture has wide crop diversity and various practices in crop diversification by farmers. With several crop species not offering a commercially attractive scale of operation for the private sector, state-funded research may be required to continue giving its attention to varietal improvement of these crop species without the least competition from the private sector.

Varietal protection may influence public research priorities too. While it may be possible that all varieties of crop plants bred by public research may not be protected or that all protected varieties may not be licensed out, all competitive varieties of major crop plants are expected to be protected and licensed for a consideration. Such flow of returns may provide an incentive to the breeders concerned and encourage their competitiveness and bring about general improvement in competitiveness across the public system.

The public sector can be as successful as the private sector in acquiring new genetic diversity from elsewhere through material transfer agreements. Public research can match the private sector by streamlining its research management to enhance efficiency, speed and competitiveness. Such a change may also encourage private-public collaboration to take advantage of the impressive infrastructure and human resources available with the public sector in diverse areas of crop improvement.

## *3. Public sector research*

Public sector research has a lesson to learn from the European experience in the context of varietal protection. Within a decade of introduction of such protection in Europe, much of its public research ceased to operate with reputed research institutions selling out to the private sector. While such changes are not likely to happen so speedily in India, the possibility in the



long run cannot be ruled out. Considering the necessity for a public R&D system, as well as a general realization that it must be further strengthened, it is expected that the PPV&FR Act will bring advantageous changes in crop improvement and variety development efforts to fulfil the all-round interests of Indian agriculture. The DAC of the Government of India with expert consultation and advice from ICAR has embarked on various issues for successful implementation of these legislations.

To sum up, WTO and other provisions in the Agreement on Agriculture need not always be viewed as deterring factors. The TRIPS agreement and the PPV&FR Act in the long run would act as catalysts for enhancing agricultural production and productivity in the country. We are moving from a green revolution to a gene revolution with strategic integration of biotechnology tools into Indian agricultural systems. It is time to strengthen and support agricultural systems through better funding, and scientists too should learn to adapt to the IPR regime. It is said: “the best way to learn to compete is to compete”; the right way to do this is through the right type of deliverables and innovative policies, especially on human resource development.

## Towards a Sound Policy Framework for Sustainable Seed Systems

Production and distribution of quality seed in India involves the participation of central and state governments, state agricultural universities (SAUs), and public, cooperative and private sector institutions. The seed sector in India consists of two national-level corporations (Neyveli Lignite Corporation and State Farms Corporation of India), 13 state seed development corporations, 24 multinational joint venture seed companies and a large number of private sector seed companies. Today, the Indian seed program boasts one of the biggest seed markets in the world, with annual sales at around US \$920 million. Of this, domestic offtake accounts for US \$900 million and sales in the global market account for the remaining US \$20 million. There are about 19 state seed certification agencies and 90 state seed testing laboratories in the country. The public sector’s seed requirement accounts for less than 15%. More than 85% of this requirement is met from farmer-saved seed and private seed companies. Farmers save seed of local varieties/straight varieties and use this continuously for about 3-4 years. However, they are compelled to purchase hybrid seed every year, because the hybrid vigor of  $F_1$  hybrid seed degenerates in  $F_2$ . The ideal seed supply system is depicted in Figure 7.1.

# Seed supply functions and organizations

## Rules and Regulations

## Research and Development

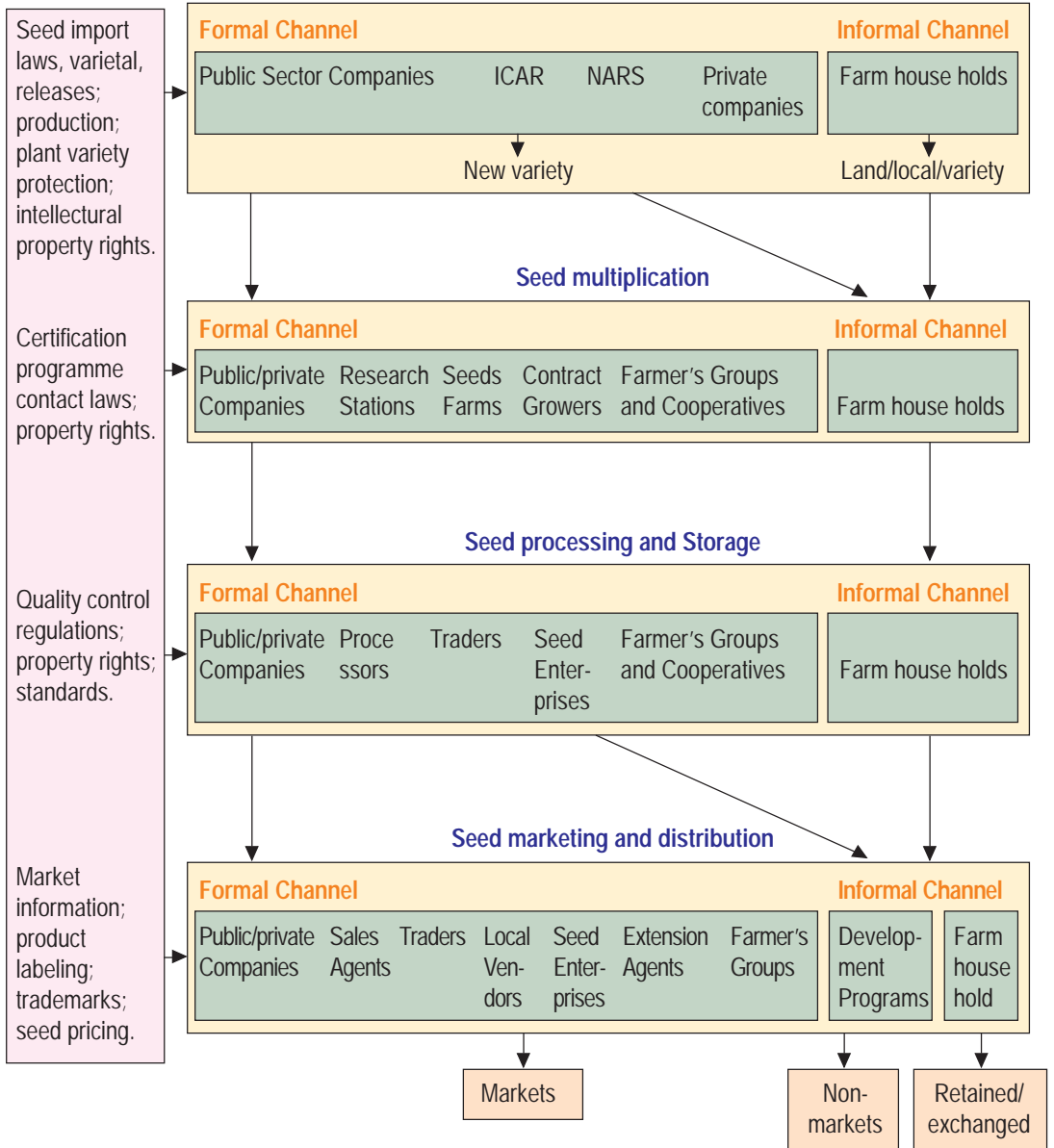


Figure 7.1. Seed system: an organizational and institutional framework.

More than 85% of the total seed sown in India is produced by farmers themselves. Moreover, the proportion of quality seed available is only 12% of the total seed used for sowing each year. Hence, large areas under food grain cultivation are still sown with seeds saved by farmers. Experimental evidence shows that cereal crops give 10–20% less yield per hectare when farmers use their own seed. Use of quality seed of improved varieties and hybrids would add about 20-30 million t to the country's annual food grain production.

In spite of the fact that India was first in the world to develop hybrids in a number of crops, the area coverage under hybrids is quite low. The proportion of hybrids in the total seed produced is not very satisfactory: cotton 23.0%; maize 59.6%; sorghum 77.6%; castor 75.0%; pearl millet 60.0%; and sunflower 29.6%. Ideally, what is needed to boost production is to increase the area under quality seed up to 100% if possible, preferably under hybrids where hybrids are available. In nonhybrid crops, the replacement rate of quality seed should ideally be 33% in self-pollinated and 50% in cross-pollinated crops. Our efforts in innovations in seed systems and seed legislation must be directed toward that end.

# Part IV: Innovative Approaches to Strengthening Local Seed Systems

**CHAPTER VI:** Seed Systems of Food-Feed Crops in the Semi-Arid Tropics of Andhra Pradesh, India

**CHAPTER VII:** Designing Alternative Seed Delivery Models: Applying Innovations

**CHAPTER VIII:** Experience of Testing Innovative Informal Seed System Models: Case Study of a Village-Based Seed Bank



# Seed Systems of Food-Feed Crops in the Semi-Arid Tropics of Andhra Pradesh, India

*Farmers' own-saved seed and the community seed exchange system together constitute the civil sector in the edifice of food, feed and seed security in India. They remain vibrant and viable in spite of several bottlenecks. This chapter presents a summary of local seed systems in four districts: Anantapur, Kurnool, Mahbubnagar and Nalgonda, which are typical of the semi-arid areas of Andhra Pradesh, India.*

## Introduction

Seed systems in Andhra Pradesh, as in the rest of the country, consist of the public, private and civil organizations. The terms 'formal' and 'informal' have been used to classify these sectors (Figure. 8.1). The most practical usage is to consider the organized/commercial supply system as comprising the formal seed sector and all other channels as the informal. The formal component is characterized by planned seed production and named and defined varieties. These are officially tested and registered as well as processed to improve quality, and come with assurances of viability, often by certification. The informal sector generally lacks these 'seed-specific' procedures, and makes less distinction between grain and seed.

## Survey

This study of the existing seed systems of food-feed and fodder crops in four dryland districts of the state was started in 2002 using informal participatory techniques and tools. Focus group discussions (FGDs) with and rapid rural appraisals (RRAs) of homogenous groups of farmers – smallholder, medium- or large-scale cultivators – were separately held in 12 representative villages across the four districts. The discussions were informal and open-ended, with the farmers given sufficient time to explain their point of view.

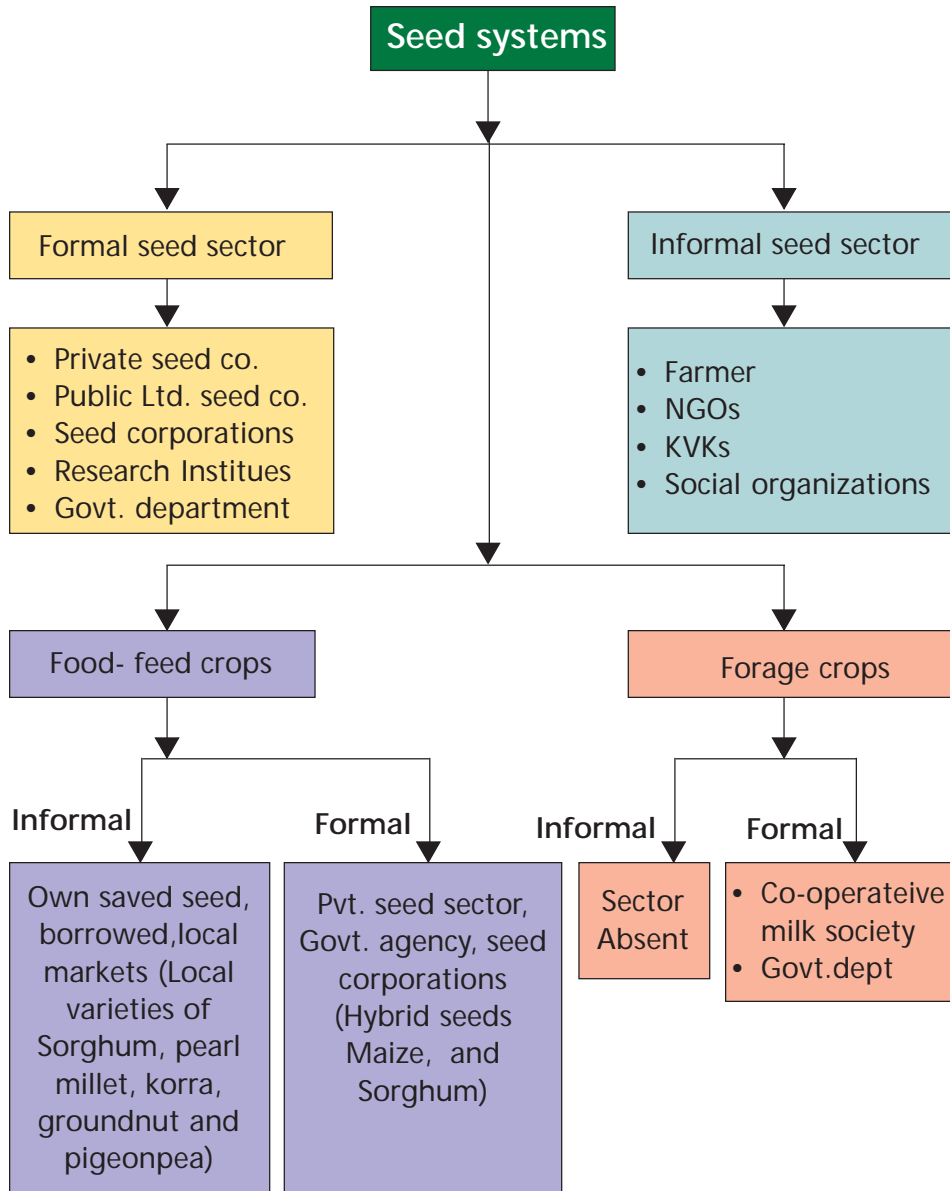


Figure 8.1. The overall schemes of seed supply in four districts of Andhra Pradesh, India.

## Agroecological Profile of the Four Districts

**Soils.** The four districts in this study represent the semi-arid and rainfed conditions typical of the Deccan Plateau in South India. While Mahabubnagar and Nalgonda fall within the southern Telangana region of Andhra Pradesh, Anantapur and Kurnool lie in the Rayalaseema region of the state (Kesava Rao et al. 2006). Deep loamy and clayey mixed red and black soils dominate these districts (Table 8.1). Andhra Pradesh has eight subagroecological regions (National Bureau of Soil Survey and Land Use Policy (NBSS&LUP 1996–97).

**Rainfall.** The regions are characterized by hot summers with low rainfall and relatively moderate winters. Nalgonda with an annual precipitation range of 560–850 mm falls in zone 7.2 and Kurnool in zone 7.1 with 436–616 mm. Rainfall is the biggest ecological factor influencing yield and crop production as most of the cultivated area is rainfed. Though the southwest monsoon sets in at uniform time, its withdrawal is delayed by about 10 days in some parts of Kurnool. Among Kurnool, Mahabubnagar and Nalgonda, the former district receives the lowest annual rainfall of about 630 mm of which about 450 mm is received from the southwest monsoon. Seasonal rainfall distribution indicates that Mahabubnagar with low precipitation from the northeast monsoon is more drought-prone in the later part of crop-growing season.

**Cropping systems.** Rice (*Oryza sativa* L.), sorghum [*Sorghum bicolor* (L.) Moench], maize (*Zea mays* L.), pearl millet [*Pennisetum glaucum* (L.) R.Br.], foxtail millet (*Setaria italica* Beauv.), pigeonpea [*Cajanus cajan* (L.) Millsp.], cotton (*Gossypium spp.*), castor (*Ricinus communis* L.), groundnut (*Arachis hypogaea* L.) and vegetables are the important crops in these districts. Pigeonpea, pearl millet and sorghum are commonly grown as intercrops in the groundnut cropping system. In Mahabubnagar and Nalgonda, pigeonpea is widely intercropped with sorghum. Crops grown in these traditional cropping systems are primarily for subsistence. The cropping system survey undertaken as part of this study between 2002-06 indicated that sorghum, pearl millet, foxtail millet, groundnut and pigeonpea were raised using own-saved seed of traditional varieties sown year after year.

**Fodder and choice of cultivars.** Farmers produce a broad range of crops and varieties not only for their own subsistence but also to meet the fodder requirement for their livestock. The stover/straw from these cropping systems is an important output for the farmers supplementing the natural



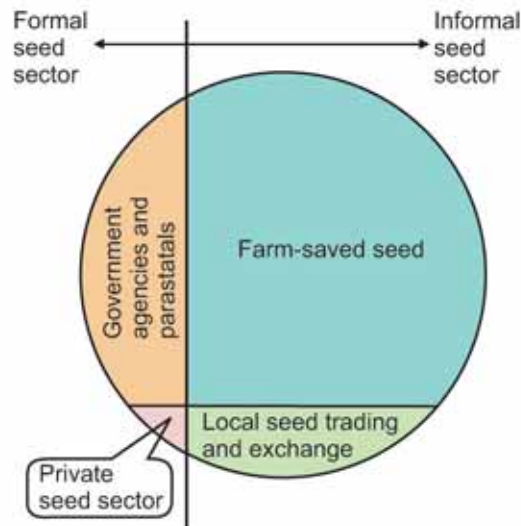
grazing of their livestock. Fodder production is usually less susceptible to drought than grains as some fodders can be harvested even in years when grain production has failed. This undoubtedly influences the farmers' choice of crops and varieties. For instance, farmers in Mahabubnagar and Nalgonda districts grow yellow-seeded sorghum varieties, which yield relatively less grain but give optimum fodder yield. In Kurnool and Anantapur districts, local varieties of groundnut are grown for a similar purpose.

**Table 8.1. Agroecological features of four project districts of Andhra Pradesh, India.**

Feature	Districts			
	Nalgonda	Mahabubnagar	Kurnool	Anantapur
Physiography	North Telangana Plateau	North Telangana Plateau	South Telangana Plateau (Rayalaseema) and Eastern Ghats	Karnataka plateau (Rayalaseema)
Soils and Available Water Capacity (AWC, mm/m)	Deep loamy and clayey mixed Red and Black soils with medium to high AWC (100-200)	Deep loamy and clayey mixed Red and Black soils with medium to high AWC (100-200)	Deep loamy to clayey mixed Red and Black soils with medium AWC (100-150)	Deep loamy and clayey mixed Red and Black soils with low to medium AWC (50-150)
Agroecological subregion (AESR)	Hot, moist, semi-arid ESR	Hot, moist, Semisemi-Arid arid ESR	Hot, dry semi-arid ESR	Hot, arid ESR
Average annual temperature (°C)	26.4	26.9	28.1	27.8
Annual rainfall (mm)	745	710	660	560
Onset of monsoon	6 June	5 June	4 June	4 June
Withdrawal of monsoon	1 Nov	5 Nov	10 Nov	10 Nov
SW monsoon rainfall (mm)	540	540	450	315
Post-monsoon rainfall (mm)	150	115	145	160
Annual PET (mm)	1615	1665	1725	1845
LGP	120-150 days	120-150 days	90-120 days	60-90 days

## Seed Delivery Systems of Food-Feed Crops

Traditional seed systems are location-specific and vary greatly within farmer communities (Figure 8.2). Approximately 80–90% of all planting material used except groundnut seed is by and large sourced from farmers' own-saved seed or the informal seed sector. The formal seed sector has made some progress in certain crops – notably with hybrids of maize in some villages of Nalgonda district but very little in others where the traditional (informal) system remains dominant. The study clearly showed that local seed systems continue to provide an effective means of seed procurement in the semi-arid districts of Andhra Pradesh



**Figure 8.2. Components of formal and informal seed systems in four semi-arid districts of Andhra Pradesh, India.**

A majority of farmers in the four districts grow food-feed crops such as sorghum, pearl millet, foxtail millet and pigeonpea and save a part of their produce as seed. Thus, farmer-saved seed of these crops meets 80–90% of the seed needs in these districts. The varieties used are invariably local landraces, and awareness about improved varieties, seed availability and seed access is poor. Seed is procured off-farm only when necessary as when own seed is not available due to drought, poverty or seed pests/diseases. The main sources of off-farm seed are local markets, relatives, other farmers and government relief agencies.

However, these statements about the predominance of the informal sector mask significant differences between crops, villages, farmer groups and their socioeconomic conditions. In the project districts, traditional seed systems are location-specific and vary greatly within farmer communities. On the one hand, food-feed crops and staples such as sorghum, pearl millet, foxtail millet and pigeonpea are generally sown with home-saved seed (Figure 8.3) for various reasons. On the other hand, in crops such as maize and sorghum where hybrid cultivars are used, usually by farmers in the large and medium landholding groups, the seed is obtained from private companies (Figure 8.4) In some cases, farmers discovered that hybrid seed, even with lower yield levels, could meet their needs for one or two further multiplications before they needed replacement with fresh seed.

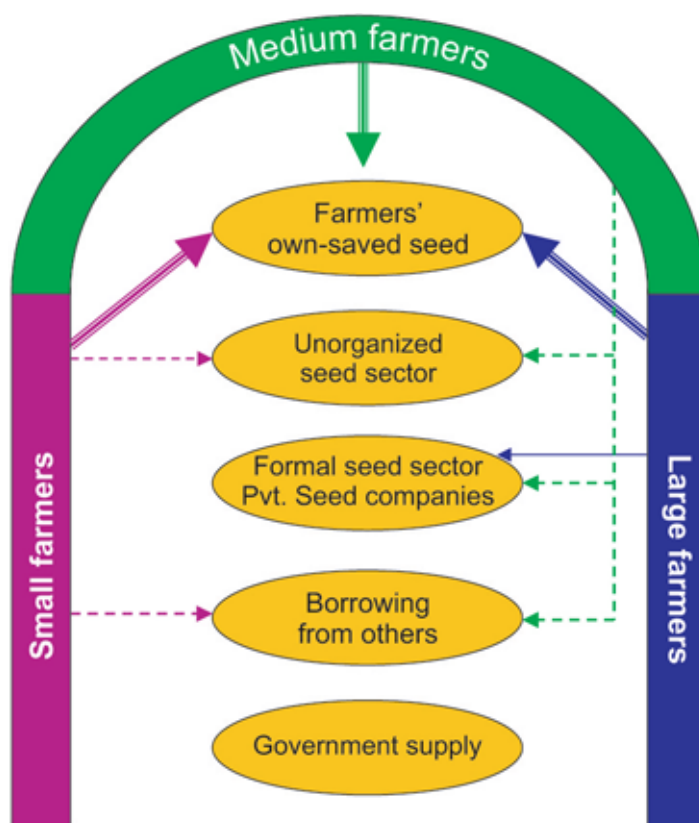


Figure 8.3. Seed delivery systems of local cultivars of sorghum, pearl millet and pigeonpea.

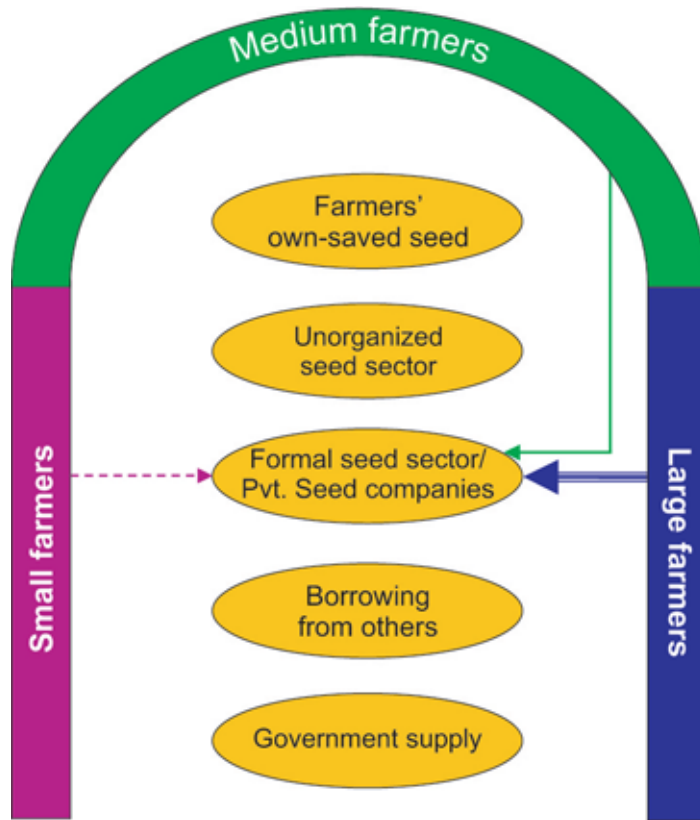


Figure 8.4. Seed delivery systems of hybrid cultivars of maize and sorghum.

## Seed Sourcing Behavior and Awareness of New Varieties

Understanding farmers' seed sources and community seed distribution channels can be a complex task. Farmers tend to obtain seeds of different crops and varieties from different sources at different times. However, with regard to their seed-sourcing behavior, it is possible to discern three main groups of farmers.

- Seed-secure farmers who can meet their own seed needs
- Farmers who source seed off-farm from time to time, out of choice
- Farmers who source seed off-farm from time to time, out of necessity

Seed-secure farmers tend to maintain their own varieties. Influx of new varieties is limited. For instance, most of the sorghum farmers in Mahabubnagar did not express any particular preference for improved varieties with a white seed coat because of their nonreliability of yield, lesser preference as food and high susceptibility to climatic vagaries, and biotic and abiotic stresses. On the other hand, the farmers of Nalgonda were positive about adopting improved cultivars of sorghum and maize. Motivating factor is higher income per unit area for large and medium-scale farmers in this district to cultivate hybrid maize, cotton, sorghum and sunflower. The awareness that large-scale farmers have regarding hybrids is quite satisfactory because of active participation of the private seed sector in Nalgonda. On the whole, however, awareness of improved cultivars is not always very well-developed in traditional farming communities (Table 8.2). This may also reflect the fact that in self-contained seed systems, the same genetic material is easily available from neighbors, which serves as an easy alternative to the risk and cost of seed procurement from informal channels.

**Table 8.2. Farmers' knowledge of seed of improved cultivars in four districts of Andhra Pradesh, India.**

Farmer group	Mahabubnagar <sup>1</sup>	Kurnool <sup>2</sup>	Nalgonda <sup>3</sup>	Anantapur <sup>4</sup>
Smallholder farmers (<5 acres)	*	*	**	*
Medium-scale farmers(5–10 acres)	*	*	**	*
Large-scale farmers(>10 acres)	*	**	***	*

\* Poor: Less than 25% of farmers aware of improved seeds; \*\* Average: 50-75% of farmers aware of improved seeds;

\*\*\* Good: More than 75% of farmers aware of improved seeds.

1. Sorghum, maize, groundnut, pigeonpea.

2. Groundnut, pearl millet, sorghum, foxtail millet, pigeonpea.

3. Maize, sorghum, pearl millet, pigeonpea.

4. Groundnut, pigeonpea.

Farmers sourcing seed off-farm usually do so from other farmers, who often are individual cultivators known in the community as reliable sources of seed. The proportion of such seed producers or distributors within a community is very small, and this type of activity is more evident in the distribution of groundnut seed in Anantapur. However, it is often not certain whether these local seed suppliers follow any special practices to produce quality seed or if they are simply well-endowed farmers who have surplus grain to sell as seed.

## Groundnut Seed System

The groundnut seed system presents a very different picture, particularly in Kurnool and Anantapur districts where the informal sector has shrunk due to agroclimatic factors and the state government has had to step in with its subsidized seed supply program through the AP State Seed Development Corporation (APSSDC). Seed sources have been related to wealth status, with big and rich farmers maintaining their own seed stocks and small farmers needing to buy or borrow seed every year. A generalized representation of the groundnut seed delivery system is given in Figure 8.5. In Kurnool, for instance, the informal sector in the form of farmers' saved seed, borrowings and local seed transactions accounts for about 50-60% (Figure 8.6) of the seed trade (Ravinder Reddy 2004a). About 40-45% of the farming community in this district depends on the subsidized seed supplied by the government agencies like APSSDC and agriculture departments. The majority of large- and a few medium-scale farmers save their seed and lend the surplus to smallholder farmers with an understanding that they repay one and a half times the quantity seed borrowed.

The situation is also different in Anantapur, where storage and borrowing of farm-saved seed has declined due to recurrent drought, poverty and prevalence of storage pests such as groundnut bruchid (*Carydon serratus*). There is a sense of insecurity among seed lenders because of frequent droughts, Hence, the majority of farmers in Anantapur, irrespective of the size of their landholding, have become dependent on the government's subsidized seed supply (Figure 8.7) (Ravinder Reddy 2004b). Sixty to seventy percent of the farmers depend on this source, but, meets only 50-60% of the total seed requirement. Therefore, farmers look to other sources of seed supply including oil mills and local groundnut traders, or buy seed within the village from better-off farmers.

The government's seed distribution program, carried out through APSSDC, has played an important role during drought years in Anantapur district. The process adopted by the corporation for seed distribution is to call for tenders from seed traders to supply groundnut seed in particular areas with the lowest bidder getting the contract. However, as there is no specification by the government as to the variety to be supplied in a particular agroclimatic zone, the contracted supplier usually procures seed as is available from the nonorganized market, oil mills, groundnut traders or even farmers. The seed is cleaned, graded, packed and supplied to farmers without specifying

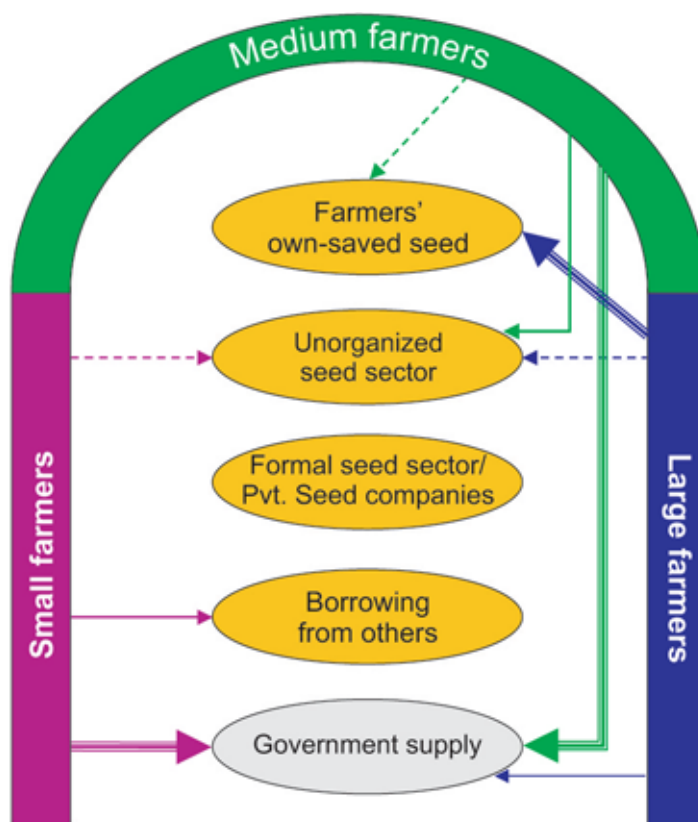


Figure 8.5. Groundnut seed delivery systems.

characteristics including the name of the variety. This often results in farmers receiving and sowing a mixture of several varieties and the cycle continues every year. With availability of groundnut seed becoming a serious issue in the last 10 years due to frequent droughts, farmers have been able to raise a good crop only about once in three years.

**Constraints to farmer-saved seed system.** A number of constraints act in concert to shrink the traditional system of farmer-saved seed in the dryland districts (Fodder Innovation Project, 2006).

- Groundnut seed is not stored for next years use due to the perceived threat of pod borer thus forcing the smallholder farmers to sell their produce and depend on external seed sources for the next crop.
- Distress disposal of produce by Farmer's due to financial and debt-servicing pressures.

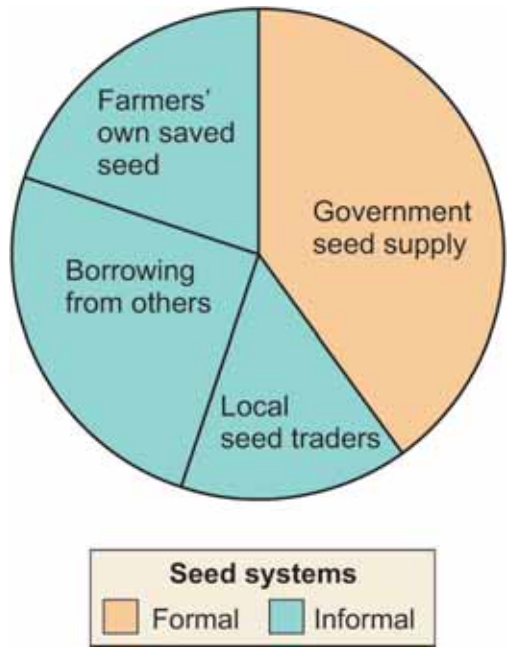


Figure 8.6. Groundnut seed supply in Kurnool district.

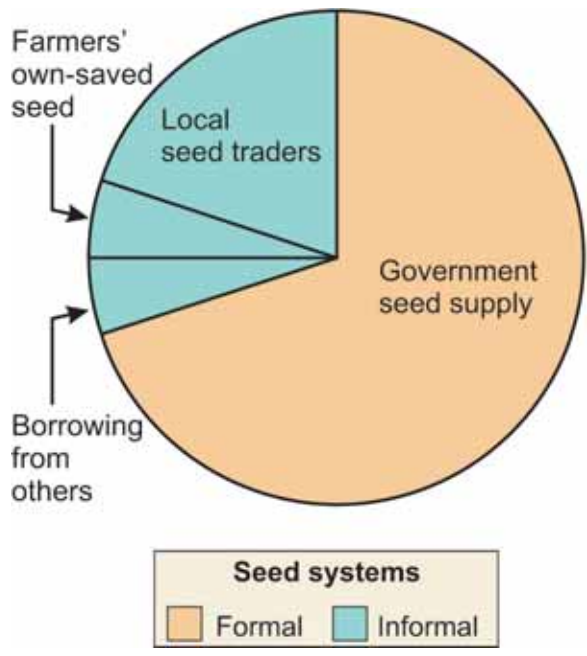


Figure 8.7. Groundnut seed supply in Anantapur district.



- Recurrent use of own saved seed for sowing resulting in lower returns to farmers
- Lack of storage facilities and the non-awareness regarding opportunity cost to increase their incomes.
- Dependence of smallholder farmers for seed on large-scale farmers, and their vulnerability to their unfair trade practices.
- Recurrent drought influencing the inflated demand for seed in the subsequent year, since drought year produces pods with shriveled kernels leading to inferior quality seeds.

**Constraints to government seed supply.** While the government supplies subsidized seed to farmers through APSSDC, it is constrained by several factors.

- Inadequate seed supply: Government seed supply is restricted to 120 kg seed per farmer irrespective of the extent of his/her landholding. Seed supply by APSSDC could only meet 40% of the total seed requirement. Therefore, the quantities supplied to different parts of the district do not always match the local demand.
- The denomination of the seed supplied is not known: It is likely that the seed supplied is a mix of different varieties and not pure types.
- The logistics are expensive and difficult to organize the seed supply by the government agencies due to high costs and other overheads.
- Government seed supply with high subsidies has been a deterrent for entry of private sector.

**Other issues.** The groundnut seed supply system, particularly in Anantapur district, has been beset by several other problems which have limited the impact of the formal seed system (Prasad et al.,2006).

- Farmers are vulnerable to unfair practices such as faulty weighing by market intermediaries. The government has constituted vigilance teams to check market malpractices but they have not been effective.
- Not all watershed/village associations are able to check unfair practices by market broking agents. In some cases, the agents have linkages with big farmers to the detriment of smallholders.
- The functioning of market yards in Anantapur district has not been efficient.
- There are conflicting references on seed characteristics across actors. Oil millers prefer longer seed with higher oil contents on other side farmers prefer smaller seeds.

## Forage Crop Seed Delivery Systems

Cultivation of forage crops in the four districts is very limited, perhaps amounting to less than 1% of the cultivated area. In addition, farmers' awareness and knowledge of forage crops and seed availability is very poor (Table 8.3).

**Table 8.3. Farmers' knowledge of seeds of forage crops.**

Farmer group	Mahabubnagar	Kurnool	Nalgonda	Anantapur
Smallholder farmers(<5 acres)	*	*	*	*
Medium-scale farmers (5–10 acres)	*	*	*	*
Large-scale farmers(>10 acres)	*	*	**	*

\* Poor: Less than 25% of farmers aware of forage seeds; \*\* Average: 50-75% of farmers aware of forage seeds; \*\*\* Good: More than 75% of farmers aware of forage seeds.

Recently, the state government's animal husbandry department and milk cooperative societies initiated drives to popularize forage crops such as *Stylosanthus hemata*, hybrid fodder sorghum and Napier *bajra* hybrid grass. They supplied free seed of *stylo* and subsidized seed of fodder sorghum and cuttings/slips of Napier grass. Most of these subsidies are availed by well-to-do farmers who can afford to cultivate fodder crops, which require irrigation.

A general representation of forage crop seed delivery systems operating in the four districts is given in Figure 8.8. In the villages of Nalgonda, dairy farmers cultivate fodder sorghum varieties, using subsidized seed supplied by the government. The role of the formal seed sector in forage seed production and distribution is negligible.

## Seed Selection and Storage

Seed selection and storage practices vary from region to region and from crop to crop. For sorghum and pearl millet, seed is selected, harvested and stored along with the stalk ear heads in earthen pots, plastic (fertilizer) bags and tin containers. Some farmers treat seed with chemicals and natural products (neem leaves, ash, etc.), while others do not treat their seed but periodically dry them in the sun after manually removing insect pests.

The majority of farmers set aside a portion of the harvest as seed. Our survey revealed that only 20–30% of farmers select seed on the basis of plant and

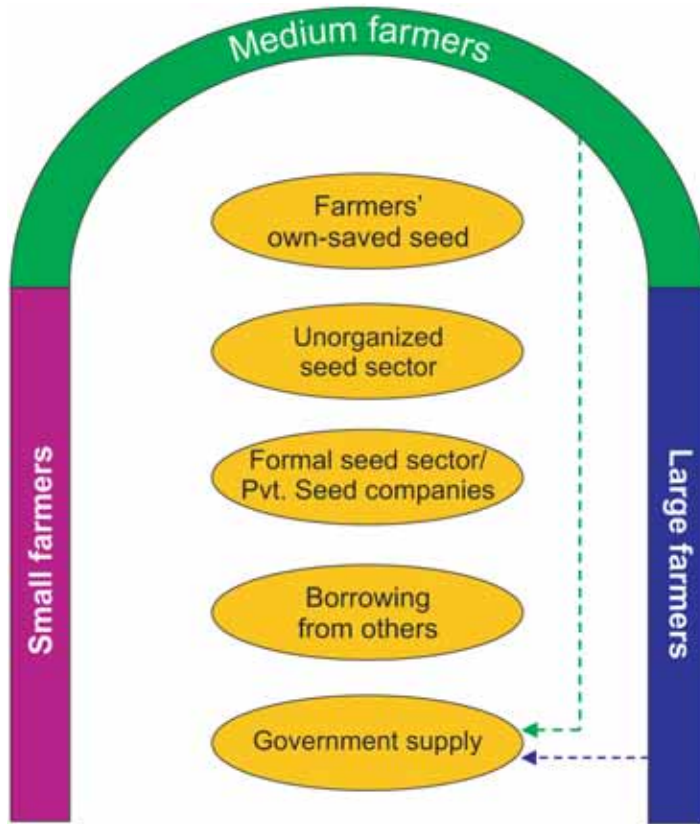


Figure 8.8. Seed delivery systems for forage crops.

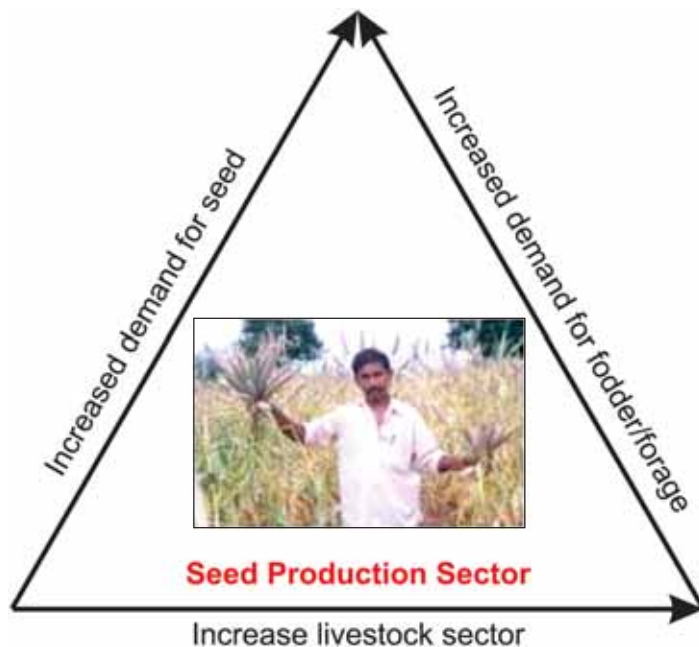
yield characters. They add wood ash and neem leaves to protect seed from storage pests. In general, such techniques appear to be adequate for cereal seed. Legume seed is more difficult to preserve. Farmers in Anantapur district face problems with groundnut bruchid, a serious storage pest, and are often left without viable seed at sowing time. Pigeonpea seed too is highly susceptible to bruchid infestation during storage, leading to poor germination.

## Livestock-Seed Interrelationship

For farmers who are engaged in crop and livestock husbandry, cash receipts from livestock products (milk, butter, *ghee*) also supplement the income. Resource-poor farmers on the other hand have limited livestock assets and are at a serious disadvantage. In rainfed areas farmers who grow cereals such

as sorghum, pearl millet and finger millet have suffered from low grain yields and poor market prices. Additionally, distant markets burden the farmer with transport charges, and cultivation areas of such cereals are shrinking, in turn affecting fodder shortage. The sale of livestock during the off-season is a common practice, and dependence on farm machinery for agricultural and transport operations is on the rise. On the whole, livestock populations are decreasing and this has a pronounced effect on small farmers.

The commercial demand for and cultivation of fodder/forage crops in the project area is weak, because animals are kept mainly on subsistence. The demand for fodder/forage seed will depend upon the development of the livestock sector in that particular village and value-added industry to livestock products. However, if the livestock sector develops, particularly in terms of value-added industry, it is expected that demand for intensive fodder/forage cultivation will increase. This will translate into “derived demand” for seed, in order to meet the fodder crop requirements. The concept of derived demand is useful, as it helps to explain (1) the interrelationships between livestock development, fodder promotion and seed production; and (2) how these factors could be used as integral components of policies that support livestock (Figure 8.9).



*Figures 8.9 Interrelationship between livestock, feed and seed sectors.*

The availability of fodder in a particular region/village is influenced by the local cropping systems. In all 12 villages surveyed in Nalgonda, Mahabubnagar, Anantapur and Kurnool districts, sorghum, maize, pearl millet and groundnut are the main food-feed crops. There is very little awareness about improved varieties of crops suitable for different seasons and soils.

In contrast, large- and medium-scale farmers are cultivating hybrid cultivars and other cash crops for higher returns per unit area, and buying fodder from other villages to feed their livestock. Fodder crops such as sweet Sudan sorghum grass are cultivated in areas where the milk cooperatives are involved in the collection of milk and supply of subsidized fodder seed. The milk cooperative is playing an important role in distributing fodder/sweet sorghum hybrid seed to farmers at subsidized rates with credit for 15–30 days. Other fodder grasses such as Napier grass and Co1 hybrid *bajra* grass have been recently introduced in most watershed villages. Within the medium- and large-scale landholding groups, 3–4 farmers per village are cultivating fodder sorghum under irrigated conditions and catering to the green fodder needs of other farmers in the village.

## An Overview of Seed Systems

In general, the study revealed that 80–90% of farmers' seed needs in the project area are met by farm-saved seed in food-feed crops such as sorghum, pearl millet and finger millet. On the other hand, in some areas, large- and medium-scale farmers growing hybrid maize and sorghum have been sourcing seed from the formal sector. As against this, cultivation of forage crops is absent and private seed companies are not particularly interested in developing or promoting them.

There is poor awareness about improved varieties, seed availability and access to seed in all villages in the project area. Seed is procured off-farm only when necessary as in times of drought or pest/disease prevalence. The main sources of off-farm seed are local markets, relatives, other farmers and government relief agencies. The formal private sector is patronized mainly by large-scale and some medium-scale farmers.

In the informal seed system, activities tend to be integrated and locally organized. The informal system embraces most of the ways in which farmers themselves produce, disseminate and access seed: directly from their own

harvest; through barter among friends, neighbors and relatives and through local grain markets or traders. The same general steps take place in the informal system as in the formal but they take place as integral parts of farmers' routine grain production rather than as separate activities. Also, rather than be monitored or controlled by government regulations, informal seed sector production is guided by local technical knowledge and standards and by local social structures and norms, including market forces. The varieties may be landraces or mixed races, or even improved varieties which have made their way into the local system. Perhaps because of their ability to meet local needs and preferences, informal channels provide most of the seed that smallholder farmers use: somewhere between 80% and 90% of the total seed sown, although this varies by region or crop (for example, the figure is much lower where hybrid maize is grown).

The schematic diagram showing the dimensions of seed systems and the various components of seed system is given in Figure 8.10. It should be noted that there is a good deal of seed flow among the different channels: formal research or commercial varieties may enter the local systems and vice versa; aid organizations may put seed from local or formal sources to the disposal of farmers. The distinction between problems of "seed availability" and "seed access" has to be assessed. The problems of seed access are much harder to answer and will depend on more detailed poverty-related information.

## Recommendations for Sustainable Seed Systems in Semi-Arid Tropics

- a. Farmer-to-farmer seed exchange and local seed markets are popular throughout the project area but these are not adequately linked with systems for improved seed. It is important that public sector research organizations, which are strong on varietal production, are linked with informal seed supplies. Locally operating institutions, such as NGOs, extension services, Krishi Vignan Kendras (KVKs), farmers' associations and other community-based organizations (CBOs) could play an important role in effecting this link.
- b. Farmer seed producers can be efficient and some of them will have the potential to expand as specialized, small- or medium-sized local seed enterprises (Ravinder Reddy 2005). For these interventions to be sustainable, they must be based on training and market development and not on direct government subsidies.

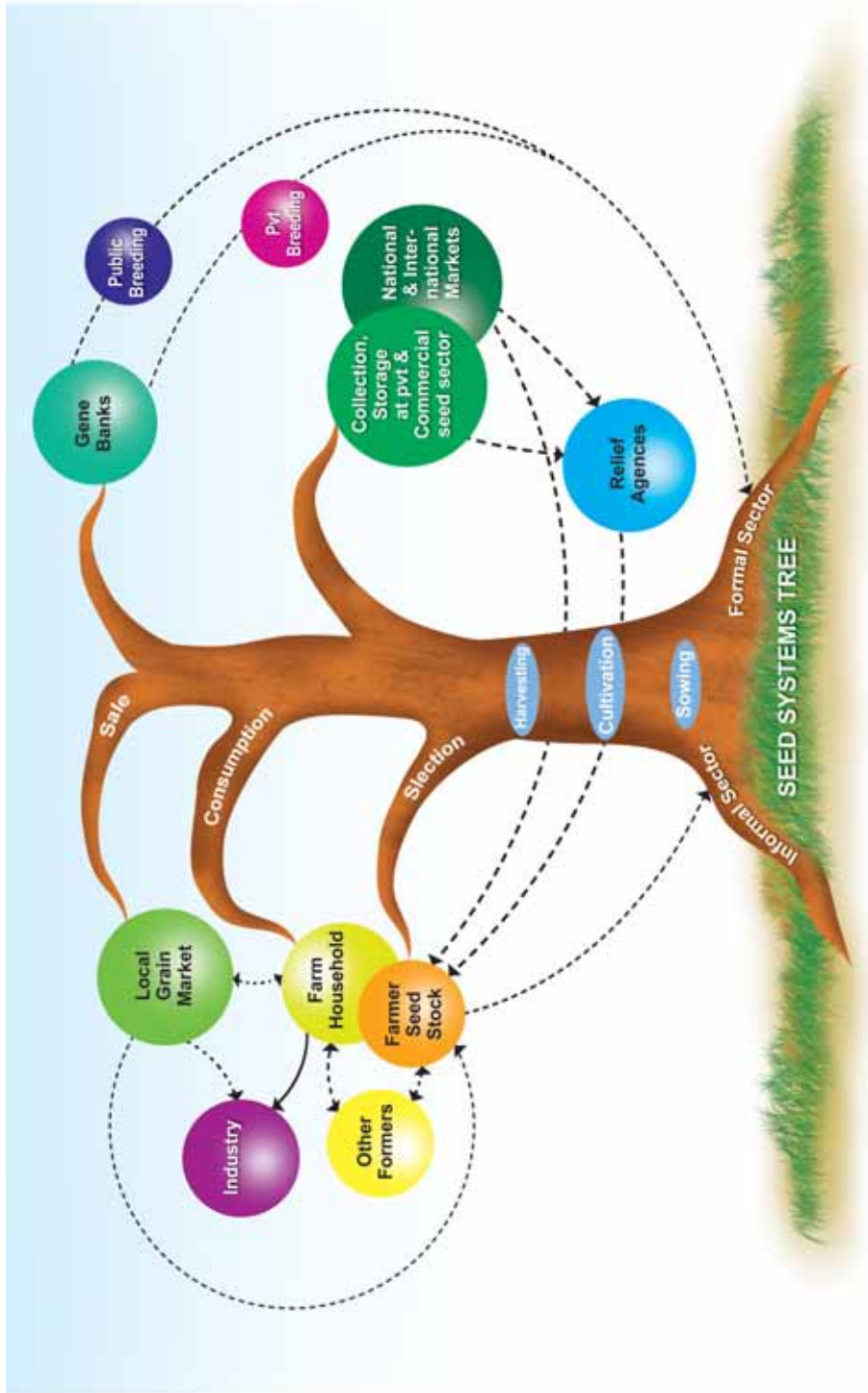


Figure 8.10. Formal and informal dimensions of seed systems

- c. Sustainable and competitive groundnut seed systems will require substantial reorientation of government philosophies and programs involving groundnut seed distribution. Rather than attempting to directly supply seed to farmers, government programs will need to provide support services that allow developing formal and informal seed enterprises to respond to market (farmer) demand for seed. This essentially seeks to offer farmers a great range of choice in terms of varieties and seed sources. Indirect subsidies may still be important for competitiveness among enterprises.
- d. Programs will need to be vigilant in eliminating subsidized seed distribution that restricts development of a sustainable local seed sector. The key to success in strengthening informal seed systems will be improving farmer and seed producer access to information on product and seed prices and market options.
- e. Development of alternative seed systems for groundnut seed production and distribution in Anantapur and Kurnool districts is an urgent need. The formal seed sector has shown little or no interest in seed multiplication of crops like groundnut with high seeding and low multiplication rates. Transportation, processing, bagging and certification costs make the seed expensive for farmers.



# Designing Alternative Seed Delivery Models: Applying Innovations

The main purpose of designing an alternative seed delivery system is to address the issues of seed supply to smallholder farmers. In this chapter we shall discuss, using specific seed delivery models, ways of strengthening seed systems to address the needs and vulnerabilities of small farmers.

## Introduction

Most community-based seed production models/schemes are initiated to address the farmers' problem of access to quality seed. The seed produced by community-based or farmer-saved seed systems is not processed and certified, and its quality is guaranteed only by its seller or the village seed committee. However, the seed so produced is low-priced, available at the farmer's doorstep at the right time and accessible to all farmers in the village. So an alternative seed supply model must impact farmers' access to quality seed of improved varieties at affordable cost.

## The Case for Strengthening Informal Seed Systems

The regulatory and legal framework governing seed in many countries hampers the development of informal seed systems. National seed regulations are mostly based on international standards, which often are incompatible with or irrelevant to the realities of farmers' seed systems. The restrictions imposed by many national seed authorities on free exchange and marketing of seed, especially compulsory variety registration and seed certification, constrain the efficient functioning of the formal seed sector and the development of alternative seed systems (von Lossau 2000). Nevertheless, regulatory frameworks are crucial for the development of national seed systems (Tripp 2003).

The major sources of seed for small-scale farmers are their own on-farm savings, seed exchange, borrowings and local traders. However, community systems of seed supply are under pressure due to recurring natural calamities, crop failure, storage problems and poverty. In drought situations, farmers depend on subsidized seed supply by government agencies, which meet only 30–40% of the seed needs of smallholder farmers (Ravinder Reddy 2005).

## Interventions required for Improving Local Seed Systems

Existing seed systems can be improved and supported by various interventions.

### 1. Facilitating farmers' access to seed through

- a. Awareness
- b. Training
- c. Capacity building

### 2. Introduction of appropriate agricultural technologies

- a. Crop diversification possibilities
- b. Crop production aspects
- c. Improved cropping systems
- d. Integrated pest and disease management
- e. Introduction of improved varieties of fodder and food-feed crops
- f. Seed health and storage management

Appropriate technologies addressing crop production constraints, adequate follow-up and monitoring are essential to ensure that the technology options introduced are appropriate to local situations.

Interventions, therefore, are needed to strengthen informal seed supply systems, such as establishing village-based seed banks as an alternative seed system. Several such alternative seed delivery models that may enable sustainability of community seed systems in the semi-arid tropics of Andhra Pradesh are given in Table 9.1 and each of them are discussed hereunder.

## Village-Based Seed Delivery Models

A study was conducted to examine the local seed systems operating in project villages in Andhra Pradesh and the farmers' response to the concept of village-based seed banks. A pilot village was selected with special emphasis on farmers operating in areas of comparatively low agricultural potential, with less fertile soils and lower and more variable rainfall, commonly known as complex, diverse and risky (CDR) areas. These farming households are likely to have limited land (of reasonable potential) and limited capital resources. The concept has been promoted by ICRISAT in its projects.

**Table 9.1. Comparison of different seed system models.**

Model attribute	Model 1	Model 2	Model 3	Model 4	Model 5
Organization/community involved	Individual farmer	VBSB <sup>1</sup>	SHG <sup>2</sup>	NGO <sup>3</sup>	KVK <sup>4</sup>
Breeder seed source	Research institute or project scientist	Research institute or project scientist	Research institute or project scientist	Research institute or project scientist	Self or research institutions
Responsibility for transport of source seed	Research institute or project scientist	Research institute or project scientist	Research institute or project scientist	Research institute or project scientist	Self Farmers
Sourcing of other inputs	Farmer	Seed bank committee/ farmers	Farmers	Farmers/ NGO	Farmers/ KVK
Choice of crop/variety	Farmers	Farmers	Farmers	NGO/farmers	KVK
Training in seed production	Project scientist (PS)	Farmers	Farmers	NGO	KVK
Seed production monitoring	Project scientist	PS, NGO, VSBC <sup>5</sup>	PS, SHG	PS, NGO.	PS, KVK
Seed quality assurance	Farmer	VSBC	SHG	NGO	KVK
Cleaning, packing and transportation	Farmer	Farmers	Farmers	NGO	KVK
Marketing	Farmer	VSBC	SHG	NGO	KVK
Fixing procurement and selling price	Farmer	VSBC	SHG	NGO	KVK
Funding for seed production	Farmer	Farmers	Farmers	Farmers/ NGO	Farmers/ KVK
Funding for seed procurement	Farmer	VO <sup>6</sup> /SBC	VO, self	VO, self, other org.	Self, other org.
Sustainability issues	Technical support, supply of breeder seed	Technical support, supply of breeder seed, funding, takeover of role once project completed, incentives for farmers for maintaining quality.	Incentives for farmers for maintaining quality, technical support, breeder seed supply, funding for procurement	Farmer produce fetches low price because there is no external quality control, certification. Supply of breeder seed, funding	Marketing, cost of seed, selection of varieties, incentives for farmers to maintain seed quality, certification

1. VBSB = Village-based seed bank; 2. SHG = Self-help group; 3. NGO = Nongovernmental organization; 4. KVK = Krishi Vignan Kendra; 5. VSBC = Village seed bank committee; 6. VO = Village organization.

Successful community initiatives were first documented by an in-depth study of seed villages in Asian Development Bank (ADB) and Tata-ICRISAT project sites in Vidisha and Guna districts of Madhya Pradesh (Dixit et al. 2005). The study provided the project with an insight into the concept and helped identify gaps so that it could be refined and implemented in the Andhra Pradesh Rural Livelihoods Project (APRLP) sites in Karivemula and Devanakonda villages in Kurnool district of Andhra Pradesh.

The main aim of establishing village based seed delivery models is to improve availability and access to seed of improved varieties for small and resource-poor farmers through capacity building of stakeholders at the community level to enhance sustainable supply of good quality seed at the right time and at an affordable price. As presented in Table 9.1 we discuss here five seed delivery models and their advantages and disadvantages.

In most developing countries, the formal seed sector is far smaller than the informal. The latter is the major source of planting material for smallholder farmers. Local seed systems contribute 80–90% of the seed requirement of smallholders (Monyo et al. 2003). Strategies to improve seed quality, access to and availability of improved varieties, multiplication and dissemination, availability of seed on time at affordable prices to resource-poor smallholder farmers can bring about changes in the food security of developing countries. Support from state/national governments and international organizations or any other funding agencies should be targeted at improving the efficiency of these investments by helping SHGs, NGOs, farmer cooperatives, community-based organizations (CBOs), Krishi Vignan Kendras (KVKs) and other schemes to improve or develop village-based seed programs relating to multiplication, quality control and marketing.

### **Model 1: Individual farmer as seed bank**

In this model individual farmer acts as the foundation of seed bank and facilitator to ensure seed supply. This model could be developed as an efficient local seed system for different crops (Figure 9.1). This seed system would be most effective for crops that require a high seed rate, which are bulky in nature, or crops that involve high transport and package costs, for example, groundnut pod. This model involves training a couple of farmers in each village in seed production technology and supporting them by supplying breeder seed and technology backstopping. The individual farmer will have the guidance and support of regional, national and

international agricultural research systems to guide him through seed production, storage and distribution of seed. The advantages and constraints to this model are given below.

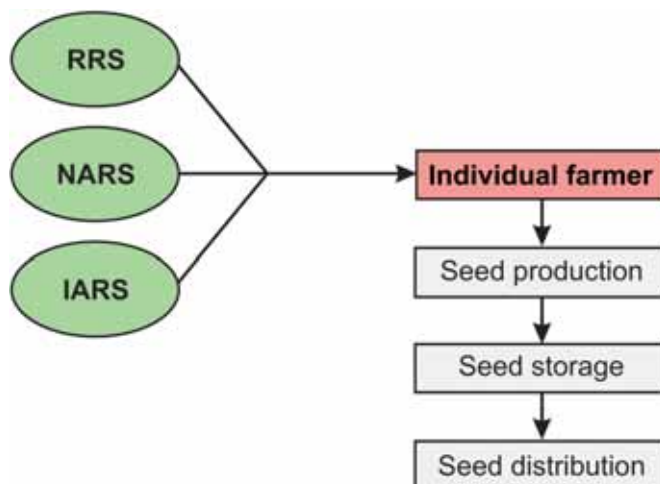


Figure 9.1 Model 1: Individual farmer as seed bank

### Advantages

- This model can be tried even in remote areas where NGOs are unwilling to take up operations.
- External finance is not required as all the costs are usually met by the farmer/seed producer.
- It provides wider scope for dissemination and adoption of improved varieties through informal seed channels.

### Constraints

- Using technical institutional services for individual farmers may be difficult to justify.
- Farmers are still unwilling to save seed because of storage pests and financial debts.
- Procurement of breeder seed would be difficult at the farmer level once the project is completed.
- There is no control on the selling price of seed.
- There is no control on seed distribution to different communities in the village.
- Seed distribution is limited to select groups.

## Model 2: Village-based seed banks

The village based seed bank model (Figure 9.2), which advocates village self-sufficiency in production and distribution of quality seed, is fast gaining ground. Seed villages or village seed banks operate with utmost transparency, mutual trust and social responsibility. Though this is not an entirely new concept, it is being promoted to reduce farmers' dependence on external inputs. In this model there is higher degree of farmer's participation and they make decisions through their participation in seed bank committee that makes decisions on selection of varieties suited to the region, seed production, storage and distribution of seed. The stake holders are farmers, who gets seed at lower prices than outside and they get the credit facilities also. The profit earned will be ploughed back to the community and seed system development activities. The village seed bank committee, self help groups and the farmers will have the guidance and support of regional, national and international agricultural research systems, including non-governmental organizations. The advantages and constraints encountered by this model are given below.

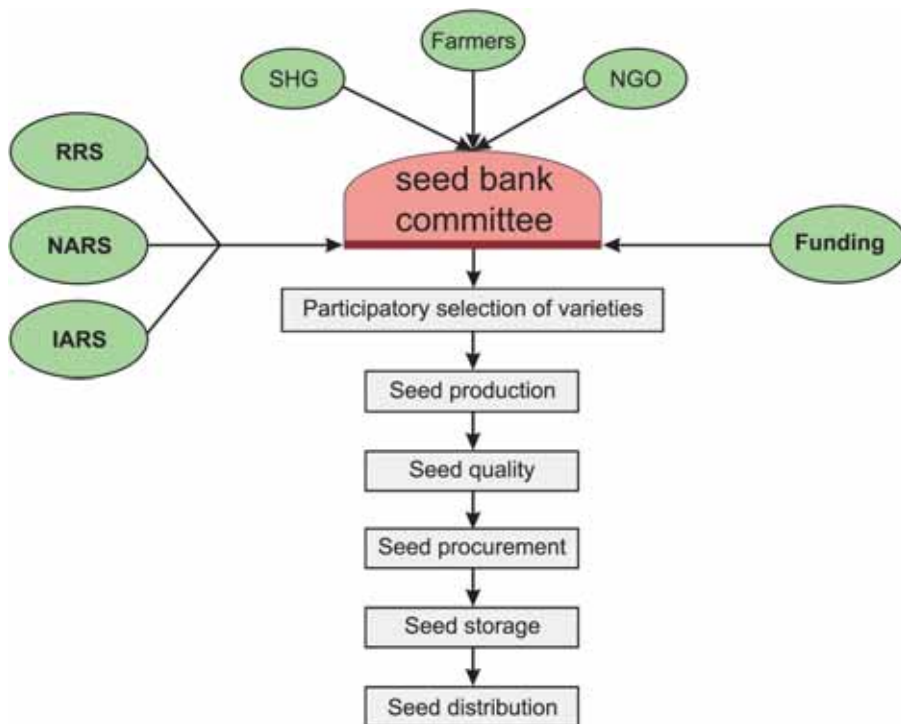


Figure 9.2 Model 2: Village based seed bank

## Advantages

- Availability of improved varieties in sufficient quantity within the village
- Assured and timely supply of seed
- Decentralized seed production
- Availability of improved-variety seed at a low price
- Improved seed delivery to resource-poor farmers
- Reduced dependence on external seed sources and hence an effective measure to curb spurious seed trade
- Encourages village-level trade and improves village economy
- Social responsibility of the seed production and delivery system
- A step ahead toward sustainable crop production
- Avoidance of diseases carried through seed (seedborne pathogens) that have been produced and imported from different agroecoregions
- Scope for farmers' participatory varietal selection
- Availability of true-to-type varieties and healthy seed

## Constraints

- Reluctance of farmers to adopt quality seed production practices
- Additional investment needed on inputs in seed production
- Lack of buy-back assurance to farmers from self-help groups (SHGs) and/or NGOs
- Paucity of proper seed storage facilities and management in villages
- Lack of funds with SHGs/NGOs for seed procurement, seed packing, storage and transportation
- Absence of a minimum support price for seed procurement
- Lack of technical support for seed production and its monitoring
- Responsibility not fixed for quality control aspects and monitoring of seed production
- Lack of availability, access and procurement of breeder seed for seed production at regular intervals

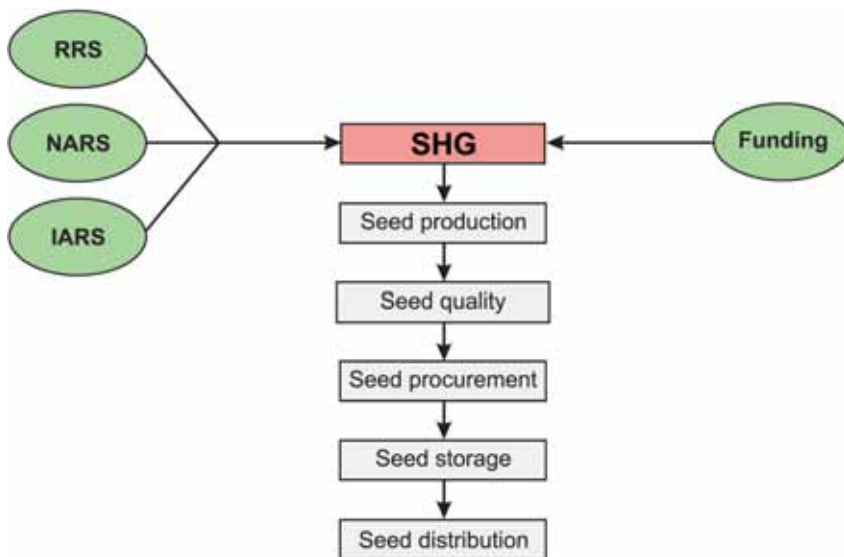
## Small-Scale Seed Enterprise Models

### Model 3: SHG-mediated system

In this model (Figure 9.3), the *rythu mithra* (farmer friends group) or SHG in each village is empowered to take up the task of seed production. Its members, however, need to adopt planning and seed production techniques

as well as secure support in terms of storage. Alternatively, arrangements may be worked out with market yards or state warehouses to have the seed properly stored.

The most critical aspects of this model are technical support and supply of breeder seed. Given such support, this model could provide significant benefits to farmers as it presents an opportunity to all members and groups to share the profits of seed production. This model performs two tasks: meeting the seed requirements of farmers as well as conserving crop genetic diversity.



*Figure 9.3 Model 3: SHG Mediated system*

### **Advantages**

- Improved access to and availability of improved varieties for all groups of farmers
- Minimum overheads
- Seed is stored in the village
- Seed available at a reasonable price and at the right time
- Control on fixing procurement and selling price of seed
- Priority for farmers' preferred varieties
- Need for institutional support for technical backstopping and supply of breeder seed



### *Constraints*

- Reluctance of farmers to adopt quality seed production practices
- Paucity of proper seed storage facilities and management in villages
- Lack of funds with SHGs/NGOs for seed procurement, seed packing, storage and transportation
- Absence of a minimum support price for seed procurement
- Lack of technical support for seed production and its monitoring
- Lack of availability, access and procurement of breeder seed for seed production at regular intervals

### **Model 4: NGO-mediated system**

In this model (Figure 9.4), an NGO is given the responsibility for a cluster of villages. It selects and engages farmers in seed production on a contract basis, giving preference to crops and varieties that are in demand in that particular area. Basically, NGOs are involved in mobilizing and training farmers/seed producers, planning seed multiplication, procuring, processing and marketing seed. As in other models, the NGO has to depend on other institutions for procuring foundation/basic seed stocks for multiplication.

### *Advantages*

- Seed production operations in cluster of villages (3-5)
- Storage of seed within the village
- Seed distribution within the operational area
- Selling price can be fixed through discussions with farmers
- Improved seed availability and access for all groups of farmers
- Minimum overhead costs

### *Constraints*

- Needs institutional support for technical backstopping and supply of breeder seed
- NGO has to depend on other institutions for procuring foundation/basic seed stocks for multiplication
- Involves more than one crop and variety in production
- Less scope for farmers' participation in selecting their choice of varieties
- More inclined toward commercial seed trade
- No scope for involving farmers in fixing procurement and selling prices
- Model needs infrastructure

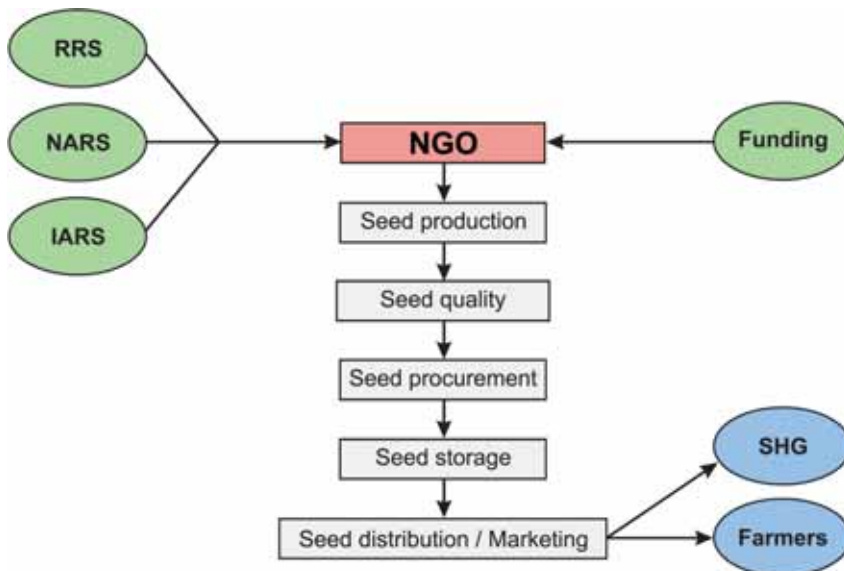


Fig 9.4 NGO Mediated system

### Model 5: KVK-mediated system

The related pros and cons of the KVK mediated system (Figure 9.5), which involves KVK as central hub in the execution of this model. In this system a KVK is given the responsibility for a cluster of villages. It selects and engages farmers in seed production on a contract basis, giving preference to crops and varieties that are in demand in that particular area. Basically, KVKs are involved in mobilizing and training farmers/seed producers, planning seed multiplication, procuring, processing and marketing seed. As in other models, the KVK has to depend on other institutions for procuring foundation/basic seed stocks for multiplication.

#### Advantages

- Seed production operations in cluster of villages (3-5)
- Storage of seed within the village
- Seed distribution within the operational area
- Selling price can be fixed through discussions with farmers
- Improved seed availability and access for all groups of farmers
- Minimum overhead costs

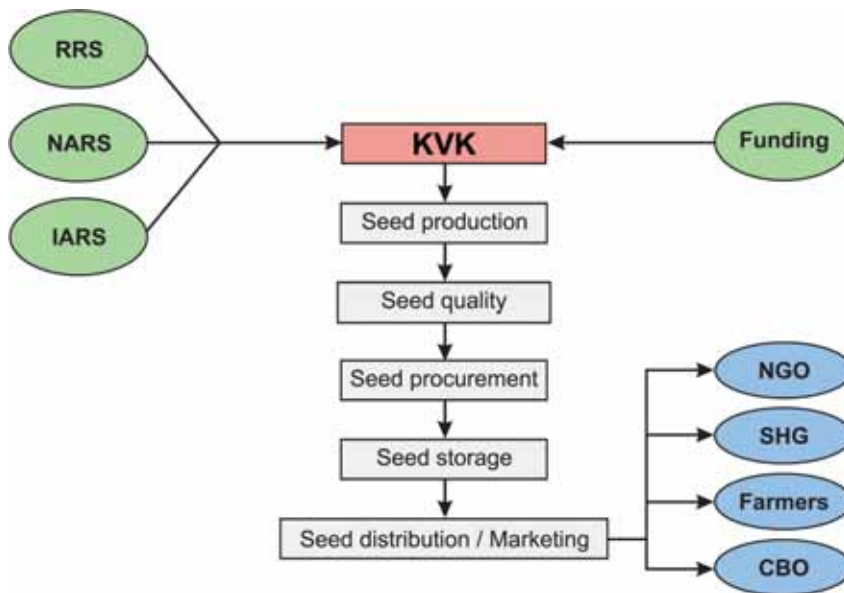


Figure 9.5 Model 5: KVK-mediated system

### Constraints

- Needs institutional support for technical backstopping and supply of breeder seed
- KVK has to depend on other institutions for procuring foundation/basic seed stocks for multiplication
- This system involves large operational area, centralized production and needs large storage place (such as a warehouse)
- Comparatively higher overhead costs
- Involves more than one crop and variety in production
- Less scope for farmers' participation in selecting their choice of varieties
- More inclined toward commercial seed trade
- No scope for involving farmers in fixing procurement and selling prices
- Model needs infrastructure

## BOX 1

### Seed System Models in Southern Africa

Many community and commercial seed supply models have been developed in southern Africa with the objective of improving seed availability (and thus adoption of new varieties) and building capacity at the community level to ensure sustainable supply of quality seed at an affordable price. This involved partnerships with national research and extension services, governmental line departments, NGOs, private seed companies and communities (Monyo et al. 2003).

#### *Model 1*

**Contract seed production by smallholder farmers for sale to commercial seed companies.** Smallholder farmers produce certified seed of new varieties identified by international research centers and sell it to private seed companies, which provide logistical support and credit for inputs. ICRISAT, for instance, provides technical support for the production of good quality seed; a private seed company offers small-scale farmers contracts to produce seed, and buys it from them subject to quality.

#### *Model 2*

**Promotion of improved seed through sale of small packets.** In this model, seed is sold in small packs (500 g to 5 kg) instead of the usual 25 kg bags. ICRISAT has demonstrated that farmers who cannot afford the larger packs eagerly buy the smaller quantities, even at nonsubsidized rates. In the past two seasons, over 80% of the seed distributed in remote areas under the small pack program was purchased, thereby helping the spread of new varieties in drought-prone areas.

#### *Model 3*

**Seed production and distribution through primary schools.** Primary schools in rural areas multiply seed of improved varieties, with technical and logistical support from ICRISAT, government agencies and other partners. The schools distribute the seed to nearby communities, ensuring that smallholder farmers have access to affordable, high quality seed at a convenient distance from their homesteads.

## BOX 2

### Community Seed Banks in Southern Africa

Community seed banks usually store seed sourced from a wide range of individuals, informal groups and NGOs. The seed is primarily that which is retained from the participants' own production with no formal quality control.

#### A typology of community seed banks

All community seed banks store seed destined for crop production. Yet seed banks vary as to their storage methods and the institutional arrangements made to set up and maintain them. Based on the storage criteria, seed banks are classified into two broad categories (Lewis and Mulvany 1997).

- **Individual seed storage:** Farmers store their own seed; this is by far the most prevalent method of storing seed in the developing world.
- **Collective seed storage:** This type of seed storage occurs when farmers, either self-organized or assisted by outside organizations, coordinate storage arrangements. Although this type of seed storage does not have roots in indigenous cultures or yeoman traditions, there has been an increase in NGO-led, farmer-participatory collective seed storage projects (Berg 1996).

The other criteria employed to further subdivide seed banks are (1) type of seed, (2) seed exchange mechanisms, and (3) seed multiplication mechanisms. Based on these criteria, five types of seed banks have been identified (Lewis and Mulvany 1997).

- **De facto seed banks:** The sum of all seed storage in a community. These have been in existence for a long time, operate informally and are made up of separately stored, locally multiplied and modern varieties of seed, kept in individual households.
- **Community seed exchange:** Organized exchange of some stored seed from *de facto* community seed banks. They operate semi-formally and are made up of individually stored, locally multiplied and modern varieties.
- **Organized seed banks:** New institutions of organized seed collection, storage and exchange. They operate formally, and are made up of individually and collectively stored, locally multiplied, modern and farmer varieties of seed.
- **Seed savers networks:** New networks that organize storage and distribution of seed, mainly farmers' and noncommercial varieties, between individuals and groups across widespread geographical locations.
- **Ceremonial seed banks:** Sacred groves and reserves. The seed (usually vegetative) is a common property resource, collectively managed and exchanged according to local (often religious) customs and traditions. Seed conservation is not the primary function of these systems but does occur as a consequence of their existence.

The boundaries between these types of seed banks are indistinct. Moreover, the factors that define these categories are not necessarily static over time. In addition, it would be possible to subsume some seed banks mentioned above into a more generalized category.

### BOX 3

#### Comparison of different types of community seed banks.

Type of seed bank	Rationale	Antecedents and institutional actors	Dominant type of seed	Physical quality of seed	Seed security	Equity of access	Economic sustainability
<i>De facto</i> community seed bank	Seed security/production	Traditional: indigenous institution	Farmer varieties	Variable	Good but under threat	Somewhat limited access for poorer, women and ethnic groups	Good
Community seed exchange	Seed security/production;	Traditional: indigenous institution;	Farmer varieties	Variable	Good	Majority have access	Good
• Tradition-al seed fairs	Improve seed exchange mechanisms	New: NGO/ community	Farmer varieties	Variable	Good	Majority have access	Good if it can be self-financed
• Seed shows/ competitions							
Organized seed banks	Seed multipli-cation	New: NGO/ grass roots group/ community partnership	Farmer varieties	Potentially improved	Improved	Access for all	Good if it can be self-financed
• Multiplying farmer varieties	/conser-vation		Farmer varieties	Potentially improved	Improved	Access for all	
• Multiplying ex situ seed	Seed con-servation	New: scientist/ NGO/ community partnership	Modern varieties	Potentially improved	Improved	Mainly benefits participating farmers	Good
• Multiplying modern varieties	Seed multipli-cation		Modern varieties	Potentially improved	Improved	Poorest benefit most	Poor
• Relief seed	Survival	New: Scientist/ farmers group partnership					
Seed savers' network	Conser-vation	NGO	Farmer varieties	Good	Good	Good	Good
Ceremonial seed banks	Religious	Traditional; Indigenous institution	Farmer varieties	Good	Good but under threat	Controlled by community leaders	Good

**Where Informal Seed Systems Are Most Suitable?** Informal seed systems may be the most appropriate in remote areas, where the formal sector finds distribution difficult and farmers can't reach seed markets easily. They may also be appropriate in smaller, limited agroecological zones, where the formal seed sector is disinterested or unable to cater because of a limited market for specific varieties or because widely marketed varieties do not suit that region. They are also suitable where the crops involved have a high seed rate and are bulky in nature, eg, groundnut pod, which translates into high transport costs.

**Strengthening the stakeholders.** Specifically, community seed programs should be provided with technical backstopping by international, national and/or state research institutes to strengthen the stakeholders and render them self-sufficient. The measures could include

- Farmers' participatory evaluation of genotypes suitable for their agroecological region;
- Maintenance of farmer-preferred varieties (landraces) currently being grown, as well as modern selected genotypes;
- Capacity building of stakeholders in seed production technologies, seed health and storage management and, in general, integrated pest and disease management strategies (Ravinder Reddy et al., 2006).
- Creating awareness of improved agricultural practices and disseminating information on improved seed material suitable for their agroecological region;
- Training farmers in better selection, treatment and storage practices of seed produced on their own farms. Training would help increase production through better use of the farmers' own genetic resources, indirectly conserving crop biodiversity in the region (Ravinder Reddy et al., 2007).
- Training farmers in seed health management and seed storage methods is important to preserve the viability of seed until the next season. Seedborne microorganisms and storage insects can make seed nonproductive during storage – a major problem for smallholder farmers. This is even more pronounced in leguminous seed, and control is particularly difficult;
- Training in selection and timely harvesting of a crop as well as postharvest precautions;
- Making varieties developed by national, international and state research centers available to smallholder farmers. These modern varieties must be

multiplied and disseminated through formal and informal seed delivery channels at affordable prices. Several such strategies have been implemented by ICRISAT and its partners in Tanzania (Rohrbach et al. 2002) and Zimbabwe (Monyo et al. 2003);

- Ensuring that village seed committee members undertake the responsibility of producing quality seed. Seed costs can be kept low only if locally produced seed stays nonprocessed and noncertified. The statutory standards of commercial seed are too expensive for the informal sector. Evolving a policy to certify village/community-based seed production without taxing smallholder farmers would offer greater scope for production of quality seed.

## Interventions Required for Developing Informal Seed Systems

- Farmer-to-farmer seed exchange systems and local seed markets function throughout the project area of this study but are not adequately linked to systems for improved seed. Local NGOs, extension services, KVKs, social organizations and farmers' associations could play an important role in improving farmers' access to quality seed. If given an enabling legal framework, such organizations could help link farmers to other seed producers, research institutions and, importantly, small commercial seed companies working in similar agroecosystems locally and regionally.
- Traditional seed systems do not fully cater to current farmer needs. Even traditional crops and varieties benefit from maintenance of source quality seed (with varietal purity and seed health). For improved or national varieties, links between farmer seed producers and sources of foundation seed are important. Even more critical are linkages that allow seed producers access to new varieties, which is not available in the informal sector.
- Farmer seed producers can be efficient; at least some of them would have the potential to expand as specialized, small- or medium-sized local seed enterprises. Farmer associations, NGOs, KVKs and social organizations have a potential role in promoting improvement in production, marketing and distribution systems for traditional farmer seed producers. This may involve linkages with research organizations for technical backstopping and the formal seed sector for improved varieties. For these interventions to be sustainable, they must be based on training and market development and not on direct government subsidies.



- Sustainable and competitive groundnut seed systems require substantial reorientation of government policies and programs involving groundnut seed distribution. Rather than attempt to directly supply seed to farmers, they will need to provide support services that allow formal and informal seed enterprises to respond to market demand. This essentially seeks to offer farmers greater choice in terms of varieties and source of seed. Indirect subsidies, however, may still be important for competitiveness among enterprises.
- Government programs may focus on the development of the informal seed sector, linking NGOs, KVKs and farmer seed producers to sources of improved foundation seed and helping to expand marketing systems for farmer-produced seed. Programs will need to be vigilant in eliminating subsidized seed distribution which restricts development of a sustainable local seed sector. The key to success in strengthening informal seed systems will be improving farmer and seed producer access to information on product and seed prices and market options.
- Development of alternative seed systems for groundnut seed production and distribution in Anantapur and Kurnool districts is eminent. The formal seed sector has shown little or no interest in seed multiplication of crops like groundnut with high seeding and low multiplication rates. Transportation, processing, bagging and certification costs make the seed expensive for farmers. Community- or village-based seed production and distribution schemes have gained popularity in recent times. The concept of village seed banks involves improved seed and technical assistance focused on 'pilot' villages in order to train farmers in seed production, storage and distribution.

## Identification of Components of Village-Based or Community Seed Production Systems

- Some of the major factors to be taken into consideration when developing village-based seed banks include need assessment, policy issues, market issues, appropriate technology, seed system studies, inputs, capacity building and funding.
- Plant breeding stands at the head of a long series of steps in seed provision. In order for the products of breeding to be delivered to farmers, there must be: (i) adequate, direct interaction between breeders and farmers, and (ii) careful coordination of all of the intermediate steps of seed provision.

- The nature of seed demanded by farmers differs. Large- and medium-scale farmers use markets to purchase uniform genetic materials that are highly responsive to chemical inputs and embody specific characteristics (eg, color and uniform grain size) rewarded by the market. In contrast, more subsistence-oriented smallholders may value characteristics such as drought tolerance, early maturity and good storage. Because of the small size of their landholdings, mixed cropping practices and strategy of minimizing production risks by diversifying the variety base, smallholders also demand smaller quantities of seed, but of a number of varieties of the same crop, and recycle seed over more seasons than larger commercial farmers.
- Strategies to improve seed quality must begin with strengthening public sector R&D on a long-term, sustainable basis. It will be especially important to build the capacity to move from homogenous seed recommendations to development and dissemination of varieties targeted to specific agroecological zones and the needs of different groups of farmers. To facilitate this process, target groups of farmers should be defined more precisely, zoning of breeding plots and field trials can be improved, and management incentive systems developed to reward researchers and extension agents when new technology is adopted by target groups.
- Strengthening public and private extension programs to increase farmer knowledge of the benefits of using new seed and transmitting information about farmer preferences to researchers will help increase the demand for new seed. Initiatives that lower production risks and improve postharvest product utilization which expands output markets are also important: seed users will be willing to pay more for new seed if their returns are increased by either lowering risks or increasing their revenues. Thus, measures to strengthen the downstream sectors of the economy are as important as strengthening the seed system itself.

Farmers need to be better integrated in every aspect of the seed system:

- as active participants in the seed research and release processes;
- as vital links in seed production and distribution through farmer-to-farmer seed exchange networks;
- as independent seed entrepreneurs producing seed for the local market; and
- as contract seed producers and informed agents/seed traders linked with private and public seed companies.

The government has a critical but different role to play in:

- providing public goods that promote efficient seed sector performance;
- developing and enforcing regulations for a heterogeneous seed sector;
- in the short- and medium-term, facilitating linkages between formal and informal sector seed suppliers as the seed system matures; and
- direct distribution of seed or seed vouchers following disasters.

Public research and extension agencies need to consider the needs of farmers who may be unable to purchase seed in the market but could benefit significantly from access to varieties with improved drought tolerance and disease resistance. For crops/regions where there is currently no commercial seed market, disseminating seed directly to farmers so that they are absorbed into the traditional system of seed supply may be a more effective strategy than trying to supply it through the higher-cost market channels, if the potential users are unlikely to be able to afford them.

- More recently, NGOs have played a role in strengthening the informal seed system, providing technical liaison with national and international research systems, educating farmers on seed selection, storage and processing, and providing technical and financial assistance to rural seed enterprises. This support has increased farmer access to improved varieties following the contraction of government-sponsored research and seed supply services. Two cautions are necessary, however: first, because NGO programs are temporary, instead of relying on them to link smallholders and research organizations, it would be better to create incentives and funding for research and extension systems to directly link with smallholder organizations. Second, a more careful analysis of the economics and sustainability of the smallholder seed firms being promoted by NGOs are needed.
- Farmers, irrespective of landholding, have draught and milch animals. Awareness about breeds and fodder is quite satisfactory due to the presence of milk cooperative societies. Small- and medium-scale farmers prefer local sorghum varieties for food and feed. There is a need for creating awareness and capacity building with regard to improved varieties of food-feed crops such as sorghum, pigeonpea and other forage crops (stylo, para grass and Napier grass). Large- and medium-scale farmers are aware of maize hybrids and their cultivation practices. Farmers are tending toward cultivation of maize hybrids because of higher returns per unit area.

Sorghum and pigeonpea crops are sown with own-saved seed by a majority of farmers across all groups. Some farmers are using  $F_2$  generation (own-saved seed) maize hybrids with 20–30% less yield.

- The commercial demand for and cultivation of fodder/forage crops in many watershed villages is weak because of a poorly developed livestock sector in which animals are kept mainly on subsistence. The demand for fodder/forage seed depends on the development of the local livestock sector and a value-added industry to livestock products. If the livestock sector develops, particularly value-added industry, demand for intensive fodder cultivation is likely to increase. This will translate into demand for fodder seed.

## Conclusion

An effective means of improving seed distribution is farmer-to-farmer seed exchange. This may be primed to a limited extent by supplies of improved seed from public agencies, agricultural research stations and nongovernmental organizations to farmers in easily accessible villages. However, such a system would be very slow. To speed up the flow of adapted improved varieties to farmers, there is a need to form a network of formal and informal or integrated seed systems, community-based organizations and research institutions, public and private seed multiplication agencies. This network will identify bottlenecks in the seed production chain, and catalyze or instigate applied and adaptive research and policy changes that may be required to ensure rapid movement of new cultivars into the local seed delivery system benefiting small and resource-poor farmers. This approach will require continued interaction between the various institutions, policy makers and stakeholders.

# Experience of Testing Innovative Informal Seed System Models: Case Study of Village-Based Seed Banks

*The concept of village-based seed banks, which advocates self-sufficiency in production and distribution of quality seed, is fast gaining currency in the effort to strengthen community seed systems. This chapter describes our experience in testing innovative seed system models and presents the case study of a village seed bank in relation to its management, capacity building, farmer-participatory selection of varieties and management of seed production, processing, storage and community-level seed trade.*

## Introduction

Many attempts are on to revive the age-old concept of seed self-sufficiency. Village seed banks bring together seed-producing farmers and organize them to work in conditions of utmost transparency, mutual trust and social responsibility under peer supervision. An attempt was made at Karivemula village in Kurnool district of Andhra Pradesh, in the year 2002 to promote the concept of village seed banks with technical backstopping provided by the ICRISAT-led Watershed Consortium. Its objective was to ensure timely supply of quality seed of improved/high-yielding varieties to all groups of farmers as an approach toward increasing productivity and creating income-generating opportunities for better livelihoods to villagers. Much prior to this intervention, a reconnaissance survey of existing village seed systems was conducted to assess the needs of the stakeholders and to plan and develop appropriate seed bank model. This involved an in-depth study of the seed banks in the pilot villages in projects being conducted by the Asian Development Bank (ADB) and Tata-ICRISAT in Vidisha and Guna districts of Madhya Pradesh, India. This helped identify gaps so that the concept could be refined and implemented in the Andhra Pradesh Rural Livelihoods Program (APRLP) sites in Andhra Pradesh, India.

## The Village Seed Bank Concept

The case studies from Madhya Pradesh provided a good deal of information. Though the communities were motivated enough to carry the process through, it was found that the lack of a scientific backup was a limitation. Such lessons learnt were put to practice in the APRLP-ICRISAT program basic objective is production enhancement to improve rural livelihoods. The main objectives of the village seed bank (VSB) concept is to make easy availability of seeds of improved cultivar to increase productivity and improve livelihoods of small-scale farmers were:

- Introduction of improved varieties and farmers' participatory selection of varieties
- Support the concept with scientific tools and community participation
- Build capacity of farmers and project staff in seed production techniques
- Incorporate lessons learnt from previous experience
- Develop a site-specific seed bank model
- Identify suitable seed production sites
- Address seed health and storage management aspects

In this process we tested two models: (1) Individual farmer as seed bank (Figure 10.1) in Devanakonda village in Kurnool district of Andhra Pradesh and (2) Village based seed bank (Figure 10.2) in four nucleus watershed villages, at Mallepally village in Nalgonda, Malleboinpalla in Mahabobnagar, Lingareddy pally in Anantapur and Karivemula village in Kurnool districts of Andhra Pradesh. Our experiences in testing these models and the results obtained are detailed below.

## The scenario

The project addressed the most common issue that is common to most villages in the project area: lack of reliable seed supply systems for food-feed and legume crops. This problem is mainly due to the fact that the parastatal seed enterprises have not been able to meet the targets involved in this task. The reality is: there is some commercial seed supply, but without hybrid technology the incentives for the private sector remain limited. Use of hybrid seed by small- and medium-scale farmers remains a dream due to lack of access, availability, timely supply and affordability. The most important aspect of hybrid technology is that the farmer has to buy seed every year. He cannot save his own seed and use it in the next season. Nongovernmental and

other local organizations have begun to experiment with a wide range of seed provision innovations, but these are limited in scope. The most effective strategy will involve a combination of public, commercial and local participation, but much work remains to be done to identify the most effective and equitable formulation.

In the meantime, farmers have inadequate access to improved seed and are unable to take advantage of new varieties developed by national and international agricultural research. Uncertain production environments, particularly the threat of drought, add to the instability of the current seed provision. Policies that seek to diversify local agriculture systems are difficult to implement because of this inadequacy. Therefore, there is an urgent need to identify appropriate policies and strategies to expand and diversify national seed systems.

### Model 1: Individual farmer as seed bank

The objective of this study was to develop a model with the “individual farmer as seed bank” supported by scientific tools to produce improved varieties that enhance crop productivity’ create access to improved varieties; and make available seed at the right time and at affordable prices to resource-poor farmers. Such a model was developed on the basis of an analysis of the reconnaissance survey and tested in Devanakonda village in Kurnool district of Andhra Pradesh

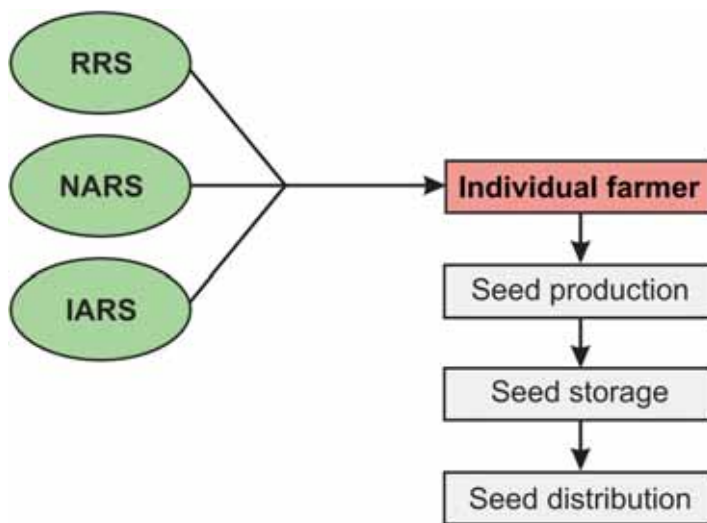


Figure 10.1 Model 1: Individual farmer as seed bank

## The Process

Our reconnaissance survey studied a village seed system that has perhaps been in operation for centuries. The big farmers here play a key role in it by storing large quantities of grain in their storehouses for two purposes: first, to sell the grain during the off-season at higher rates; and second, to sell the grain as seed to village farmers in drought years or when there is a shortage of seed. Small and resource-poor farmers source their seed from these large-scale farmers. The general practice is to repay in cash or kind 1½ times the grain borrowed. In some villages, the big farmers have started small, informal seed businesses. They grow open-pollinated varieties (OPVs) under irrigated conditions specifically for the purpose of seed in the case of groundnut, but without using breeder/certified seed and not applying any other quality parameters for seed production/certification.

In recent years, farmers in Anantapur district have come to believe that sowing groundnut seed produced in the *rabi* (postrainy) season gave higher yields than *kharif* (rainy) season seed. They also believe that sowing seed produced in fields other than their own field will yield higher. This is one of the reasons why groundnut farmers do not save their own seed in that district and depend on external sources every year.

To begin with, groundnut breeder seed was distributed (Table 10.1) to select farmers in Denanakonda in the rainy season of 2003. Exercises were conducted to make farmers participate in selection of varieties and the selected variety was

**Table 10.1. Quantity of groundnut seed distributed during rainy season 2003**

Improved Variety	Quantity (Kg)
ICGS 11	50
ICGS 76	50
ICGV 86590	50
TAG 24TMV 2	10

taken up for seed production by interested farmers in the postrainy season under irrigated conditions. On-station and on-farm capacity building of selected farmers was undertaken, and NGO personnel, watershed development teams (WDTs) and village para workers were trained in seed production techniques as well as crop protection aspects like Integrated Pest and Disease Management (IPDM), seed storage and seed health



management. Almost 75% of the land in Devanakonda is normally used for groundnut cultivation during rainy season, and there was considerable interest among farmers in growing improved varieties.

**Table 10.2. Groundnut seed produced and sold by individual farmers in Devanakonda village of Kurnool district , Andhra Pradesh.**

Year	No. of farmers	Varieties	Seed sold (quintal)		Seed retained for own use (quintal)
			Cash	Kind*	
2003	2	Improved***	18	2	25 (45) **
		Local	20	-	6 (26)
2004	5	Improved	23.5	2	21.5 (47)
		Local	39	6	22 (62.5)
2005	6	Improved	35	3	18.5 (56.5)
		Local	25	-	12 (37)

\* Seed sold on the basis of repayment in kind.

\*\* Figures in parentheses are total quantity of seed produced.

\*\*\* Improved varieties mentioned in table 10.1

It is evident from the results of the intervention that there was an increase in the number of individual farmers who took up seed production of improved varieties and sold the seed to other farmers in the village besides using for his own farm. The sales were predominantly on a cash basis rather than kind (Table 10.2). Here we see a shift in the local seed system among smallholder and resource poor farmers, where farmers are willing to invest on inputs like improved variety and good quality seed because of access to them, timely availability and affordable costs.

Several studies done in Africa have observed that modes of seed exchange are changing as most farmers are at least partially integrated into the market economy (Lewis and Mulvany 1997). The exchange of small grain-seed used to be generally free of charge, or bartered for labour, an axe, or any other material of common interest but it is now on a cash basis. Mugegeza (1996) notes that selling seed to other farmers has become the most prevalent form of exchange in Zimbabwe.

In Karivemula, there was an increase in the production of seed of improved and local varieties as well as in the number of farmers engaged in this activity. We also noticed a shift in the local seed system in which smallholder and resource-poor farmers were willing to invest in inputs like improved varieties and good quality seed because they now had access to them at the right time

and the right price. This change in attitude is a positive indication that farmers are willing to adopt technology suitable to their eco-region provided there is access and availability of materials in their vicinity. The concept of 'individual farmer as seed bank' has the potential to be a successful innovation in local seed systems. By giving the support of scientific tools to a traditional system of seed exchange, this innovation can be sustainable in disseminating improved varieties and improved production technologies at the village level.

## Pros and cons of the model

- This model can be tried even in remote areas where NGOs are reluctant to take up operations.
- External finance not required as all costs are met by farmer/ seed producer.
- It is effective and provides wider scope for dissemination and adoption of improved varieties through informal seed channels.
- Using technical institutional services may not be justifiable for individual farmers.
- Farmers are still unwilling to save seed because of storage pests and other financial debts.
- Procurement of breeder seed would be difficult at the farmer level once the project is completed.
- There is no control on the selling price of seed.
- There is no control on seed distribution to different communities in the village.
- Seed distribution is limited to select groups.

## Model 2: Village based seed banks

The village based seed bank is graphically represented below in Figure 10.2, and the process involved is discussed hereunder.

## Process

Project implementing agency (PIA) jointly with SHG implemented the project in liaison with research institutes group [Regional Research Stations (RRS); (International Agricultural Research Centers (IARC); National Agricultural Research Centers (NARC)] for technical backstopping and with donor agency for financial support. The PIA will identified the potential

farmers and project staff for training course. The course constituted of technical details about the seed production, varietal characteristics, isolation distance, purity standards, rouging of off-types, pest and disease management. post-harvest practices like seed cleaning, health and storage management were taught during training at appropriate time. Farmers with the help of PIA were encouraged to question the seed production process and formulate their own bylaws to enforce quality seed production among fellow farmers. This model was tested in four nucleus watershed villages, at Mallepally village in Nalgonda, Malleboinpalla in Mahabobnagar, Lingareddy pally in Anantapur and Karivemula village in Kurnool districts, PIA and Seed bank committee has passed informal resolution for quality seed production in their respective villages. Karivemula, a nucleus watershed village in Kurnool district, was chosen as the pilot village and the results of our intervention are presented as a case study.

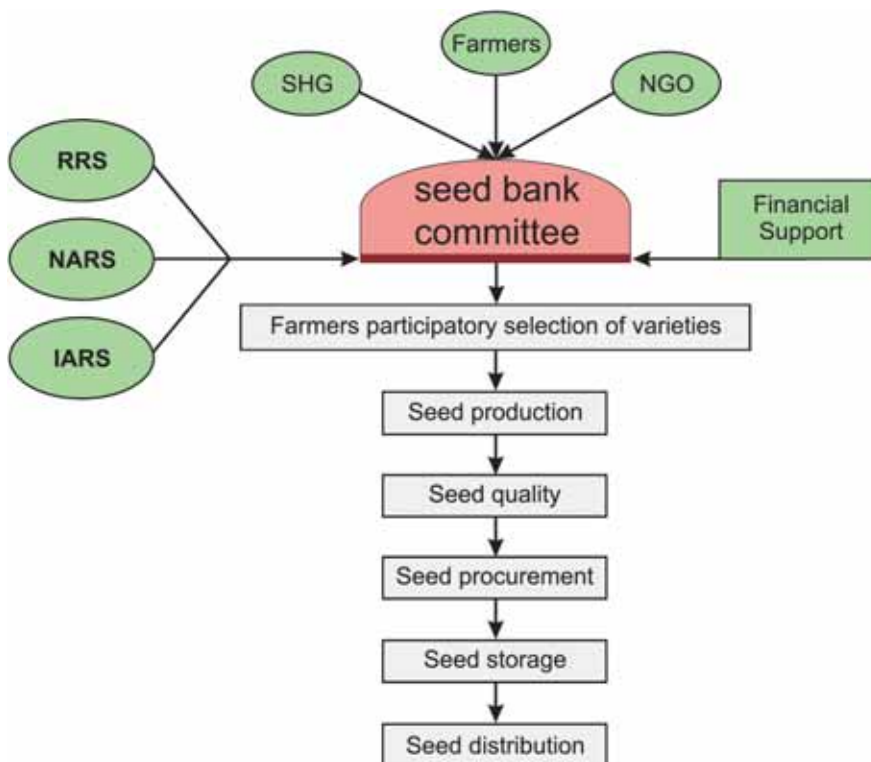


Fig. 10.2 Model 2: Village based seed bank

## 1. Reconnaissance

Before upscaling the seed village concept in APRLP project villages, a rapid rural appraisal (RRA) was undertaken to get an overall picture of the existing seed systems in the project area. This was done by interviewing a total of 36 informal farmer groups in three watershed villages each in Mahabubnagar, Nalgonda, Anantapur and Kurnool districts. Informal group discussions were held with different groups of farmers – invited on the basis of their landholdings: small (< 1ha), medium (2-5ha) and large (>5ha) – and also individual interviews with village leaders, NGOs and progressive farmers. A cross-sectional representation of small-, medium-, and large-scale farmers with agriculture as their main occupation was selected for the informal group discussions. Observations and data collected during the informal interviews in different watershed villages were documented (Ravinder Reddy et al. 2006).

### *Findings of village survey*

#### **a. Farmers' sources of seed**

The survey revealed that traditional seed systems are location-specific and vary greatly within farmer communities. Farmers' sources of seed and seed delivery systems are discussed more fully in the chapter VI: Seed Systems of Food-Feed Crops in the Semi-Arid Tropics of Andhra Pradesh, India.

- Karivemula has a vibrant agricultural economy. The most important crop is groundnut, which is grown in over 400 ha. The other significant crops are tomato (320 ha), cotton (192 ha), sunflower (160 ha), pearl millet (120 ha) and chillies (40 ha).
- Over 70% of smallholder farmers depend on other sources for groundnut seed.
- Awareness of improved groundnut varieties is poor.
- The average groundnut pod yield from local varieties is 750–1250 kg ha<sup>-1</sup>.
- Over 95% of the cultivators own small/medium-sized landholdings (Table 10.3) and are not aware of improved cultivars (Table 10.4).

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**Table 10.3. Farmers' landholdings in Karivemula.**

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Farmer category	Proportion (%)
Smallholder farmers (<1 ha)	39.9
Medium-scale farmers (1–5 ha)	55.9
Big farmers (>5 ha)	4.1

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**Table 10.4. Farmers' knowledge of seed of improved varieties in Karivemula.**

Farmer group	Awareness about improved varieties <sup>1</sup>
Smallholder farmers (<1 ha)	*
Medium-scale farmers (2–5 ha)	*
Large-scale farmers (>5 ha)	**
1. Groundnut, pearl millet, finger millet, pigeonpea.	
* Poor; less than 25% farmers are aware of improved varieties; ** Average ( 50-75% farmers are aware of improved varieties; *** Good above 75% farmers are aware of improved varieties.	

- The majority of medium-scale landholders and almost all large-scale farmers use their own seed for sowing while smallholders depend largely on external sources for seed (Table 10.5 ).

**Table 10.5. Sources of groundnut seed in Karivemula.**

Farmer category	Seed source		
	Own-saved seed	Nonorganized markets and government supply	Borrowed from other farmers <sup>1</sup>
Smallholder farmers (<1 ha)	30%	20%	50%
Medium-scale farmers (2–5 ha)	40%	30%	30%
Large-scale farmers (>5 ha)	100%	-	-
1. Groundnut seed is borrowed and repaid in kind in the ratio of 1:1.5.			

Most small- and some medium-scale farmers source groundnut seed from other farmers, nonorganized markets, moneylenders, fertilizer/pesticide dealers and government agencies which supply subsidized seed. Government agency distribution of seed for each household is not fulfilling the complete seed requirement of the farmer and hence he has to depend on other sources to fulfill his seed requirement.

### **b. Productivity constraints**

- Frequent droughts
- Low soil fertility
- Poor soil water conservation practices
- Low-yielding crop varieties
- Poor extension services on crop production
- Uncertainties of prices and markets
- In groundnut, seed accounts for a major input cost

- Poor credit facility and high interest rates charged by private moneylenders
- Poor awareness, nonavailability availability and inaccessibility of improved varieties
- Poor seed quality

Based on the findings of the survey, it was decided to organize the farmers of Karivemula to start a village seed bank on a pilot basis. The findings gave an insight into the areas that needed emphasis during mobilization. It was decided to approach the problem holistically by taking into consideration the cultivators' constraints. Quality seed needs to be facilitated with scientific practices to yield the best results; therefore, special emphasis was placed on developing an alternative seed system through a consortium approach (see APRLP-ICRISAT consortium diagram (Fig. 10.3) by involving agricultural universities, regional research stations, the state agriculture department, national agricultural research centers (NARCs), international research centers (IRCs), nongovernmental organizations (NGOs), community-based organizations (CBOs) and farmers. The following activities were undertaken to develop the village seed bank (VSB) with technical backstopping by several agencies mentioned above :

- Farmer-participatory selection of varieties
- Improved crop production practices
- Seed treatment with appropriate protectant chemicals
- Nutrient management based on soil analysis
- Appropriate soil and moisture conservation measures
- Pest and disease surveillance and integrated management
- Right harvesting time, method and seed storage techniques
- Seed health management

## 2. Formation and management of VSBs

The concept of village seed banks (VSBs) was received with great enthusiasm by self-help groups (SHGs), village organizations (VOs) and project implementing agencies (PIAs) in the watershed villages. The proposal for constituting a village committee to manage the seed bank was successfully implemented. The secretaries of the village organizations and SHGs became members of the VSB committee and were given the responsibility of seed production, procurement, storage and fixing the procurement and selling prices of seed. The PIA, usually an NGO, and the VSB committee passed resolutions to ensure the quality of seed and redistribution of procured seed

in the village. Their responsibilities also included decisions regarding allocation of seed quantities to each farmer in the nucleus watershed (Karivemula village) and satellite villages (five villages around the nucleus watershed).

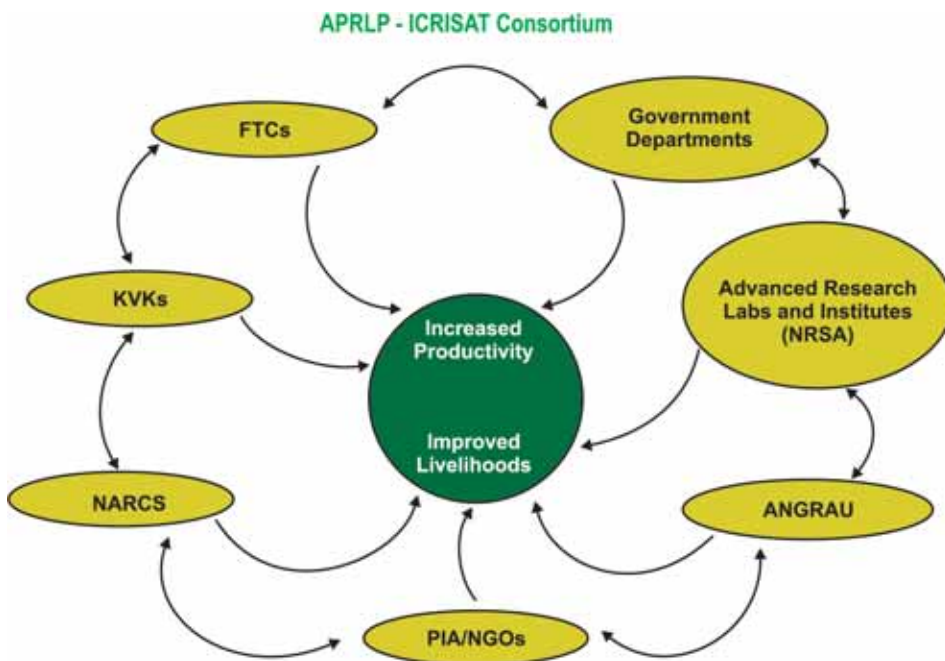
### 3. Capacity building strategy

In order to harness synergy between technology and community participation, special emphasis was placed on building farmers' capacity to produce quality seed. Systematic and timely training programs on seed production were developed, and logistics planning was used to attain the objectives.

A peripatetic training strategy was adopted for attaining maximum coverage in the given time. In each nucleus watershed village, two persons each from the PIA/NGO and watershed development team (WDT) apart from 2–3 interested farmers and ICRISAT field staff were targeted for training. The method followed in the Karivemula nucleus watershed village was replicated in all the other watershed villages of the APRLP–ICRISAT project. About 15–20 farmers were trained at each site. The consortium mode of execution is given in Figure 10.3.

The PIAs were asked to identify potential trainees from among the farmers and project staff.

They were assigned the responsibility and liberty to make arrangements best suited to their conditions. The course consisted of technical details relating to the VSB concept and seed production. The trainees were taught the principles of seed production, varietal characteristics, isolation distance, purity of seed, pest and disease management in seed production plots, and seed health and storage management. On-farm training in identifying and controlling pests and diseases and seed health management strategies was imparted. Posters and illustrations were used as teaching aids. Posters reiterating key points were displayed in the PIA's offices for ready reference after the conclusion of the training program. Farmers were encouraged to come up with queries about the seed production process and formulate their own bylaws to enforce quality seed production among fellow farmers. The PIAs, VSBCs and farmers together passed a resolution to make production of quality seed morally binding on the community.



*Figure 10.3 APRLP-ICRISAT consortium approach*

#### 4. Farmers' participatory selection of varieties

In the rainy season of 2002, breeder seed of selected varieties of different crops were procured from various research stations (consortium partner institutions) and provided at a subsidized price (Table 10.6) to farmers who volunteered to take up on-farm trials of the seed with their local varieties as control. At the end of the season, PIAs, VOs and the farmers were involved in evaluating these varieties on the basis of pod yield, fodder value and other varietal characters. The farmers of Karivemula selected three varieties of groundnut, ICGS 11, ICGS 76 and ICGV 86590, saved the seed and multiplied it during the postrainy season. In the rainy season of 2003, seed production of different crops and selected varieties was taken up. The seed was procured by the VSBC (Table 10.7) and distributed on demand to other farmers in the village.



**Table 10.6. Distribution of breeder seed (kg) in watershed villages during rainy season, 2002.**

WatershedVillage	Castor	Castor	Pigeonpea	Greengram	Sorghum	Pearl millet	Groundnut
	Jyothi	Kranthi	Asha	MGG 295			
Nalgonda	900	850	1400	1450	550	400	-
Mahabubnagar	1000	1750	1850	285	850	0	-
Kurnool	220	310	1100	330	425	900	300
Total	2120	2910	4350	2065	1825	1300	300

## 5. Monitoring seed production

During the seed production process, PIAs, VOs, seed growers and ICRISAT scientists jointly inspected the production plots. The farmers were trained and given technical guidance on the different steps of seed production: selection of the field, identification of varietal characters, removal of off-type plants (rouging), disease and pest control measures, precautions to be taken during harvesting and threshing and information on seed health, grading and storage management.

## 6. Seed health management

The following guidelines were developed to help farmers understand and adopt seed health management in select crops.

### *a. Groundnut seed and pod diseases*

- Treat the seed with Benlate® + captan (1:1) at the rate of 3 g kg<sup>-1</sup>.
- Select healthy plants for the purpose of seed and harvest pods separately.
- Maintain optimum plant water relation to harvest fully mature kernels.
- Grade the seed, and select bold seed for sowing; and discard small, shriveled, discolored ones.
- Avoid nonmature, semi mature, moisture-stressed or over mature kernels.
- Do not harvest seed crop on cloudy and wet days.
- Dry pods properly and store them in a well-ventilated place.
- Sow seeds at a depth of 3.75–8.75 cm depending on soil moisture – this facilitates good seedling emergence.
- Rotate the crop every 2–3 seasons with cereals such as sorghum, maize and millet to reduce the inoculum of soil- borne diseases.
- Uproot dead and wilting plants every week and destroy them.

### b. Castor wilt

- Treat the seed with 2 g kg<sup>-1</sup> carbendazim followed by 10 g kg<sup>-1</sup> *Trichoderma viridi*.
- Apply farmyard manure (FYM) (190 kg ha<sup>-1</sup>) mixed with *Trichoderma viridi* 2.5 kg ha<sup>-1</sup>.
- Pull out disease-affected plants at regular intervals from flowering to maturity and burn them.
- Avoid using fields prone to water logging for seed production.
- Avoid collection of seed from wilted plants.

### c. Pigeonpea wilt

- Harvest seed from disease-free plants.
- Treat seeds with Benlate® + thiram (1:1) 3 g kg<sup>-1</sup> seed.
- Intercrop with cereals sorghum, pearl millet and maize.
- Uproot wilted plants at regular intervals from flowering to pod maturity and use them as fuel.
- Avoid collecting seed from wilted plants.

## 7. Seed procurement

The farmers and members of the seed committee inspect the quality of seed not only at the time of procurement but during seed production too. A sample of the seed is kept aside from each seed lot and subjected to germination tests before seed distribution in the next season. The seed committee and the farmers fix the procurement price, which usually is 5–10% above the market price. The seed procurement prices of different crops in Karivemula during the season, November, 2004 are given in (Table10.7) and the quantity of seed procured in Table10.8. The committee decides the selling price after taking into consideration the market prices of seed and grain.

**Table 10.7. Seed procurement prices fixed by the village seed bank committee of Karivemula.**

Crop	Seed procurement price (Rs kg <sup>-1</sup> )	Grain price range in market (Rs kg <sup>-1</sup> )
Groundnut	17.50	15–17
Castor	15.00	13–14
Pigeonpea	17.50	14–16

**Table 10.8. Quantity of seed procured by village seed bank in Karivemula**

<b>2004</b>				
Watershed village seed procured	PIA (NGO)	Crop	Variety	Quantity (tons) of
Karivemula-Kurnool district	Awakening people action for rural development (APARD)	Groundnut	ICGS 11	16.08
			ICGS 76	64.34
			ICGV 86590	12.10
		Pigeonpea	Asha	9.00
		Castor	Kranthi	5.50
<b>2005</b>				
Karivemula-Kurnool district	Awakening people action for rural development (APARD)	groundnut	ICGS 11	3.00
			ICGS 76	10.00
			ICGV 86590	5.60
			TAG 24	21.70
			TMV 2	10.300
<b>2006</b>				
Karivemula-Kurnool district	Awakening people action for rural development (APARD)	Groundnut	ICGS 11	3.00
			ICGS 76	4.00
			ICGS 91114	13.00
			TAG 24	20.00
			TMV 2	162.00
		Pegionpea	LRG 41	5.36
		Chickpea (Bengalgram)	KAK 2	7.6
	JB 11	4.50		

Village seed bank concept extended to satellite watershed villages in year 2005, Karadikonda and Jillelabudka produced 6000 kg of groundnut seed (TAG 24-4000kg and TMV 2-2000kg) and 1000 kg each of TMV2 and TAG 24 respectively in Devanakonda Mandal of Kurnool district.

Thus, the committee ensures that the farmers have an incentive to sell and buy seed within the village. However, it was seen that large-scale farmers saved their own seed and distributed it to relatives and friends in the village and elsewhere.

## 8. Funding

The money required for the procurement of seed from farmers (seed producers) was secured from the District Water Management Agency (DWMA), a government of Andhra Pradesh organization funded by the Department for International Development (DFID), UK.. The amount was

extended to the VOs mediated by NGOs as a revolving fund (Figure 10.4). The VO in turn funded the HGs involved in seed production at a minimum interest rate.

## 9. Seed storage management

The PIA and SHG are given the responsibility of selecting a proper place for seed storage, normally a house with a reinforced cement concrete (RCC) roof, stone flooring and cement walls. The house is cleaned and whitewashed, and the walls and floor sprayed with Malathion at the rate of 2 mL L<sup>-1</sup>. The seed bags are sun-dried for a couple of days and sprayed with malathion before being filled. All legume seeds are sun-dried and stored in clean gunny bags and fumigated with aluminium phosphide at the rate of 3 g cu mt<sup>-1</sup>. for 5–7 days.

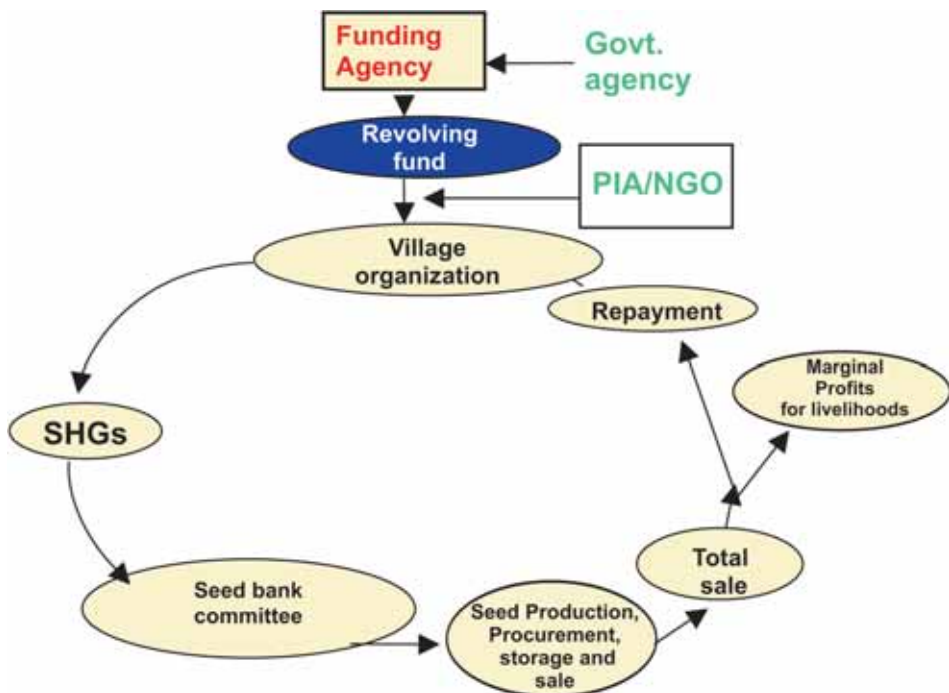


Figure 10.4 Fund flow diagram of village seed bank.

## Guidelines for seed storage

The following guidelines are followed for proper storage of the seed.

### *a. Preventive measures*

- Use new bags to avoid insect infestation and mechanical mixture.
- Thoroughly clean and whitewash the storage structure.
- Disinfect seed storehouse with a residual spray of insecticide such as malathion 50EC (one part per 100 parts of water) at the rate of 5 L 100 sq m<sup>-1</sup>.
- Make sure that stacking and labelling is done properly while arranging seed bags.
- Ascertain that seed is properly dried before storage.
- Store seeds of different types such as cereals and pulses separately to avoid the spread of insect attack.

### *b. Maintenance of seed store*

- Make sure that the processing units and storage structures are always clean.
- Keep all sweeps away from the seed godowns so that insects do not breed and reinfest seed.
- Carry out inspections of seed lots in storage structures at least once a fortnight. Fumigate seeds thoroughly if insect infestation is detected.
- Fumigate with aluminium phosphide (2–3 tablets of 3 g each per ton of material with an exposure period of 5–7 days or 1 tablet per cu m space). Fumigation may be done at intervals of 40–50 days.
- Carry out periodic sampling (30–40 days) to check for insect infestation.

## Seed treatment

Regardless of their circumstances or location, farmers are invariably concerned about the quality of the seed they use. The time from sowing to plant establishment is of critical importance in nearly all cropping systems. Based on their own experience and the good results obtained from farmers' participatory on-farm trials on seed treatment (Ravinder Reddy et al 2006), the VSBC resolved to treat seed prior to distribution. They concluded that

treatment plays an important role in protecting seed from seed and soilborne pathogens; also, it works out to be more effective and more economical. The VSBC's treatment of seed is detailed in Table 10.9.

**Table 10.9. Seed treatment schedule adopted by village seed bank.**

Crop	Seed treatment	Dosage (g kg <sup>-1</sup> seed)
Pearl millet	Thiram	2.5
Groundnut	Benlate® + captan (1:1)	3.0
Pigeonpea	Benlate® + thiram (1:1)	3.0
Castor	Carbendazim	2.0

## Benefits of seed treatment

- Inexpensive and effective method of disease control
- Easy to apply and saves time
- Uniform protection all over field
- Inexpensive crop establishment insurance up to seedling stage
- Protects seed and seedlings from seed and soilborne diseases
- Increases germination percentage.
- Reduces number of chemical sprays and environmental pollution
- Increase in yield.

## 10. Seed distribution /Marketing

The VSBC resolved to sell seed only to farmers of the village and release small quantities to satellite villages. In case of there being a surplus, it would be sold to individual growers of other villages through their SHGs at the same price as to local farmers. The seed marketing was never been a constraint because VSBC constituted of members from CBO supported the seed bank activities. The selling price was fixed at less than the commercial market price and more than the procurement price. The difference in price was to cover expenses such as the premium paid to seed producers, processing costs, salaries, wages, electricity, bags, chemicals, rent, cost of seed treatment, transport and cleaning losses and interest on the capital. The quantity of seed distributed in the village is given in Table 10.10.

**Table 10.10. Seed distributed in Karivemula**

Year/crop	Quantity seed distributed (quintals)	No. of Farmers benefited	Area (ha) under improved varieties
2004			
Groundnut	92.0	46	36
Pigeonpea	8.65	83	173
Castor	5.00	110	-
2005			
Groundnut	145.3	68	142
2006			
Groundnut	202	87	202
Pegionpea	5.36	76	137
Chickpea	12.1	96	26

Farmers of the neighboring villages approached the VSBC of Karivemula for seed in May-June, and priority was given to those who had registered in advance by paying Rs 100. In satellite villages, the responsibility of seed distribution was given to the respective SHG. While distributing seed (groundnut pods) to farmers, a pack of seed treatment fungicide was also given with appropriate instructions and advice on improved crop management practices.

## 11. Adoption of improved varieties

The area under improved groundnut varieties in Karivemula increased from 1.2 ha in 2002 to 8 ha in 2003, 36 ha in 2004 and 142 ha in 2005, and 202 ha in 2006 and the number of farmers adopting new varieties from 3 in 2002 to 87 in 2006 (Table 10.10).

**Table 10.11. Adoption of improved varieties of groundnut by farmers in Karivemula.**

Variety	Number of farmers				
	2002 rainy season <sup>f</sup>	2002 postrainy season	2003 rainy season	2004 rainy <sup>f</sup> season	2005 rainy season
ICGS 11	1	1	4	17	4
ICGS 76	1	2	6	21	7
ICGV 86590	1	1	3	12	11
TAG 24	-	-	-	5	24
TMV 2	-	-	-	-	22
Total	3 (1 ha)	4 (2 ha)	13 (8 ha)	50 (36 ha)	68 (142 ha)

About 400 ha was expected to come under improved varieties in the rainy season of 2008 in the nucleus watershed village. Information and awareness about improved varieties and VSB activity spread to the satellite watersheds through farmer interactions, relatives, farmers' day celebrations and local newspapers.

**Table 10.12. Effect of improved varieties of groundnut on pod and haulm (fodder) yield.**

Variety	Pod yield (kg)	Increase in pod yield over local variety (%)	Haulm yield (kg ha <sup>-1</sup> )	Increase in haulm yield over local variety (%)
ICGS 76	2380	73	2670	34
ICGS 11	2128	54	2200	11
ICGV 86590	1916	39	1968	1
Local cultivar	1374	-	1989	-

## Livelihood options

Since improved varieties were now available within the village at reasonable prices, farmers were able to take up sowing on time. This led to a 55% increase on an average in pod production, 15% increase in fodder production (Table 10.12), and Rs 12,500 ha<sup>-1</sup> increase in income over the local variety in 2003–04. In many parts of the semi-arid tropics, crop residues are the main source of feed for livestock. In India, crop-residues from dual-purpose crops including rice, wheat, sorghum, pearl millet, pulses and oil seeds account for up to 60% of total feed (Parthasarathy Rao and Bhowmick, 2001). In the northern part of Nigeria, the major sources of feed are crop residues of sorghum, maize, millet, cowpea and groundnut. Despite the massive amounts of crop residues saved and fed to livestock, feed shortage and low quality feed remains a major constraint to smallholder livestock production. (Roothaert et.al.2006a) . These models or technologies developed consist of dual-purpose legume and cereal varieties that have higher food and crop residue yields, better feeding value of crop residues, and management practices that improve either yields or feeding value, or both, (Roothaert et.al. 2006b). In India an improved dual-purpose groundnut variety, ICGV 91114, produces higher pod and fodder yields than the local variety, and has the potential to raise milk production by 10% due to high feeding value of its haulms (ICRISAT, 2006).



The adoption of dual-purpose improved groundnut varieties led to an improvement in livelihoods in terms of increased production and higher returns per unit area.. The VSB concept also set in motion an alternative seed system, guided farmers toward much-needed seed security and increased awareness about new/improved crop varieties and production technologies. It also contributed significantly to revenue generation (Table 13.)

**Table 10.13. Revenue generated by self-help groups through village seed bank in Karivemula, 2004.**

Crop	Quantity of seed seed procured (quintal)	Seed purchase price (Rs kg <sup>-1</sup> )	Seed selling price (Rs kg <sup>-1</sup> )	Gross profit (Rs)
Groundnut	92.42	17.50	20.00	23105.00
Castor	5.00	15.00	20.00	2500.00
Pigeonpea	8.65	17.00	22.00	4325.00
Total income				29830.00
Expenditure <sup>1</sup>				8500.00
Net income				21330.00

1. Includes seed store rent and expenses on seed cleaning, grading, packing and pest control.

## Positive Results and Lessons Learnt

The implementation of the seed bank concept in the APRLP-ICRISAT project sites provided a good learning opportunity for the project staff. Encouraged by the results in Karivemula, the government of Andhra Pradesh has adopted the seed bank model developed by ICRISAT for upscaling in 322 mandals in the state to strengthen alternative seed systems. The results of this intervention will encourage SHGs, NGOs, KVKs and farmers to invest in small-scale rural seed enterprises, which will duly enhance adoption and dissemination of new improved varieties and production technologies.

- The seed production capacity of smallholder farmers can be developed by providing linkages to institutions and NGOs for technology backstopping.
- The program disseminated improved open pollinated varieties (OPVs) to smallholder farmers in dryland areas. This can greatly accelerate the diffusion of improved varieties.
- Small seed producers are motivated by the incentive of higher procurement prices for seed produced by them.
- The new varieties are of longer duration than the local varieties.

- There is low preference/acceptability in the market for the new varieties.
- The selling price of improved varieties is lower by 10–15% in the local markets.
- The new varieties yield 55–60% more than the local cultivar.

## Frequently Asked Questions by Farmers

- “Who will buy our seed? At what price?”
- “Where do we store seeds until the next season, protected from biotic and abiotic factors?”
- “Can we store seed safely in village conditions?”
- “Can we sell seed without any legal problems?”
- “Where can we source breeder seed?”

## Farmers’ Concerns

- Maintaining minimum isolation distance is a practical problem during the rainy season. Pigeonpea and castor, which need such a practice, are grown in almost all villages in Nalgonda and Mahabubnagar districts, particularly by smallholder farmers.
- Seed production in the postrainy season is acceptable but the lack of assured irrigation is a constraint. Low yield and high cost of cultivation are concerns for pigeonpea during the postrainy season.

## Advantages of VSBs as farmers see them

- Availability of improved seed varieties in sufficient quantity within the village
- Assured and timely supply of seed
- Decentralized seed production
- Availability of improved variety seed at low prices
- Improved seed delivery systems to resource-poor farmers
- Reduced dependence on external seed sources and hence an effective measure to curb the spurious seed trade
- Encourages village-level trade and improves village economy
- Invokes social responsibility of farmers in seed production and delivery
- A step ahead toward sustainable crop production
- Avoids introduction of diseases through seed (seedborne pathogens) produced and imported from different agroecoregions
- Scope for farmers’ participatory varietal selection
- True-to-type varieties and healthy seed within farmers’ reach.

## Constraints

- Farmers' reluctance to adopt quality seed production practices
- Additional investment for inputs in seed production
- Lack of buy-back assurances from SHGs/NGOs/VSBs
- Lack of proper seed storage facilities in villages
- Lack of funds with SHGs/NGOs for seed procurement, seed packing, storage and transportation
- Difficulties in fixing a minimum support price for seed procurement
- Lack of technical support for seed production and monitoring
- Assigning responsibility for quality control aspects and monitoring of seed production
- Availability, access and procurement of breeder seed at regular intervals

## Impact

Planning to scaling-up of the VSB concept, the model developed by ICRISAT to other villages in Andhra Pradesh by the Department for Agriculture.

## Basic guiding principles for developing sustainable alternative seed systems

- A seed bank should be built upon a solid understanding of all the seed systems farmers use and the role they have in supporting livelihoods. The local system is usually more important for farmers' seed security and has been shown to be quite resilient. Depending on the context, the focus of a seed bank should normally be on keeping the local seed system operational. However, such systems are often not sufficiently understood because of their complexity. There is a need for more emphasis on understanding local seed systems; their role in supporting livelihoods, and on needs assessment.
- Alternative seed systems must be effective with the immediate objective of facilitating access to seed of appropriate and improved varieties.
- Seed bank interventions should facilitate farmers' choices of crops and varieties.
- Seed bank interventions should aim at improving, or at least maintaining, seed quality. They should facilitate access to improved varieties that are adapted to the local environment and the needs of farmers, including their fodder requirements and nutritional needs.

- Monitoring and evaluation should be built into all seed bank interventions to facilitate learning by doing and thereby to improve interventions.
- An information system should be put in place to improve from pilot village learning, as a repository of information gained from cumulative experience. Such information systems should be institutionalized at the national level.
- The intervention must have a strategy to move from the pilot village level to the district and state levels; capacity building or a development phase should be included in the design of the intervention.

## Conclusion

Smallholder and marginal farmers are often at a disadvantage in absorbing agricultural technology related to genetic enhancement of the productive potential of crops. This is because of the system of centralized production and distribution of improved seeds. Though the organized sector is able to produce a large quantity of seeds, the supply chain is unable to cope with the demand across the length and breadth of the country. Thus, the farming community depends to a large extent on own-saved seed and external sources such as nonorganized markets, borrowings from other farmers and government departments.

The formal seed sector has made a small contribution in seed multiplication for crops like groundnut with high seeding rates and low multiplication rates. However, transport, processing, bagging and certification costs make the seed too expensive for smallholder farmers. For such crops, the most economical way would be to produce seed at the village level through community-based seed systems and sell it to local communities without incurring the extra costs of processing and certification. Village-based seed banks provide an alternative solution to this problem and help farmers become self-reliant. This initiative needs both organized communities and institutional technical backstopping to strengthen local seed systems. Efforts toward upscaling seed banks resulted in encouraging learning outcomes.



# Part V: Seed saving and quality control

**CHAPTER IX: Developing a community based seed system**

**CHAPTER X: Quality assessment of farmers saved sorghum grain/seed in the community**

# Developing a Community-Based Seed System

*The lack of scientific knowledge of seed production, quality control and innovative interventions are the main handicaps of farmer-saved seed systems, which have resulted in inferior quality seed and poor outputs. This chapter is a synthesis of knowledge that needs to be imparted to community seed systems to produce, process, treat, test, store, trade and barter and re-sow seed for food, feed, fodder and livelihood security. The mechanisms of creating and training seed growers' associations to promote seed quality are also detailed here.*

## Introduction

Farmers have for centuries selected and saved seeds to grow in the next season. They learnt to cross-pollinate plants by hand or by mixing varieties within the same field to maintain and adapt their crops. Thus they assisted in the evolution of locally adapted crops. Some of these varieties may be resistant to certain pests, and others more tolerant of salinity or drought. Some varieties can be sown or harvested earlier or later in the season. Traditional crops also provide a wide range of nutrients to the diet. The seeds of traditional crops and knowledge of their growth and use are therefore important resources and should be conserved and used.

The quality of farmer-saved seed is constrained by poor harvests, inadequate on-farm storage facilities, insufficient means to multiply quality seed and poor seed distribution systems. There is thus a need to strengthen the local capacity to produce, store and distribute seed of many crop varieties, including some landraces/farmers' varieties, which are useful in diverse and evolving farming systems.

## Steps for Strengthening Community Seed Production, Saving and Storage

- (a) Appropriate policies for seed production and distribution are needed to help focus government-supported initiatives on the varietal needs of resource-poor farmers with particular attention to the needs of women

farmers, and to minor crops that are inadequately covered by the private sector.

- (b) Promote small-scale seed enterprises and strengthen linkages between gene banks, plant breeding organizations, seed producers and small-scale seed production and distribution enterprises.
- (d) Strengthen seed quality control schemes for small-scale enterprises and provide appropriate incentives, credit schemes, etc. to facilitate the emergence of seed enterprises, paying attention to the needs of the small farming sector, of women and of vulnerable or marginalized groups.
- (c) Support and strengthen farmers' organizations in order that they can more effectively express their seed requirements, paying particular attention to the needs of women and of vulnerable or marginalized groups.
- (d) Provide training and infrastructural support to farmers in seed technology in order to improve the physical and genetic quality of farmer-saved seed.
- (e) Develop approaches to support small-scale, farmer-level seed distribution, learning from the experiences of community and small-scale seed enterprises already in operation in some countries.
- (f) Seed quality of farm-processed seed can be as good as and often better than certified seed if farmers take the first step by selecting the right variety, controlling purity with good rotation, and follow standard agronomic practices to achieve disease and weed control. They can choose a mobile seed processor that can offer the equipment, management and expertise to achieve the standard required.

## Seed Quality Guidelines for Farmers

### *a. Seed production*

- A seed is likely to give rise to a plant that has characteristics similar to its parent plants, unless the parents come from  $F_1$  hybrid seeds. Therefore, seeds should be selected from strong and healthy plants.
- It is very important to remove nonhealthy or diseased plants from the field as soon as they are seen. Plants with nondesirable characteristics should be removed from the field before they flower and pollinate other plants, but after making sure that there is a diversity of characteristics in the field.
- If a farmer wants to develop or introduce specific characteristics in a plant, he can do so by controlling the pollination of plants chosen for seed production. To combine desirable characteristics, the farmer can transfer the pollen from a chosen plant to fertilize another chosen plant. For plants such as maize, which are usually wind-pollinated, the male flower should be shaken over the female flower to transfer the pollen.



- If plants are being cross-pollinated for particular characteristics, the farmer must prevent the pollination of the chosen plants by pollen from plants with other characteristics. This can be done by isolating the plants as prescribed.
- Seeds must be dried to the prescribed moisture level before storing them to improve their storage life. Moisture in the seed may encourage mold, bacteria or other pests and diseases which may affect seed viability.
- On the other hand, seeds should not be dried too much or too rapidly as they may crack or lose their ability to germinate. They can be dried in the morning sun or in partial shade, but should not be exposed to strong sunlight.
- To dry seeds, spread them out thinly on paper, cloth, flat basket or plate in a warm place off the ground. They should not be dried on metal as it may become too hot. Turn over the seed several times a day to ensure even drying. When the seeds do not feel damp or stick together, they are likely to be ready for storage.
- Any seeds that are immature, broken, diseased or pest-infested should be taken out. Stones, dirt and seeds from other plants should also be removed.
- Winnowing can remove smaller contaminants such as dust, weed seeds and dry leaves. To winnow the seeds, place them in a large flat container and toss them into the air when there is a gentle wind, then catch them in the container. The light contaminants will be blown away by the wind.

### *b. Seed certification*

- To encourage decentralized seed production, the “truthfully labeled” designation could be used as an alternative to the existing system of centralized public certification. In this case, no field inspection is made, producers are wholly responsible for seed quality, and are required to describe certain quality aspects on the label (Tripp and van der Burg 1997). However, under such a system there would be a need to develop enforcement mechanisms that might operate by involving individuals (possibly extension agents) who have been trained by the public certification agency in field inspections for artisan quality seed, or by shifting the responsibility for quality control to an autonomous or local public institution, including seed certification agencies. In both cases, producers should pay for the field inspection services.

### *c. Seed storage*

- Seeds must be stored in a way that prevents them from being attacked by pests or diseases, and that maintains their quality. Some seeds can be

stored for a long time without losing their germination rate, and others for only a few months. This depends on the type of seed, the moisture content of the seed and the storage conditions. Good storage conditions for seeds are: Low moisture, low temperature, low light, protection against rodents, protection against insect pests and diseases.

- High temperature can encourage biological activity in seeds and shorten their storage life, particularly if there is any moisture in the seeds. Bright light can also be damaging to stored seeds. Seed containers should be kept in a cool area and out of direct sunlight.
- To keep rodents away, seeds should be stored in a hygienic area. The floor should be swept so there are no scraps of food that may attract rodents. Seed containers should be well-sealed and if possible kept off the ground so that rodents cannot get in. Sometimes seeds are stored in specially built huts that are raised off the ground.
- Storage weevils, fungi and bacteria can infest seeds in storage. Seeds should be free of such pests before storing them. Weevils, fungi and bacteria multiply in warm and moist conditions. To prevent this from happening, the seeds should be kept dry and cool. Appropriate pesticides/substances may be mixed with the seeds to help prevent pests and diseases. Mixing the seeds with clean, dry sand and filling the container will prevent weevils moving around.
- The quality of the seeds affects how well they will store and their ability to germinate and grow well in the field. Testing the seed before storage ensures that only good quality seeds are stored. A germination test gives an idea of the proportion of plants that are likely to grow from a certain quantity of seed, and will show how many seeds must be sown in order to obtain the desired number of plants. Use between 10 and 100 seeds for the germination test, depending on how many seeds there are.
- To test the germination rate, place the seeds some distance apart on a clean damp cloth or paper towel. For large seeds it is better to use sterilized soil. Soil can be sterilized by pouring boiling water over it to kill germs. The seeds should be placed somewhere warm, but out of direct sunlight. Keep the seeds damp, but not too wet, by sprinkling with water or covering with a clean damp cloth or paper towel.
- If none of the seeds has germinated, it may be necessary to leave them for more time, keeping them warm and damp. If most of the seeds have germinated and have healthy-looking roots and shoots, the rest of the seeds from that harvest should be viable and suitable for storage and sowing. If less than half of the seeds have germinated, or if many of them are nonhealthy, the rest of the harvest are probably also nonhealthy with a low germination rate. The farmer may decide not to store these seeds. If seed

are in short supply, these seeds may still be stored and sown, but a note should be made that they are not good quality seeds. It may be useful to test the quality of seeds before storage, and to test home-saved seeds and seeds that have been bought or exchanged, before sowing them.

## Developing a Community Seed Program

The response from farmers to development initiatives varies from one place to another. Some of the factors motivating them as seed growers include a good harvest and increased income from the sale of seed. A poor harvest in the first season can discourage them and lead to them giving up.

While some farmers do become self-reliant within a few seasons, it takes a minimum of five years to develop a sustainable community seed program. The first three years should focus on capacity building such as technical training in seed production, business skills, group dynamics, leadership and getting farmers to understand the seed production process. The next two years should concentrate on exit strategies or the final handing over of the management of seed production to the community. Some of the important activities during this last stage include taking farmers on orientation visits to places such as research stations and gene banks (for seed sources) and the State Seed Certification Agencies (SSCAs). This will acquaint the farmers with seed production and certification procedures and expenses. In addition, seed producers should visit seed companies and other service providers (NGOs, KVKs) as they may act as potential market outlets. A study visit to more experienced seed growers' associations would be of benefit to new seed growers.

## The Model

A basic model for developing a community seed program detailed below must have involvement of universality in developing community seed systems in the semi-arid tropics. A model developed for a specific area/village/region may not yield the same result elsewhere because of the variation in the willingness of the stakeholders, the crops and varieties grown, climatic conditions, socioeconomic and perhaps biotic factors.

## Reconnaissance Survey

After identifying the areas of operation, the nongovernmental organization (NGO) or project implementing agency (PIA) should carry out a reconnaissance survey of seed needs assessment (SNA) (Ravinder Reddy et al. 2006). This is a series of participatory dialogues to engage a community in a

diagnosis of the problems relating to seed and to secure the community's commitment to develop and act on its own solutions. The SNA will also identify knowledge gaps that can be corrected during training. The SNA should assist communities in developing an action plan on what needs to be done, while remembering that the role of the NGO is only to facilitate this process.

## Participatory Selection of Crops/Varieties

It is for the communities to identify the crops and varieties to be multiplied. There is a tendency for farmers to select only improved varieties at the expense of important local varieties. Facilitators should check this tendency. Farmers should be encouraged to select a good mix of crop types (crop diversity). Locally adapted varieties would be ideal in the first year. This tends to increase the chances of success since farmers already have adequate experience growing them. The NGO should be proactive in promoting farmers' participation in the selection of varieties/crops for a particular area/region/village.

## Selection of Seed Growers

Once the crops for multiplication have been identified through farmers' participatory selection, the community can select individuals who will be the seed growers. Since food legumes are known to be conserved and multiplied mostly by women, it is only appropriate and advantageous that seed production of such crops be done by them. To help farmers carefully select their local seed growers, the NGOs can help facilitate a process developing criteria for selecting seed growers. Some suggested criteria are

- He/she should be resident of the village.
- Should be a farmer with land holding.
- Must be trustworthy.
- Willing to attend training programs without fail.
- He/she should be friendly in nature and approachable to others.
- Inclination to put in sincere efforts.
- Must be willing to work in a team.
- Experienced in growing one or more of the crops intended for multiplication.
- Must be honest and willing to repay seed loans.

Having such a set of criteria reduces bias and helps farmers to choose the seed growers correctly. Experience has shown that where an NGO decides to

interpose and select the seed growers, other farmers have had to secure seed for them instead.

## Capacity Building

After seed growers have been identified, technical training should follow. The seed growers are trained in basic seed production techniques including rules and regulations and seed certification methods, seed health management and seed storage management. Training is enhanced when followed by an educational tour to areas where similar programs exist. This is farmer-to-farmer learning. Farmers must be trained in business skills and some basic group dynamics and leadership.

As with all farmer training, the trainer should be conversant with principles of adult learning and facilitation skills. Training can be conducted by competent extension officers so long as they fully understand the basic seed production standards and the Seeds Act. For such innovation projects a consortium approach has yielded good results (Ravinder Reddy et al., 2006)

## Procurement of Basic Seed and Distribution

The NGO or farmers need to secure basic seed (foundation seed) for their seed production activities (Ravinder Reddy et al. 2006). Basic seed can be difficult to secure. Therefore, a proper seed source has to be found much before the start of the season. Where poor weather has affected the growing season, it would be imperative to arrange seed for the following season. It is advisable to subcontract breeders recognized by government or research organizations to produce basic seed in specified quantities. Contact arrangements may be worked out for a specific period to ensure timely supply of basic seed.

In the absence of basic seed, a seed grower can plant certified seed, but only for one season. Thereafter farmers must secure basic seed for quality seed and long-term benefits.

## Formation of Seed Growers Association

Some seed growers would certainly prefer to work as individuals but in seed growing, forming an association has the following advantages:

- Registration is cheaper for a group than for individuals. Self-help groups can take up this activity right away without any registration.

- It is cost-effective to work as a team when procuring basic seed and selling seed: There is the benefit of bulk buying and selling.
- Group contributions can be used for paying for activities such as crop inspections, seed sampling and testing.
- During the early years of seed growing the team is important for providing mutual support, encouragement and a collective voice.
- However, for farmers to work effectively as a group, needs assessment can determine whether they need to be trained in group dynamics, leadership, record keeping, conflict management and business skills.
- The seed growers association would be required, in the longer term, to mobilize funds to sustain their seed growing activities.

## Seed Marketing

The success of a community seed project lies in the ability of the seed growers to sell their produce. Some farmers have used field days, weekly village markets, village local market days as a way of advertising available seed to fellow farmers. Others have used public meetings and ceremonies in their villages to sell seed. Seed growers should be innovative in adopting ideas that are workable within their rural setup. They, however, should be careful not to price their seed beyond the local farmers' willingness to pay.

Wherever possible, help establish a credit scheme such as a revolving fund. This will enable community-based organizations to buy up seed from seed growers which will then generate new loans for resource-poor farmers. Some farmers do loan seed to other farmers, to be repaid later in the form of grain, labor or livestock.

After selling off their produce, farmers should be encouraged to save some of the income for purchasing new seed and covering other overheads in the next growing season.

Many development projects have used community-level seed production as the starting point for commercial seed development. The results have been disappointing with little commercial sustainability. The reasons for this lack of success are two fold: a lack of attention to transaction costs (for making contracts for source seed, ensuring quality control and obtaining information) and a lack of experience and resources for marketing. Community-level seed projects need more appropriate goals to be successful, such as testing and disseminating new varieties, developing farmers' experimentation capacities, and forming better links between farmers and researchers.

# Quality Assessment of Farmer-Saved Sorghum Grain/Seed in the Community

*Although the informal seed sector provides a dynamic and flexible system of seed supply, continuous use of nontested seed inevitably leads to degeneration of seed quality. Here we share our experience gained through an on-farm survey of the fungal profile of sorghum seed and grain collected from rural communities. Information on storage systems and options to improve the quality of molded grain is presented in detail.*

## Introduction

In many developing countries, the threat of seedborne diseases is normally ignored, and control measures are unknown or inadequate. Often the consequences are poor seed quality, dissemination and buildup of seedborne diseases and, ultimately, yields far below potential. A farmer using healthy seed is more likely to reap a big harvest. The quality of seed must be known before it is sown. However, this is not always apparent to the naked eye. Moreover, the difference between seed and grain is very thin. Seed supply from both formal and informal systems suffers from a series of problems due to the lack of investment in education, research and quality control. The main problems are low quality of seed, limited use of clean and healthy seed by farmers and seed producers, and lack of knowledge of the significance of seedborne infections in the field compared to other means of transmission, eg, soil and collateral hosts.

## Mycoflora and Mycotoxins

A pictorial guide published jointly by the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and the Natural Resources Institute, UK (Navi et al. 1999) gives information on the identification of mold fungi on sorghum grain. However, it lacks information on the frequency of occurrence of mold in (1) samples collected from rainy- and postrainy-season harvests, (2) storage structures, (3) cultivars and (4)

treatments. Hodges et al. (1999) and Navi et al. (2002) partially address this question. This chapter attempts to fill that gap and assesses the consequences of the presence of fungi on grain germination.

Sorghum is one of the most important staple food crops in the semi-arid tropics of Asia and Africa, where it sustains some of the poorest communities. The crop is grown in harsh environments where other crops do not grow well. Improvements in production, accessibility, storage, utilization and consumption of this food crop will significantly contribute to the food security of the inhabitants of these areas (FAO 1995).

In India, more than 70% of the foodgrain production is stored in bulk in different storage structures made from locally available materials like mud, bamboo and plant materials. Sorghum grain is stored on a large scale by government organizations like the Central Warehousing Corporation, Food Corporation of India (FCI) and by traders, most commonly in jute bags in above-ground structures. Some of the storage structures are neither rodent-proof nor secure from fungal and insect attack. Inadequate storage methods lead to grain losses of an unacceptable degree. On an average, 6% of the foodgrain is lost in such storage structures, about half of it due to rodents and half to insects and fungi (Gwinner et al. 1996). The mycoflora associated with sorghum grain pose the risk of contamination by mycotoxins (Gonzalez et al. 1997). Field fungi often invade grain before harvest in the field and affect the quality of grain. The damage caused by them is often neglected until it reaches an advanced stage. In addition to direct losses, some of the fungi, such as *Fusarium* spp and *Aspergillus* spp produce mycotoxins that contaminate food and feed and create health hazards for humans, cattle and poultry (Bhat et al. 2000).

A cost-effective way to cut such losses and risks would be to protect grain from deterioration before harvest by planting a wide variety of tolerance/resistance sources for sorghum grain mold (Bandyopadhyay et al. 1988; Bandyopadhyay et al. 2000; Navi et al. 2003; Singh et al. 1995). Similarly, postharvest losses can be reduced by paying attention to the technical and practical aspects of storage. Cleaning and drying the grain enhances storability, but storage structure design and construction are important too.



## Methodology of Sampling Grain Stored by Farmers

To assess the fungal profile of sorghum seed and grain collected from rural communities, 67 sorghum samples were selected from a collection of 73 taken during surveys conducted in two villages each in Andhra Pradesh and Karnataka states and eight villages in Maharashtra state in 1997. The samples had a representative selection of crops, cultivars (variety/hybrid/landrace), storage types and the farmer population in the respective community (Hodges et al. 1999). The rainy-season harvest of 1996 was represented by 34 samples and the postrainy season harvest of 1996/97 by 33. The samples drawn were from sorghum foodgrains stored by farmers in jute bags (JB), mud-lined baskets (MB), metallic containers, polypropylene bags (PB), open storage in the corner of a room and a combination of MB/PB and JB/PB. Samples of approximately 5 kg grain were collected from each lot using a compartment probe (80 cm long  $\times$  2.5 cm diameter) where there was open access to the grain bulk (MB and loose grain piles). Where access was more difficult (stacks of JB and PB), a short probe (27 cm long  $\times$  1.5 cm diameter) was used (Hodges et al. 1999).



Figure 12.1. Blotter method used to assess grain mold fungi in laboratory conditions.  
Source: Navi et al. (1999).

Grain /Seed storage structures used in rural areas of Andhra Pradesh, Karnataka and Maharastra states



1. Jute bags (JB)
2. Metallic containers (MC)
3. Mud lined bamboo baskets (MB)
4. Polypropylene bags (PB)
5. open storage in corner of a room may be MB/PB and JB/PB

## Fungal Profile Measurement

Eight hundred grains were taken from each sample, and subsamples of 200 grain were used for assessing the fungal profile and germination percentage of the grain in four treatments: (1) grain surface-sterilized in 1% sodium hypochlorite (NaOCl) prepared from Clorox® (Clorox, Oakland, CA 94612, USA) containing 5.25% NaOCl, and not treated with fungicide benomyl; (2) grain surface-sterilized and treated with benomyl (0.05%) [Benofit® 50WP (benomyl 50% WP) EID Parry (India)]; (3) grain not surface-sterilized but treated with benomyl; and (4) grain neither surface-sterilized nor treated with benomyl. The main objective of the experiment was to study the association of fungi including *Fusarium* spp in the samples collected. The purpose of treating grains with benomyl was to understand sporulation or elimination of *Fusarium* spp after the fungicide treatment (Navi 2005). The grain from each treatment were separately transferred in steam-sterilized Petridish humid chambers at 25 grain per Petridish (Fig. 12.1) and were incubated at  $28 \pm 1^\circ\text{C}$  with a 12-hour photoperiod for 5 days. Individual grain in all the treatments was examined under a stereo microscope (Olympus COI®) for grain colonization and a compound microscope (Olympus BH2®) for proper identification of fungi using the scotch-tape method. The identities of the fungi were confirmed from the literature (Standen 1945; Nelson 1959; Barron 1968; Ellis 1971; Ellis 1976; Barnett and Hunter 1972; Raper and Fennel 1973; Sutton 1980; Sivanesan 1987; Champ et al. 1991; Pitt 1991; Hanlin 1990; Hawksworth et al. 1995). The characteristic difference between major and minor fungi was based on the frequency of occurrence of a fungus. If it was  $> 5\%$  occurrence, it was considered as major and  $< 5\%$  as minor by using the general linear means procedure and the least significant difference (LSD) calculated using Tukey's Studentized Range test using the SAS package (Cary, NC, USA) to understand the effect of seasons, storages, cultivars and seed treatment on the frequency of mold fungi.

## Germination Potential of Sorghum Grain/Seed Saved by Farmers

In the rainy-season samples, the mean grain germination percentage was 46% less than in the postrainy-season samples. It may possibly be true that samples from the rainy season tend to possess less viability than postrainy-season samples. Low germination might also depend on colonization by diverse fungi in different storages and cultivars grown during the rainy

season. Grains sampled from jute bags had the highest germination percentage followed by MB, and grains piled in the corner of a room had the lowest germination percentage. Similarly, among eight cultivars, grain germination was relatively higher in local yellow, Dagri and Maldandi compared with improved varieties and hybrids. Grain germination varied from 75% to 100% in local cultivars, and from 35% to 62% in hybrids. Again, this measurement is interlinked with the harvesting season. The majority of local cultivars are grown during the postrainy season and the improved varieties and hybrids during the rainy season. Perhaps, observations among the treatments indicated no significant difference (Navi 2005).

## Fungal Profile in Sorghum Grain/Seed Saved by Farmers

Fifty-one fungi and a bacterial contamination were detected in approximately 54000 grains examined across seasons, storages, cultivars and treatments. Of these, *Alternaria alternata* (Fr.) Keissler (Fig. 2a); *Aspergillus flavus* Link (Fig. 2b); *A. niger* Van Tieghem (Fig. 2c); *Bipolaris australiensis* (M.B. Ellis) Tsuda & Ueyama (Fig. 2d); *Curvularia lunata* (Wakker) Boedijn (Fig. 2e); *C. lunata* var *aeria* (Bat., Lima & Vasconcelos) M.B. Ellis (Fig. 2f); *Fusarium verticillioides* (Sacc.) Nierenberg (Synonym *Fusarium moniliforme* Sheldon) Lisea Fujikuroi Sawada (Fig. 2g); *Penicillium citrinum* Thom (Fig. 2h); *Phoma sorghina* (Sacc.) Boerema, Dorenbosch & Van Kesteren (Fig. 2i); and *Rhizopus stolonifer* (Ehrenb:Fr.) Lindner (Fig. 2j) showed a mean frequency of >5%. The frequency levels of the 41 other fungi with less than 5% frequency have been reported (Navi 2005).

## Harvesting Seasons and Fungal Profile in Farmer-Saved Grain/Seeds

The harvesting season showed a significant impact on the frequency of the mycotoxin-producing fungus *F. verticillioides*, formerly *F. moniliforme*. The frequency of this fungus was 5.5% higher in grain sampled from the rainy-season harvest compared with grain sampled from the postrainy-season harvest. While the frequencies for *A. flavus* were 1.6% higher in the rainy season than in the postrainy-season harvest. Likewise, the spectrum of other major fungi varied with the harvesting season. The fungi with >5% frequencies were *A. alternata*, *A. niger*, *C. lunata*, *C. lunata* var *aeria*, *F. verticillioides* and *R. stolonifer*. It is obvious that the rainy-season samples are

caught in the rain any time between flowering and post-maturity and tend to have internal infection, which might lead to reduced grain germination percentage. Similarly, it is also possible to have a higher fungal frequency in samples collected from the rainy-season harvest than from the postrainy-season harvest due to the prevailing rain toward the crop maturity stage and high relative humidity in the crop canopy.

## Storage Type and Fungal Profile in Farmer-Saved Grain/Seed

Looking at the frequency of *F. verticillioides*, a mycotoxin-producing *Fusarium* species (Navi et al. 2005a), it is apparent that storage structures influenced its frequency. Grain stored in MB had the least frequency compared with 2–14% for the other storage structures. This was possibly because of less aeration, low relative humidity and low moisture in the container. On the contrary, the frequency of *R. stolonifer* was 50% in grain stored in metallic containers followed by *A. flavus* and *A. niger*, indicating that these may be potential storage fungi occurring in this particular storage structure. Similarly, the frequencies of the other fungi varied with the storage structure (Navi 2005). Navi (2005) reported the frequency of *F. verticillioides* as high as 13.5% in grain sampled from PB/MB, followed by grain sampled from the corner of a room (12.7%), MB (9.7%) and PB (5.1%). The higher frequencies of *F. verticillioides* from grain stored in a corner of a room could be due to infection that had occurred in the field prior to harvest (Navi et al. 2005) or the fungus might have reproduced faster given the exposure of the grain. Also, the higher frequency in MB and PB could be due to high humidity or moisture buildup during storage. Likewise, the frequency of *C. lunata* and *C. lunata* var *aeria* was higher in grain sampled from MB, PB and PB/MB. The major fungi were the same five as reported above.

## Cultivars and Fungal Profile

The germination percentage of grain of hybrid sorghums showed the opposite relationship with major fungal frequencies compared with local cultivars. Hybrid CSH 9 had the highest frequency of *C. lunata* var *aeria*, followed by *C. lunata*, *A. alternata* and *F. verticillioides* (Navi 2005). Interestingly, 7–10% *F. verticillioides* frequency was observed among the hybrids compared to 2–8% in the local cultivars. The low frequency of *F. verticillioides* shown by Maldandi grain is a plus point from the point of view

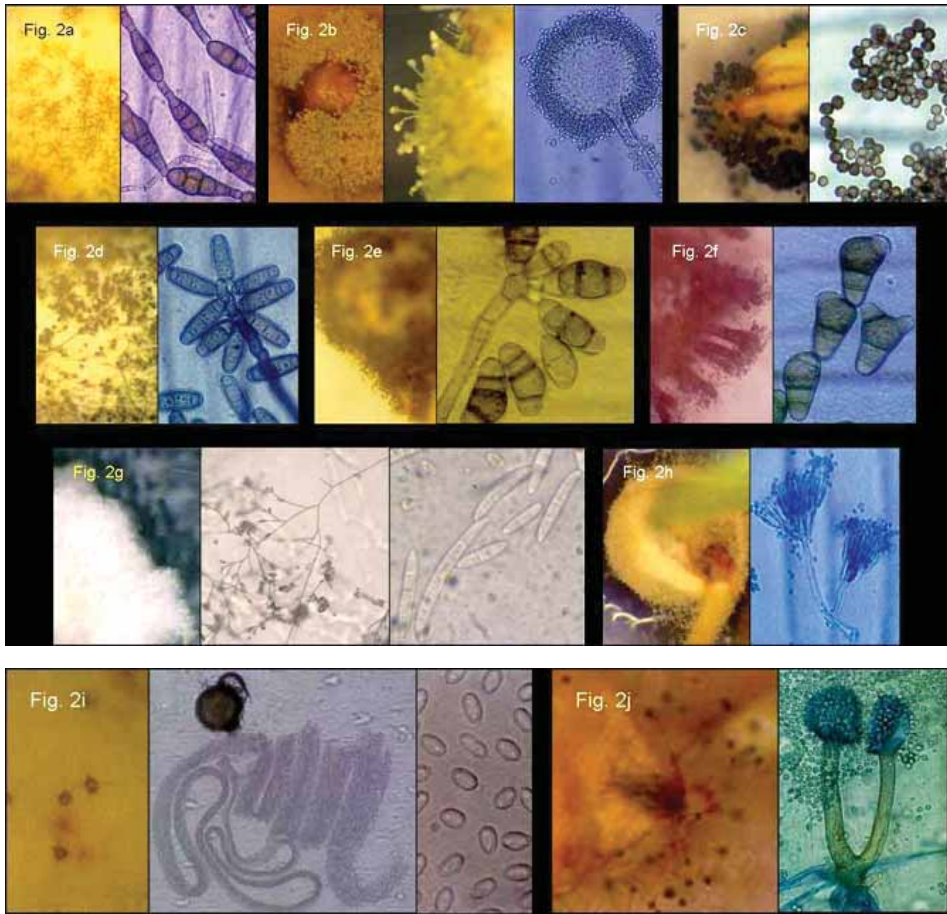


Figure 12.2. Fungi with >5% frequency across harvesting seasons, storages, cultivars and treatments observed in the blotter test: *Alternaria alternata* (2a); *Aspergillus flavus* (2b); *A. niger* (2c); *Bipolaris australiensis* (2d); *Curvularia lunata* (2e); *C. lunata var aerea* (2f); *Fusarium verticillioides* (2g); *Penicillium citrinum* (2h); *Phoma sorghina* (2i); and *Rhizopus stolonifer* (2j). Picture source: Navi et al. (1999).

of consumers who prefer this postrainy-season cultivar over other varieties and hybrids. The frequency of *A. flavus* among hybrids ranged from 0.6% to 2.5%. The frequency of *P. citrinum* went up to 3% in Maldandi/Dagri local, while in the hybrids it was only 0.0–0.2%. Overall, fungal frequency was higher in hybrids compared with local cultivars including Maldandi. It is possible that most of the hybrids are grown during the rainy season as rainfed crops rather than in the postrainy season under assured irrigation. On the

contrary, most of the improved varieties and local cultivars are grown during the post-rainy season as a rainfed crop than under assured irrigation. It was observed that local cultivars grown during the rainy season are mainly for fodder purposes and rarely for food (Navi et al. 2002).

## Chemical Treatment and Fungal Profile

Surface sterilization normally kills most fungi adhering to the seed. However, in our study, surface sterilization of grain with sodium hypochlorite did not remove many fungi, indicating that most of the major fungi listed in Figure 2 were internally seedborne. Yet, grain treated with benomyl, with or without surface sterilization, considerably reduced the frequency of *A. flavus*, *A. niger*, *F. verticillioides* and *P. citrinum*. Typically, benomyl (0.05%) greatly reduced the frequency of *F. verticillioides* to < 1% compared with 15% in the control. Besides *F. verticillioides*, benomyl was also effective against *A. flavus*, *A. niger*, *P. citrinum* and *P. sorghina*, but not against *Alternaria* spp, *Bipolaris* spp and *Curvularia* spp indicating that it may be good to treat sorghum grain to eliminate some of the fungi mentioned above provided the grain are used for sowing and not for consumption.

## Fungal Frequency and Grain/Seed Germination

The frequency of occurrence of *C. lunata* var *aeria* and *A. flavus* was higher in non germinated grains than in germinated. Among the fungi observed on non germinated grains, the frequency of *C. lunata* var *aeria* was highest followed by *R. stolonifer*, *C. lunata* and other fungi. In germinated grains, the frequency of *R. stolonifer* was higher followed by other fungi (Navi 2005).

## Inferences on Farmer-Saved Grain/Seed Quality

Looking at the range of fungi connected with sorghum grain, either colonized in the field prior to harvest or developed in storage, it may be useful to focus on some of the available approaches to minimize grain damage by fungi and the health risk associated with potential mycotoxin contamination. Harvesting of crops is seasonal, but consumption of grain is continual. Fungi can develop in storage if grain have been damaged during harvest, handling, threshing and drying; are stored without sufficient drying; and exposed to increased moisture during storage. It has been observed that *A. flavus* and *P. citrinum* are frequently recorded in very low frequencies in molded panicles during the

rainy season and in samples taken from farmers' storage. However, they have also been recorded in storage (Christensen and Meronuck 1986). In a study conducted on inheritance of grain mold resistance in sorghum grain without a pigmented testa (Rodriguez-Herrera et al. 2000), most prevalent fungi isolated from the field were *F. moniliforme* (46%), *Alternaria* sp (32%), *C. lunata* (8%), *F. semitectum* (7%) and *Drechslera* sp (3%).

Understanding the frequency of potential toxin-producing fungi like *Fusarium* spp and *Aspergillus* spp is essential to guard against nutritional and qualitative losses. Navi et al. (2005a) have reported the prevalence of at least five *Fusarium* spp in the Indian grain mold complex which are potential fumonisins producers and their frequency of occurrence in grain samples collected from five Indian locations (Navi et al. 2005b). It may be possible to use mold inhibitors like propionic acid during the drying process to reduce the risk of mold development in storage (Shetty et al. 1995).

## Options to Improve Quality of Molded Sorghum Grain

In India, sorghum grain is used either for human consumption or for cattle and poultry. Therefore, fungicidal treatment of grain prior to storage may not be acceptable to farmers unless the grain is meant to be used for sowing purposes. Removal of the pericarp is sufficient to remove most of the fungi and reduce mycotoxin contamination, as has been shown in rice (*Oryza sativa* L.) (Vasanthi and Bhat 1998). In the case of sorghum, removal of the pericarp is possible by several means including mechanical dehulling to minimize the moldy appearance of molded grain (ICRISAT 1986). Village-level dehulling of molded grain has been suggested to improve the quality of molded grain (Stenhouse et al. 1998). It may be possible to decorticate the grain using rice polishers (Raghavendra Rao and Desikachar 1964) or the decorticator developed by the International Development Research Center (IDRC), Canada (Reichert et al. 1982), which leaves the germ intact. The commercial value of dehullers and dehulled products has been demonstrated with clean sorghum grain (Geervani and Vimala 1993). Further research is required on several aspects of value addition to superficially molded grain for which linkages with sorghum processors and consumers are necessary. These research areas include identification of suitable cultivars with adequate mold resistance and grain quality characters; optimization of the dehulling procedure and equipment for grain with different levels of moldiness, grain hardness, grain size and mold resistance; limits of grain moldiness under



which the technology is operable; economics of value addition and its effect on consumer acceptance; nutritional, storage quality and safety of dehulled grain and other related areas. However, before extensive research can begin, there is a need to determine the consumer acceptability and marketability of the dehulled products and identify the market opportunities in the rural and urban sectors. Therefore, a prefeasibility study is required for dehulling technology which appears to be one of the few short-term solutions to the most important food quality problem of sorghum consumed by the poor.

Recent studies also have suggested polishing or dehulling the molded grain to minimize mold damage (Bandyopadhyay et al. 2000). There is a need to determine the consumer acceptability apart from marketability of the dehulled grain. Similarly, pounding molded grain and treating with crude garlic extract has been reported to reduce major fungal frequency (including *Fusarium* spp) and ergosterol content of molded grain with an emphasis for safer consumption by humans, animals and poultry birds (Navi and Singh 2000; Navi and Singh 2003). Again, this method of treating molded grain needs acceptability by a greater percentage of farmers than at a specific location where the grain were sampled for the study. It may be hard to disregard the acceptance of pounded grain treated with garlic extract because of the easy availability of garlic in most Indian homes, and it is an environmentally friendly treatment. Use of garlic extract for the control of sorghum ergot (*Claviceps* spp), particularly in seed production, was effective and environmentally friendly (Singh and Navi 2000). Similarly, from a limited study by Navi and Singh (2003) on the use of garlic extract (3.17% to 6.25% depending on mold severity) to treat molded grain, it was reported to have had an impact on mold growth and ergosterol content. Hence, this study might aid in framing competitive control approaches to reduce damage due to storage fungi for safer consumption by humans and cattle. Pounding and crude garlic extract treatment of molded grain to reduce the infection of *F. verticillioides*, *F. pallidoroseum* and *C. lunata* and ergosterol content have been reported (Navi and Singh 2000; Navi and Singh 2003). Therefore, based on our limited study, it would be difficult to provide an integrated package for the management of storage fungi of sorghum. However, it is suggested to (a) store grain in jute bags, as many Indian farmers do, than storing in other containers mentioned in the study to minimize the damage from potential fumonisins producing *Fusarium* spp; and (b) grow mold-tolerant/resistant genotypes during the rainy season (Bandyopadhyay et al.1988; Bandyopadhyay et al. 2000; Singh et al. 1995; Rao et al. 1995; Navi et al. 2003).

# Part VI: Summary, Annexure & Literature cited

- Summary
- Acronyms
- Annexure I
- Annexure II
- Literature cited
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## Summary

Early human civilizations realized that some of the plants growing in the wild could be used for food, clothing and health care. Thus began the evolution of world agriculture. Farmers identified, selected and cultivated plants that were useful to them and were best suited for cultivation in their region. Crop plants from these areas spread to others as a result of farmer-to-farmer sharing, exchange and sale of plant material. Human migration, travel, trade and war also helped in the spread of crops to new regions far from their place of origin. There, these exotic cultivars were again selected by local farmers and adapted to local conditions and needs. This was the origin of community seed systems.

Since the advent of hybrid technology, farmers now have to replenish their seeds each season with supplies from external sources (such as public sector research institutions and private seed producers) to harness hybrid vigor. This has no doubt helped increase production manifold but at the same time, it has also increased farmers' dependence on external agencies. As a result, the once informal and decentralized village seed industry has yielded ground to a highly centralized system. However, the organized seed sector finds it difficult to meet the demand for seed of the whole array of crops and varieties cultivated across the country. This has forced farmers in many areas to turn to unreliable seed supplies resulting in a range of complex socioeconomic problem.

The history of the formal seed industry in India dates back to 1957. Since then, it has passed several milestones along the way and today several major seed systems, both formal and informal, operate in the country. This book discusses the need for an integrated seed supply system operating within the framework of the national seed policy. It outlines the efforts to promote seed trade, variety development, seed production, quality assurance, seed distribution and marketing, infrastructure facilities, seed import and export, promotion of the domestic seed industry and strengthening of monitoring mechanisms for the implementation of the national seed policy. It also deals with issues relating to legislations on plant variety protection and farmers' rights, which are aimed at protecting local seed systems by imparting freedom to farmers to save, exchange and sow any seed.

Although the informal sector provides a dynamic and flexible system of seed supply, it mainly relies on nontested material, repeated use of which leads to degeneration of seed quality. While the formal seed sector presents an

alternative, farmers tend to depend on their own seed, not only because of inadequate access to the formal sector, but also because the range of cultivars and varieties available from it is not always suitable for their needs. On-farm growing and maintenance of locally adapted landraces, cultivars and wild species do allow the farmer to restrict the impact of production constraints like drought, flooding, heat, cold, pests and diseases. However, community seed systems are likely to take no, or inadequate, control measures against seedborne diseases, the consequence of which may be buildup and dissemination of disease and yields far below potential.

This book presents a synthesis of knowledge that needs to be imparted to community seed systems in order to produce, process, treat, test, store, trade or barter and resow seeds for food, feed, fodder and livelihood security. It also outlines the mechanisms of creating and training seed growers' associations. It shares the experience gained through an on-farm survey of the fungal profile and germination potential of seed and grain collected from communities. Information on storage systems and options for improving the quality of molded grain is presented at length.

We have discussed in this book the elements and factors that support a sustainable seed system, in the light of the focus that such a system is never static and is always interacting with changing structural and policy dynamics within a geographical boundary. A sustainable system has an innate capacity to cope with change and reevolve to serve the needs of the community. Livelihoods consist of capabilities, assets – both material and social – and activities required for a living. A livelihood is sustainable when it can cope with and recover from stresses and shocks, maintain or enhance its capabilities and assets, and provide net benefits to other livelihoods locally and widely, both now and in the future, while not undermining the natural resource base. Therefore, the focus of interventions should be to create seed security operating at the household, community, national and regional levels. Issues of gender in the seed and food chain, the role of women as seed conservers and issues that influence food security in the context of the ecological, political and socioeconomic environment have been discussed at length in this book.

In this book we discuss ways of strengthening seed systems to address the needs and vulnerabilities of such farmers, using specific delivery models and innovations such as the concept of village seed banks. We also describe our experience in testing innovative seed system models and a case study of a

village seed bank in relation to its management, capacity building, participatory selection of varieties and management of seed production, processing, storage and community-level seed trade.

Despite the penetration of markets in the local economy, traditional coping strategies based on local processes of seed exchange are still important. Any successful developmental intervention aimed at increasing the resilience of seed systems should take into account these traditional exchange practices. For example, a strategy for improving local institutions and seed exchange networks could be aimed at increasing production and multiplication of seeds at the local level and facilitating movement of farmers between the formal and informal sectors, rather than distributing seeds from outside to farmers. Hence, availability of good quality seed at the right time, right place and right price is an important prerequisite for the food security of a nation.

## Acronyms

ADB	Asian Development Bank
AICSIP	All India Coordinated Sorghum Improvement Project
ANGRAU	Acharya NG Ranga Agricultural University
APARD	Awakening People Action for Rural Development
APRLP	Andhra Pradesh Rural Livelihoods Programme
ASSINSEL	International Association of Plant Breeders for the Protection of Plant Varieties
CBO	Community-Based Organization
CIMMYT	Centro Internacional de Mejoramiento de Maíz y Trigo
CSC	Central Seed Committee
CSCB	Central Seed Certification Board
CSTL	Central Seed Testing Laboratory
CVRC	Central Variety Release Committee
DAC	Department of Agricultural Cooperation
DFID	Department For International Development (UK)
DOA	Directorate of Agriculture
DUS	Distinctiveness Uniformity and Stability
DWMA	District Water Management Agency
EDV	Essentially Derived Variety
EPA	Environment Protection Act
FAO	Food and Agriculture Organization
FIP	Fodder Innovation Project
FGD	Focus Group Discussion
FRs	Farmers' Rights
GATT	General Agreement on Tariffs and Trade

GDP	Gross Domestic Product
GEAC	Genetic Engineering Approval Committee
GMO	Genetically Modified Organism
HRD	Human Resource Development
HYV	High-Yielding Variety
ICAR	Indian Council of Agricultural Research
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IPDM	Integrated Pest and Disease Management
IPR	Intellectual Property Rights
ILRI	International Livestock Research Institute
IRCs	International Research Centers
ISTA	International Seed Testing Association
KVK	Krishi Vignan Kendra
MAHYCO	Maharashtra Hybrid Seeds Company
MLT	Multilocational Testing
MNC	Multinational Corporations
MTA	Material Transfer Agreement
NGB	National Gene Bank
NGO	Nongovernmental Organization
NIAB	National Institute of Agricultural Botany (UK)
NRCS	National Research Centre for Sorghum
NSB	National Seed Board
NSC	National Seeds Corporation
OECD	Organization for Economic Cooperation and Development
NSP	National Seeds Project
OPV	Open-Pollinated Variety

PBR	Plant Breeders' Rights
PIA	Project Implementing Agency
PIC	Prior Informed Consent
PVP	Plant Variety Protection
RCV	Reference Collection Variety
RRA	Rapid Rural Appraisal
SAT	Semi-Arid Tropics
SAUs	State agricultural universities
SFCI	State Farms Corporation of India
SHG	Self-Help Group
SSDC	State Seeds Development Corporation
SSTL	State Seed Testing Laboratory
SVRC	State Variety Release Committee
TNC	Transnational Corporation
TRIPS	Trade-Related Aspects of Intellectual Property Rights
UPOV	Union for the Protection of New Plant Varieties
VCU	Value for Cultivation and Usage
VO	Village Organization
VSB	Village Seed Bank
VSBC	Village Seed Bank Committee
WIPO	World Intellectual Property Organization
WDT	Watershed Development Team
WTO	World Trade Organization



## Annexure I: Draft Seed Bill, 2004 (Revised Seeds Act)

### An Act

- to provide for regulating the sale, import and export of seeds;
- to facilitate supply of quality seeds to farmers throughout the country; and
- to establish a National Seeds Board to advise government in all matters connected therewith.

### 1. Short title, extent and commencement

- a) This Act may be called the Seeds Act, 2002.
- b) It extends to the whole of India;
- c) It shall come into force on such date as the Central Government may, by notification in the Official Gazette, appoint, and different dates may be appointed for different provisions of this Act, and for different states or for different areas thereof.

### 2. Definitions

In this Act, unless the context otherwise requires:

- a) “**Agriculture**” includes horticulture;
- b) “**Central Seed Laboratory**” means the Central Seed Laboratories established or declared as such under Sub-section (1) of Section 4;
- c) “**Certification Agency**” means the certification agency established under Section 18 or accredited under Section 19;
- d) “**Board**” means the National Seeds Board constituted under Sub-section (1) of Section 3;
- e) “**Container**” means a box, bottle, basket, tin, barrel, case, receptacle, sack, bag, wrapper other thing in which any article or thing is placed or packed;
- f) “**Export**” means taking out of India to a place outside India;
- g) “**Import**” means bringing into India from a place outside India;
- h) “**Kind**” means one or more related species or sub-species of crop plants each individually or collectively known by one common name such as cabbage, maize, paddy and wheat;
- i) “**Registered kind or variety**” in relation any seed, means any kind or variety thereof registered under section 5;
- j) “**Prescribed**” means prescribed by rules made under this Act;

- k) “**Seed**” means any type of living embryo or propagule capable of regeneration and giving rise to a plant which is true to such type;
- l) “**Seed Inspector**” means a Seed Inspector designated as such under section 23;
- m) “**State Government**” in relation to a Union territory, means the administrator thereof;
- n) “**State Seed Testing Laboratory**” in relation to any State, means the State Seed Laboratory established or declared as such under Sub-section (2) of Section 4 for that State;
- o) “**Variety**” in relation to plants, means a plant grouping within a single botanical taxon of the lowest known rank, which can be:
  - i) defined by the expression of the fundamental characteristics resulting from a given genotype of the plant grouping;
  - ii) distinguished from any other plant grouping by expression of at least one of the said fundamental characteristics; and
  - iii) considered as a unit with regard to its suitability for being propagated which remains unchanged after such propagation and includes propagating material of such variety.
- p) “**Registered variety**” means the variety registered under Section 5;
- q) “**Farmer**” means any person who cultivates crops either by cultivating the land himself or through any other farmer and includes a farmer who conserves and preserves, severally or jointly, with any person any wild species or traditional varieties, or adds value to such wild species or traditional varieties through selection and identification of their useful properties;
- r) “**Dealer**” means a person carrying on the business of selling, exporting or importing seeds, and includes an agent of a dealer under Section 12;
- s) “**Registering Authority**” means a Registering Authority appointed under this Act;

### 3. National seeds board

- a) The Central Government shall, by notification in the Official Gazette establish a Board to be known as National Seeds Board for the purpose of this Act;
- b) The Board shall be a body corporate by the name aforesaid having perpetual succession and a common seal with power to acquire, hold and dispose of properties, both movable and immovable, and to contract, and shall by the said name sue and be sued;

- c) The head office of the Board shall be at such place as the Central Government may, by notification in the Official Gazette, specify with the approval of Central Government;
- d) The Board shall consist of Chairperson, Vice-Chairperson, five ex-officio members and other nominated members;
- e) A. The ex-officio members of the Board shall be:
- |   |                    |
|---|--------------------|
| i) Secretary, Agriculture & Cooperation,<br>Government of India;                              | <b>Chairperson</b> |
| ii) Agricultural Commissioner, Government of India<br>Department of Agriculture & Cooperation | <b>Member</b>      |
| iii) Deputy Director General (Crop Sciences),<br>Indian Council of Agricultural Research      | <b>Member</b>      |
| iv) Deputy Director General (Horticulture),<br>Indian Council of Agricultural Research        | <b>Member</b>      |
| v) Joint Sectary (Seeds), Government of India<br>Department of Agriculture & Cooperation      | <b>Member</b>      |
| vi) Horticulture Commissioner, Government of India<br>Department of Agriculture & Cooperation | <b>Member</b>      |
- B. Vice-Chairperson, shall be a person of outstanding caliber and eminence and long experience in the field of seed development or in a related field of agricultural development, appointed by the Government of a period of five years;
- C. The following Members shall be nominated by the Government of India:
- i) Secretary (Agriculture) from one State, of each of the five geographical zones, on rotation basis;
  - ii) Director of Agriculture from two States, on rotation basis;
  - iii) Director, State Seed Certification Agency from two States, on rotation basis;
  - iv) Managing Director, State Seeds Corporation from two States, on rotation basis;
  - v) Two representatives of farmers;
  - vi) Two representatives of seed industry;
  - vii) Two specialists / experts in the field.
- f) Vice-Chairman shall be the Chief Executive of the Board and shall exercise such powers and perform such duties as may be prescribed and as may be delegated by the Board;
- g) The tenure of the ex-officio Members of the National Seeds Board under Sub-section 5(a) to (vi) shall be co-terminus with their tenure in the concerned office, unless removed by the order of the Government;

- h) The Members nominated under Sub-section 5(c) (i) to (vii) shall, unless their seats become vacant earlier by resignation or death or otherwise, be entitled to hold office for two years;
- i) The functions of the Board shall be exercised notwithstanding any vacancy therein;
- j) The Board may, subject to the previous approval of the Central Government, make bye-laws fixing quorum and regulating its own procedure and the conduct of all business to be transacted by it;
- k) The Board may appoint one or more Committees consisting wholly of Members of the Board or wholly of other persons or partly Members of Board and partly of other persons as it thinks fit for the efficient discharge of its duties and functions under this Act;
- l) Functions of the Board: National Seeds Board shall advise the Central Government and the State Government on all matters related to:
  - i) Seed programming and planning;
  - ii) Seed development and production;
  - iii) Registration of kind or varieties of seeds;
  - iv) Maintenance of National Register of Varieties;
  - v) Determination of quality parameters, and criteria for registration, certification etc;
  - vi) Conduct of Value for Cultivation and Use (VCU) test or any other test for the purpose of registration;
  - vii) De-registration of varieties;
  - viii) Certification of seeds;
  - ix) Accreditation of seed producing organizations for purposes of self certification;
  - x) Export and import of seeds;
  - xi) Seed legislation and its enforcement; and
  - xii) Such other functions assigned by the Central Government.

#### **4. Central and state seed testing laboratories**

- a) The Central Government may establish a Central Seed Testing Laboratory or declare any seed laboratory as the Central Seed Testing Laboratory, to carry out the functions under this Act, and Rules framed there under;
- b) The State Government may, on the recommendation of National Seeds Board, establish one or more State Seed Testing Laboratories or declare any seed testing laboratory in the Government non-Government sector

as a State Seed Testing Laboratory where analysis of seeds shall be carried out under this Act in the prescribed manner.

## **5. Registration of kind or variety of seeds**

- a) Seed of any kind or variety for the purpose of sowing or planting will be sold in the country only if the said kind or variety has been registered by the Board for the purpose of this Act on fulfillment of the criteria as prescribed;
- b) Registration will be granted for new varieties on the basis of multi-locational trials to determine VCU over a minimum period of three seasons, which in case of some long duration varieties and some Horticulture crops may be increased;
- c) Until completion of trials required to be conducted for fulfillment of the criteria for registration under Sub-clause (2), sale of seed of the kind or variety for which application for registration has been applied, may be permitted on the basis of provisional registration granted by the Board on the basis of information filed by the applicant relating to trials conducted in India for one season, as prescribed;
- d) Any kind or variety that has been notified under Seeds Act, 1966, will be deemed to be registered for the purpose of this Act.

## **6. Accreditation of institutions for conducting VCU trials**

The Board will accredit ICAR Centres, State Agricultural Universities and private organizations to conduct VCU trials for the purpose of registration, as prescribed.

## **7. Maintenance of national register of varieties**

All varieties that are registered under Section 5 (2) will be entered in the National Register of Varieties maintained by the Board.

## **8. Exclusion of certain kind or varieties from registration**

Notwithstanding anything contained in this Act, no registration of a kind or variety shall be made under this Act, if prevention of commercial exploitation of such kind or variety is necessary to protect public order or public morality or human, animal and plant life and health or to avoid serious prejudice to the environment.

## **9. Powers to specify minimum limits of germination and purity and criteria for registration**

The National Seeds Board will specify:

- a) the minimum standards of germination, genetic and physical purity with respect to any seed of a registered kind or variety;
- b) the mark or label to indicate that such seed conforms to the minimum standards of germination, genetic and physical purity specified under Clause (a) of Section 9 above and the particulars which such mark or label may contain;
- c) criteria and background data required for registration of a kind or variety;
- d) trials to be carried out for the purpose of registration and provisional registration.

## **10. Period of registration**

Registration under Section 5 (2) and (4) shall be granted for a fixed period as prescribed.

## **11. Power of de-registration**

The board may cancel the registration granted to a variety under Section 5 if it is satisfied that:

- a) registration has been obtained by mis-representation or concealment of the essential data; or
- b) the variety is obsolete and has out lived its utility and should not, in the public interest, be made available for sale in the market; or
- c) prevention of commercial exploitation of such variety is necessary in the public interest to protect public order or public morality or human, animal and plant life and health, or to avoid serious prejudice to the environment.

## **12. Regulation of sale of seeds**

- a) No person or dealer shall himself or by another person on his behalf carry on the business of selling, keeping for sale, offering to sell, or otherwise supplying any seed which is not of a registered kind / variety;
- b) All such seed should;
  - i) be identifiable as to its kind or variety;
  - ii) conform to the minimum limits of germination, genetic and physical purity specified under Clause (a) of Section 9;

- iii) bear, on their container, in the prescribed manner, the mark or label containing the correct particulars thereof prescribed;
- iv) comply with such other requirements as may be prescribed by the Board.

### **13. Maintenance of records and submission of returns**

Every dealer shall maintain such books, accounts and records including the particulars about the seed lot, expiry of seed standards, etc. relating to his business as may be directed by the Board or the State Government.

### **14. Power to direct a dealer to sell or distribute seed in a specified manner**

If considered necessary in public interest, the Board may, by any order in writing direct any producer or dealer to sell or distribute any seed in such manner as may be specified therein.

### **15. Maintenance of list of dealers and seed producers**

The State Government shall maintain, in each district, a list of dealers and seed producers.

### **16. Dealers to follow specific procedure**

Every dealer shall:

- a) display stock and price list in the place of business indicating opening and closing stocks, on daily basis of different seeds held by him, and a list indicating prices or rates of different seeds;
- b) issue cash or credit memo for purchase of seeds wherein the particulars of lot number, germination percentage and validity period of germination should be indicated; and
- c) submit a monthly return relating to his business for the preceding month in the Form prescribed by the State Government.

### **17. Exemption of farmers from registration**

Nothing in this Act shall restrict the right of the farmer to save, use, exchange, share or sell his farm seeds and planting material, except that seeds shall not be sold under a brand name in a commercial marketing arrangement.

Explanation – Farmers shall not be required to register their kind or variety to save, use, exchange, share or sell his farm seeds and planting material.

## **18. Certification agency**

The State Government or the Board, in consultation with the State Government, may establish one or more Certification Agencies for the State to carry out the functions entrusted to the Certification Agency by or under this Act. The Board will perform all the functions of the erstwhile Central Seed Certification Board.

## **19. Accreditation of certification agencies**

The State Government or the Board may:

- a) accredit individuals or organizations to carry out certification, including self certification on fulfillment of criteria prescribed by the Board;
- b) accredit seed producing organizations to carry self-certification as prescribed.

## **20. Grant of certificate by certification agency**

- a) Any person selling, keeping for sale, offering to sell, bartering or otherwise supplying any seed of any registered kind or variety may, if he desires to have such seed certified by the Certification Agency, apply to the Certification Agency, for the grant of a certification for the purpose;
- b) Every application under sub-section (1) shall be made in such form, shall contain such particulars and shall be accompanied by such fees as may be prescribed;
- c) On receipt of any such application for the grant of a certificate, the Certification Agency shall, after such enquiry as it thinks fit and after satisfying itself that the seed to which the application relates conforms to the prescribed standards of minimum limits of germination, genetic and physical purity specified under Section 9 (a), grant of a certificate in such form and on such conditions, within a specific, within a specific time limit, as may be prescribed.

## **21. Revocation of certificate**

If the State Government or the Board is satisfied, either on a reference made to it in this behalf or otherwise, that:



- a) the certificate granted by it under Section 20 has been obtained by misrepresentation as to an essential fact; or
- b) the holder of the certificate has without reasonable cause, failed to comply with the conditions subject to which the certificate has been granted or has contravened any of the provisions of this Act or the rules made thereunder.

Then, without prejudice to any other penalty to which the holder of the certificate may be liable under this Act, the State Government or the Board may, after giving the holder of the certificate an opportunity of showing cause, revoke the certificate.

## 22. Appeal

- a) Any person aggrieved by a decision of Certificate Agency under Section 20(3) and 21, may within thirty days from the date on which the decision is communicated to him and on payment of such fees as may be prescribed, prefer an appeal to such authority as may be specified by the Board or State Government in this behalf;

Provided that the appellate authority may entertain an appeal after the expiry of the said period of thirty days if it is satisfied that the appellant was prevented by sufficient cause from filing the appeal in time.

- b) On receipt of an appeal Sub-section (1) the appellate authorities shall, after giving the appellant an opportunity of being heard, dispose of the appeals expeditiously as possible;
- c) Every order of the appellate authority under this section shall be final.

## 23. Seed inspectors

- a) The State Government may designate such seed inspectors, having prescribed qualifications to exercise such fund functions for the achievement of the objectives of this Act as, shall be prescribed in the Rules, and define the areas within which they shall exercise jurisdiction;
- b) Every Seed Inspector shall be deemed to be a Public Servant within the meaning of Section 21 of the Indian Penal Code (45 of 1860) and shall be officially subordinate to such authority as the State Government may specify in this behalf.

## 24. Restriction on export and import of seeds of registered kinds or varieties

- a) All import of seed or planting material shall be subject to provisions of the Plants, Fruits and Seeds (Regulation of Import into India) Order, 1989;
- b) Seed imported for sale in the country, shall conform to minimum limits of germination and purity as prescribed under Section 9 (a) and (b);
- c) Import of seed for sale shall be permitted only of registered varieties. Registration of such varieties shall be granted on the basis of trials conducted for minimum period of three seasons in India, which, in case of some long duration varieties and Horticulture crops may be increased as per procedure and conditions prescribed by the Board;
- d) An unregistered variety may be allowed to be imported in limited quantity for research and trial purposes on the basis of data from trial over one season in the country of origin;
- e) Notwithstanding anything contained in this Act, no import of a variety shall be made under this Act in cases where prevention of commercial exploitation of such variety is necessary to protect public order or public morality or human, animal and plant life and health or to avoid serious prejudice to the environment;
- f) Any person intending to import seed or planting material shall declare that such material is, or is not, as the case may be, a product of transgenic manipulation, or involves GURT (Genetic Use Restriction Technology);
- g) If the seed or planting material to be imported is a product of transgenic manipulation or involves GURT, such material can be imported only if subjected to testing and screening as prescribed, and shall carry a declaration to this effect on its label when placed on sale.

## 25. Penalty

1. If any person:
  - a) contravenes any provision of this Act or any rule made thereunder; or
  - b) contravenes any direction issued by the Board or the State Government under this Act; or
  - c) prevents a Seed Inspector from exercising any power conferred on him by or under this Act:

He shall, on conviction be punishable;

- i) for the first offence with fine which may extent from minimum ten thousand rupees to maximum twenty-five thousand rupees;

- ii) in the event of such person having been previously convicted of an offence under this section, with imprisonment for a term which may extend to six months, or with fine which may extend to fifty thousand rupees, or with both.
2. When any person has been convicted under this Act for the contravention of any of the provisions of this Act or the rules made thereunder, the seed in respect of which the contravention has been committed may be forfeited by the Government.

## 26. Offences by companies

- a) Where an offence under this Act has been committed by a company every person who at the time the offence was committed was in charge of, and was responsible to the company for the conduct of the business of the company, as well as the company shall be deemed to be guilty of the offence and shall be liable to be proceeded against and punished accordingly;

Provided that nothing contained in this sub-section shall render any such person liable to any punishment under this act if he proves that the offence was committed without his knowledge and that he exercised all due diligence to prevent the commission of such offence.

- b) Notwithstanding anything contained in Sub-section (1) where an offence under this Act has been committed by a company and it is proved that the offence has been committed with the consent or connivance of, or is attributable to any neglect on the part of, any officer or partner of the company, such officer or partner shall also be deemed to be guilty of that offence and shall be liable to be proceeded against and punished accordingly;

Explanation – for the purpose of this section:

- i) “**Company**” means any body corporate and includes a firm or other association of individuals; and
- ii) “**Officer**” in relation to a firm, means a member of the Board of Directors or any functionary of the company;
- iii) “**Partner**” in relation to a firm, means a shareholder of the company.

## 27. Protection of action taken in good faith

No suit, prosecution or other legal proceeding shall lie against the Government or any officer of the Government for anything which is in good faith done or intended to be done under this Act.

## **28. Power to give directions**

The Central Government may give such directions to any State Government as may appear to the Central Government to be necessary for carrying into execution in the State any of the provisions of this Act or of any rule made thereunder.

## **29. Exemption**

Nothing in this Act shall apply to any seed of any registered kind or variety grown by a farmer and sold or delivered by him on his own premises or in the local market direct to another farmer for being used by that farmer for the purpose of sowing or planting.

## **30. Powers to make rules**

- a) The Central Government and the National Seed Board may make rules and regulations to carry out the purposes of this Act;
- b) In particular and without prejudice to the generality of the foregoing powers, such rules may provide for;
- c) Every rule made under this Act shall be laid as soon as may be after it is made, before each House of Parliament while it is in session for a total period of thirty days which may be comprised in one session or in two or more successive sessions, and if, before the expiry of the session immediately following the session or the successive sessions aforesaid, both Houses agree in making any modification in the rule or both Houses agree that the rule should not be made, that rule shall, thereafter have effect only in such modified form or be of no effect, as the case may be; so however, that any such modification or annulment shall be without prejudice to the validity of anything previously done under that rule.

## Annexure II: Protection of Plant Varieties and Farmer's Rights Act, 2001

The purpose of this act in India is to provide for the establishment of an effective system for protection of plant varieties (PPV) rights of farmers and plant breeders, to encourage the development of new varieties of plants. Whereas it is considered necessary to recognize and protect the rights of the farmers in respect of their contribution made at any time in conserving, improving and making available plant genetic resources for the development of new plant varieties. And whereas for accelerated agricultural development in the country, it is necessary to protect plant breeders' rights to stimulate investment for research and development, both in the public and private sector, for the development of new plant varieties. And whereas, such protection will facilitate the growth of the seed industry in the country which will ensure the availability of high quality seeds and plant material to the farmers. And whereas to give effect to the aforesaid objectives, it is necessary to undertake measures for the protection of the rights of farmers and plant breeders; And whereas India, having ratified the Agreement on Trade Related Aspects of Intellectual Property Rights should *inter-allia* make provision for giving effect to sub-paragraph (b) of paragraph 3 of article 27 in Part II of the said Agreement relating to protection of plant varieties; Be it enacted by Parliament in the Fifty-first Year of the Republic of India as follows:

### Chapter-I: Preliminary

**1. Short title, extent and commencement:** (1) This Act may be called the Protection of Plant Varieties and Farmers' Rights Act, 2000; (2) It extends to the whole of India; (3) It shall come into force on such date as the Central Government may, by notification in the Official Gazette, appoint; and different dates may be appointed for different provisions of this Act and any reference in any such provision to the commencement of this Act shall be construed as a reference to the coming into force of that provision.

**2. Definitions:** In this Act, unless the context otherwise requires: (a) "Authority" means the Protection of Plant Varieties and Farmers' Rights Authority established under sub-section (1) of section 3; (b) "benefit sharing" in relation to a variety, means such proportion of the benefit accruing to a breeder of such variety of such proportion of the benefit

accruing to the breeder from an agent or a Licensee of such variety, as the case may be, for which a claimant shall be entitled as determined by the Authority under section 26. (c) “breeder” means a person or group of persons or a farmer or group of farmers or any institution which has bred, evolved or developed any variety; (d) “Chairman” means the Chairman of the Tribunal; (e) “Chairperson” means the Chairperson of the Authority appointed under clause (a) of sub-section (5) of section 3; (f) “Convention country” means a country which has acceded to an international convention for the protection of plant varieties to which India has also acceded, or a country which has a law on protection of plant varieties on the basis of which India has entered into an agreement for granting, plant breeders’ right to the citizens of both the countries; (g) “denomination”, in relation to a variety or its propagating material or essentially derived variety or its propagating material, means the denomination of such variety or its propagating material or essentially derived variety or its propagating material, as the case may be, expressed by means of letters or a combination of letters and figures written in any language; (h) “essential characteristics” means such heritable traits of a plant variety which are determined by the expression of one or more genes of other heritable determinants that contribute to the principle features, performance or value of the plant variety; (i) “essentially derived variety”, in respect of a variety (the initial variety) shall be said to be essentially derived from such initial variety when it— (i) is predominantly derived from such initial variety, or from a variety that is itself predominantly derived from such initial variety, while retaining the expression of the essential characteristics that results from the genotype or combination of genotype of such initial variety; (ii) is clearly distinguishable from such initial variety; and (iii) conforms (except for the differences which result from the act of derivation) to such initial variety in the expression of the essential characteristics that result from the genotype or combination of genotype of such initial variety. (j) “extant variety” means a variety available in India which is—(i) notified under section 5 of the Seeds Act, 1966; or (ii) farmers’ variety; or (iii) a variety about which there is common knowledge; or (iv) any other variety which is in public domain; (k) “farmer” means any person who—(i) cultivates crops either by cultivating the land himself; or (ii) cultivates crops by directly supervising the cultivation of land through any other person; or (iii) conserves and preserves, severally or jointly, with any person any wild species or traditional varieties or adds value to such wild species or traditional varieties through selection and identification of their useful properties. (l) “farmers’ variety” means a variety which— (i) has been

traditionally cultivated and evolved by the farmers in their fields; or (ii) is a wild relative or land race of a variety about which the farmers possess the common knowledge. (m) “Gene Fund” means the National Gene Fund constituted under subsection (1) of section 45; (n) “Judicial Member” means a Member of the Tribunal appointed as such under sub-section (1) of section 56 and includes Chairman; (o) “Member” means a Judicial Member or a Technical member of the Tribunal and includes Chairman; (p) “member” means a member of the Authority appointed under clause (b) of sub-section (5) of section 3 and includes the Member-Secretary; (q) “prescribed” means prescribed by rules made under this Act; (r) “propagating material” means any plant or its component or part thereof including an intended seed or seed which is capable of or of suitable for regeneration into a plant; (s) “Register” means a national Register of Plant Varieties referred to in section 13; (t) “Registrar” means a Registrar of Plant Varieties appointed under sub-section (4) of section 12 and includes the Registrar-General; (u) “Registrar-General” means the Registrar-General of Plant Varieties appointed under sub-section (3) of section 12; (v) “Registry” means the Plant Variety Registry referred to in sub-section (1) of section 12; (w) “regulations” means regulations made by the Authority under this Act; (x) “seed” means a type of living embryo or propagule capable of regeneration and giving rise to a plant which is true to such type; (y) “Variety”, means a plant grouping except micro-organism within a single botanical taxon of the lowest known rank, which can be— (i) defined by the expression of the characteristics resulting from a given genotype of that plant grouping; (ii) distinguished from any other plant grouping by expression of at least one of the said characteristics; and (iii) considered as a unit with regard to its suitability for being propagated, which remains unchanged after such propagation, and includes propagating material of such variety, extant variety, transgenic variety, farmers’ variety and essentially derived variety. (z) “Tribunal” means the Plant Varieties Protection Appellate Tribunal established under section 54; (z-a) “Technical Member” means a Member of the Tribunal who is not a Judicial Member.

## Chapter II: A. The plant varieties and farmers’ rights protection authority

**3. Establishment of Authority:** (1) The Central Government shall, by notification in the Official Gazette, establish an authority to be known as the Protection of Plant Varieties and Farmers’ Rights Authority for the purposes of this Act; (2) The Authority shall be a body corporate by the name

aforesaid, having perpetual succession and a common seal with power to acquire, hold and dispose of properties, both movable and immovable, and to contract, and shall by the said name sue and be sued; (3) The head office of the Authority shall be at such place as the Central Government may, by notification in the Official Gazette, specify and the Authority may, with the previous approval of the Central Government, establish branch offices at other places in India; (4) The Authority shall consist of a Chairperson and fifteen members; (5) (a) The Chairperson to be appointed by the Central Government, shall be a person of outstanding calibre and eminence, with long practical experience to the satisfaction of that Government especially in the field of plant varietal research or agricultural development. (b) The members of the Authority, to be appointed by the Central Government, shall be as follows, namely: (i) the agriculture Commissioner, Government of India, Department of Agriculture and Cooperation, New Delhi, Member ex-officio; (ii) the Deputy Director General in charge of Crop Sciences, Indian Council of Agricultural Research, New Delhi, ex-officio; (iii) the Joint Secretary in charge of Seeds, Government of India, Department of Agriculture & Cooperation, New Delhi, ex-officio; (iv) the Horticulture Commissioner, Government of India, Department of Agriculture & Cooperation, New Delhi, ex-officio; (v) the Director, National Bureau of Plant Genetic Resources, New Delhi, ex-officio; (vi) one member not below the rank of Joint Secretary to the Government of India, to represent the Department of Bio-Technology, Government of India, ex-officio; (vii) one member not below the rank of Joint Secretary to the Government of India to represent the Ministry of Environment and Forests of the Government of India, ex-officio; (viii) one member not below the rank of Joint Secretary to the Government of India to represent the Ministry of Law of the Government of India, ex-officio; (ix) one representative from a National or State level farmers' organisation to be nominated by the Central Government; (x) one representative from a tribal organization to be nominated by the Central Government; (xi) one representative from the seed industry to be nominated by the Central Government; (xii) one representative from an agricultural university to be nominated by the Central Government; (xiii) one representative from a National or State level women's organisation associated with agricultural activities to be nominated by the Central Government; (xiv) two representatives of State Governments on rotation basis to be nominated by the Central Government; (c) The Registrar General shall be the ex-officio Member-Secretary of the Authority; (6) The term of office of the Chairperson and the manner of



filling the post shall be such as may be prescribed; (7) The Chairperson shall appoint a Standing Committee consisting of five members, one of which shall be a member who is a representative from a farmers organisation to advise the Authority on all issues including farmers rights; (8) The Chairperson shall be entitled to such salary and allowances and shall be subject to such conditions of service in respect of leave, pension, provident fund and other matters as may be prescribed. The allowances for non-official members for attending the meeting of the Authority will be as such as may be prescribed. The allowances for non-official members for attending the meeting as prescribed; (9) The Chairperson may resign his office by giving notice thereof in writing to the Central Government and on such resignation being accepted, he shall be deemed to have vacated his office; (10) On the resignation of the Chairperson or on the vacation of the office of Chairperson for any reason, the Central Government may appoint one of the members to officiate as Chairperson till a regular Chairperson is appointed in accordance with clause (a) of sub-section (5).

**4. Meeting of Authority:** (1) The Authority shall meet at such time and place and shall observe such rules of procedure in regard to the transaction of business at its meetings (including the quorum at its meetings and the transaction or business of its Standing Committee appointed under sub-section 7 of section 3) as may be prescribed; (2) The Chairperson of the Authority shall preside at the meetings of the Authority.<sup>5</sup> (3) If for any reason the Chairperson is not able to attend any meeting of the Authority, any member of the Authority chosen by the members present at the meeting shall preside at the meeting; (4) All questions which come before any meeting of the Authority shall be decided by a majority of the votes of the members of the Authority present and voting and in the event of equality of votes, the Chairperson of the Authority or in his absence, the person presiding shall have and exercise a second or casting vote; (5) Every member who is in any way, whether directly, indirectly or personally, concerned or interested in a matter to be decided at the meeting shall disclose the nature of his concern of interest and after such disclosure, the member concerned or interested shall not attend that meeting; (6) No act or proceeding of the Authority shall be invalid merely by reason of— (a) any vacancy in, or any defect in the constitution of the Authority; or (b) any defect in the appointment of a person acting as the Chairperson or a member of the Authority; or (c) any irregularity in the procedure of the Authority not affecting the merits of the case.

**5. Committee of Authority:** (1) The Authority may appoint such committees as may be necessary for the efficient discharge of its duties and performance of its functions under this Act; (2) The persons appointed as members of the committee under sub-section (1) shall be entitled to receive such allowances or fees for attending the meetings of the committee as may be fixed by the Central Government.

**6. Officers and employees of Authority:** Subject to such control and restriction as may be prescribed, the Authority may appoint such other officers and employees as may be necessary for the efficient performance of its functions and the method of appointment, the scale of pay and allowances and other conditions of service of such other office and employees of the Authority shall be such as may be prescribed.

**7. Chairperson to be Chief Executive:** The Chairperson shall be the Chief Executive of the Authority and shall exercise such powers and perform such duties as may be prescribed.

**8. General functions of Authority:** (1) It shall be the duty of the Authority to promote, by such measures as it thinks fit, the encouragement for the development of new varieties of plants and to protect the rights of the farmers and breeders; (2) In particular, and without prejudice to the generality of the foregoing provisions, the measures referred to in sub-section (1) may provide for— (a) the registration of extant and new plant varieties subject to such terms and conditions and in the manner as may be prescribed; (b) developing characterization and documentation of varieties registered under this Act; (c) documentation, indexing and cataloguing of farmers' varieties; (d) compulsory cataloguing facilities for all varieties of plants; (e) ensuring that seeds of the varieties registered under this Act are available to the farmers and providing for compulsory licensing of such varieties if the breeder of such varieties or any other person entitled to produce such variety under this Act does not arrange for production and sale of the seed in the manner as may be prescribed; (f) collecting statistics with regard to plant varieties, including the contribution of any person at any time in the evolution or development of any plant variety, in India or in any other country, for compilation and publication; (g) ensure the maintenance of the National Register of plant variety.

**9. Authentication of orders of Authority:** All orders and decisions of the Authority shall be authenticated by the signature of the Chairperson or any other member authorized by the Authority in this behalf.

**10. Delegation:** The Authority may, by general or special order in writing, delegate to the Chairperson, any member or officer of the Authority subject to such conditions or limitations, if any, as may be specified in the order, such of its powers and functions (except the power to make regulations under section 94) under this Act as it may deem necessary.

**11. Power of Authority:** In all proceedings under this Act before the Authority or the Registrar— (a) the Authority or the Registrar, as the case may be, shall have all the powers of a civil court for the purposes of receiving evidence, administering oaths, enforcing the attendance of witnesses, compelling the discovery and production of documents and issuing commissions for the examination of witnesses; (b) the Authority or the Registrar may, subject to any rules made in this behalf under this Act, make such orders as to cost as it considers reasonable and any such order shall be executable as a decree of a civil court.

## **B. The registry, registration of varieties and conditions of registration**

**12. Registry and offices thereof:** (1) The Central Government shall establish for the purpose of this Act, a Registry which shall be known as the Plant Varieties Registry; (2) The head office of the Plant Varieties Registry shall be located in the head office of the Authority, and for the purpose of facilitating the registration of plant varieties, there may be established, at such places, as the Authority may think fit, branch offices of the Registry; (3) The Authority shall appoint a Registrar General of Plant Varieties who shall be entitled to such salary and allowances and shall be subject to such conditions of service in respect of leave, pension, provident fund and such other matters as may be prescribed; (4) The Authority may appoint such number of Registrars as it thinks necessary for Registration of plant varieties under the superintendence and direction of the Registrar General under this Act and may make regulations with respect to their duties and jurisdiction; (5) The term of office and the conditions of service of the Registrars shall be such as may be provided by regulations; (6) The Authority may, by notification in the Official Gazette, define the territorial limits within which a branch office of the Registry may exercise its functions; (7) There shall be a seal of the Plant Varieties Registry.

**13. National Register of Plant Varieties:** (1) For the purposes of this Act, a register called the National Register of Plant Varieties shall be kept at the

head office of the Registry, wherein shall be entered the names of all the registered plant varieties with the names and addresses of their respective breeders, the right of such breeders in respect of the registered variety, the particulars of the denomination of each registered variety, its seeds or other propagating material along with specification of salient features thereof and such other matters as may be prescribed; (2) Subject to the superintendence and direction of the Central Government, the register shall be kept under the control and management of the Authority; (3) There shall be kept at each branch office of the Registry a copy of the register and such other documents as the Central Government may, by notification in the Official Gazette, direct.

### Chapter III: A. Registration of plant varieties

**14. Application for Registration:** Any person specified in section 16 may make an application to the Registrar for registration of any variety— (a) of such genera and species as specified under sub-section (2) of section 29; or (b) which is an extant variety; or (c) which is a farmers' variety.

**15. Registrable varieties:** (1) A new variety shall be registered under this Act if it conforms to the criteria of novelty, distinctiveness, uniformity and stability; (2) Notwithstanding anything contained in sub-section (1) an extant variety shall be registered under this Act within a specified period if it conforms to such criteria of distinctiveness, uniformity and stability as shall be specified under regulations made by the Authority; (3) For the purposes of sub-section (1) and sub-section (2) as the case may be a new variety shall be deemed to be: (a) novel, if at the date of filing of the application for registration for protection, the propagating or harvested material of such variety has not been sold or otherwise disposed of by or with the consent of its breeder or his successor for the purposes of exploitation of such variety ; (i) in India, earlier than one year, or (ii) Outside India in the case of trees or vines earlier than six years, or in any other case, earlier than four years; before the date of filing such application. Provided that a trial of a new variety which has not been sold or otherwise disposed of shall not affect the right to protection. Provided further that the fact that on the date of filing the application for registration the propagating or harvested material of such variety has become a matter of commonly known other than through the aforesaid manner shall not affect the criteria of novelty for such variety; (b) distinct, if it is clearly distinguishable by at least one essential characteristic from any another variety whose existence is a matter of common knowledge

in any country at the time of filing of the application; Explanation—For the removal of doubts, it is hereby declared that the filing of an application for the granting of a breeder's right to a new variety or for entering such variety in the official register of varieties in any convention country shall be deemed to render that variety a matter of common knowledge from the date of the application in case the application leads to the granting of the breeder's right or to the entry of such variety in such official register, as the case may be; (c) uniform if subject to the variation that may be expected from the particular features of its propagation it is sufficiently uniform in its essential characteristics; (d) stable, if its essential characteristics remain unchanged after repeated propagation or, in the case a particular cycle of propagation, at the end of each such cycle; (4) A new variety shall not be registered under this Act if the denomination given to such variety: (i) is not capable of identifying such variety; and (ii) consists solely of figures; and (iii) is liable to mislead or to cause confusion concerning the characteristics, value identity of such variety or the identity of breeder of such variety; or (iv) is not different from every denomination which designates a variety of the same botanical species or of a closely related species registered under this Act; or (v) is likely to deceive the public or cause confusion in the public regarding the identity of such variety; (vi) is likely to hurt the religious sentiments respectively of any class or section of the citizens of India; or (vii) is prohibited for use as a name or emblem for any of the purpose mentioned in section 3 of the Emblems and Names (Protection of Improper Use) Act, 1950; or (viii) is comprised of solely or partly of geographical name: Provided that the Registrar may register a variety. the denomination of which comprises solely or partly of a geographical name, if he considers that tile use of such denomination in respect of such variety is an honest use under the circumstances of the case.

## B. Application for registration

**16. Persons who may make application:** (1) An application for registration under section 14 shall be made by: (a) any person claiming to be the breeder of the variety; and (b) any successor of the breeder of the variety; or (c) any person being the assignee of the breeder of the variety in respect of the right to make such application or (d) any farmer or group of farmers or community of farmers claiming to be the breeder of the variety; (e) any person authorized in the prescribed manner by a person specified under clause (a) to (d) to make application on his behalf; (f) any university or

publicly funded agricultural institution claiming to be the breeder of the variety; (2) An application under sub-section (1) may be made by any of the persons referred to therein individually or jointly with any other person;

**17. Compulsory Plant Variety denomination:** (1) Every application shall assign a single and distinct denomination to a variety with respect to which he is seeking registration under this Act in accordance with the regulations; (2) The Authority shall, having regard to the provisions of any international convention or treaty to which India has become a party, make regulations governing the assignment of denomination to a plant variety; (3) Where the denomination assigned to the variety do not satisfy the requirements specified in the regulations, the Registrar may require the applicant to propose another denomination within such time as may be provided by such regulations; (4) Notwithstanding anything contained in the Trade Mark Act, 1999 a denomination assigned to a variety shall not be registered as a trade mark under that Act.

**18. Form of applicant:** (1) Every application for registration under section 14 shall: (a) be with respect to a variety; (b) state the denomination assigned to such variety by the applicant; (c) be accompanied by an-affidavit sworn by the applicant that such variety does not contain any gene or gene sequence involving terminator technology; (d) be in such form as may be specified by regulation; (e) contain a complete passport data of the parental lines from which the variety has been derived along with the geographical location in India from where the genetic material has been taken and all such information relating to the contribution, if any, of any farmer, village community, institution or organisation in breeding, evolution or developing the variety; (f) be accompanied by a statement containing a brief description of the variety bringing out its characteristics of novelty, distinctiveness, uniformity and stability as required for registration; (g) be accompanied by such fees as may be prescribed; (h) contain a declaration that the genetic material or parental material acquired for the breeding, evolving or developing the variety has been lawfully acquired; and (i) be accompanied by such other particulars as may be prescribed: Provided that in case where the application is for the registration of farmers' variety, nothing contained in clause (h) to (i) shall apply in respect of the application and the application in such form as may be prescribed; (2) Every application referred to in sub-section (a) shall be filed in the office of the Registrar. (3) Where such application is made by virtue of a succession or an assignment of the right to apply for registration, there shall be furnished at the time of making the

application, or within such period after making the application as may be prescribed, a proof of the right to make the application.

**19. Test to be conducted:** (1) Every applicant shall, along with the application for registration made under this Act, make available to the Registrar such quantities of seeds of a variety for registration of which such application is made, for the purpose of conducting tests to evaluate whether such variety along with parental material conform to the standards as may be specified by regulations: Provided that the Registrar or any person or test centre to whom such seed has been sent for conducting test shall keep such seed during his or its possession in such manner and in such condition that its viability and quality shall remain unaltered. (2) The applicant shall deposit such fee as may be prescribed for conducting tests referred to in sub-section (1). The tests under sub-section (1) shall be conducted in such manner and by such method as may be prescribed.

**20. Acceptance of application or amendment thereof:** (1) On receipt of an application under section 14, the Registrar may, after making such inquiry as he thinks fit with respect to the particulars contained in such application, accept the application absolutely or subject to such condition or limitations as he deems fit.

(2) Where the Registrar is satisfied that the application does not comply with the requirements of this Act or any rules or regulations made there under, he may, either—(a) require the applicant to amend the application to his satisfaction; (b) reject the application; Provided that no application shall be rejected unless the applicant has been given a reasonable opportunity of presenting his case.

**21. Advertisement of application:** (1) Where an application for registration of a variety has been accepted absolutely or subject to conditions or limitations under sub-section (1) of section 20, the Registrar shall, as soon as after its acceptance, cause such application together with the conditions or limitations, if any, subject to which it has been accepted and the specifications of the variety for registration of which such application is made including its photographs or drawings. To be advertised in the prescribed manner calling objections from the persons interested in the matter; (2) Any person may, within three months from the date of the advertisement of an application for registration on payment of the prescribed fee, give notice, in writing in the prescribed manner, to the Registrar, of his opposition to the registration: (3) Opposition to the registration under sub-section (2) may be

made on the following grounds, namely: (a) that the person opposing the application is entitled to the breeder's right as against the applicant; or (b) that the variety is not registrable under this Act; (c) that the grant of certificate of registration may not be in public interest; (d) that the variety may have adverse effect on environment. (4) The Registrar shall serve a copy of the notice of opposition on the applicant for registration and, within two months from the receipt by the applicant of such copy of the notice of opposition, the applicant shall send to the Registrar in the prescribed manner a counter statement of the grounds on which he relies for his application, and if he does not do so, he shall be deemed to have abandoned his application; (5) If the applicant sends such counter statement, the Registrar shall serve a copy thereof on the person giving notice of opposition; (6) Any evidence upon which the opponent and the applicant may rely shall be submitted, in the manner prescribed and within the time prescribed, to the Registrar and the Registrar shall give an opportunity to them to be heard, if so desired; (7) The Registrar shall, after hearing the parties, if so required, and considering the evidence, decide whether and subject to what conditions or limitations, if any, the registration is to be permitted and may take into account a ground of objection whether relied upon by the opponent or not.

(8) Where a person giving notice of opposition or an applicant sending a counter statement after receipt of a copy of such notice neither resides nor carries on business in India, the Registrar may require him to give security for the cost of proceedings before him and in default of such security being duly given may treat the opposition or application, as the case may be, as abandoned; (9) The Registrar may, on request, permit correction of any error in, or any amendment of, a notice of opposition or a counter statement on such terms as he may think fit.

**22. Registrar to consider grounds for opposition:** The Registrar shall consider all the grounds on which the application has been opposed and after giving reasons for his decision, by order, uphold or reject the opposition.

**23. Registration of essentially derived variety:** (1) An application for the registration of an essentially derived variety of the genera or species specified under sub-section (2) of section 29 by the Central Government shall be made to the Registrar by or on behalf of any person referred to in section 14 and in the manner specified in section 18 as if for the word "variety" the words "essentially derived variety" have been substituted therein and shall be accompanied by such documents and fee as may be prescribed; (2) When



the Registrar is satisfied that the requirements of sub-section (1) have been complied with to his satisfaction, he shall forward the application with his report and all the relevant document to the Authority.

(3) On receipt of an application under sub-section (2), the Authority shall get examined such essentially derived variety to determine as to whether the essentially derived variety is a variety derived from the initial variety by conducting such tests and following such procedure as may be prescribed; (4) When the Authority is satisfied on the report of the test referred to in sub-section (3) that the essentially derived variety has been derived from the initial variety, it may direct the Registrar to register such essentially derived variety and the Registrar shall comply with the direction of the Authority; (5) Where the Authority is not satisfied on the report of the test referred to in sub-section (3) that the essentially derived variety has been derived from the initial variety it shall refuse the application; (6) The rights of the breeder of a variety contained in section 28 shall apply to the breeder of essentially derived variety:

Provided that the authorisation by the breeder of initial variety to the breeder of essentially derived variety under, sub-section (2) of section 28 may be subject to such terms and conditions as both the parties may mutually agree upon; (7) An essentially derived variety shall not be registered under this section unless it satisfies the requirements of section 15 as if for the word “variety”, the words “essentially derived variety” have been substituted therein; (8) When an essentially derived variety has been registered by the Registrar in compliance with the direction of the Authority under sub-section (4), the Registrar shall issue to the applicant a certificate of registration in the prescribed form and sealed with seal of the Registry and send a copy thereof to the Authority and to such other authority, as may be prescribed, for information.

## Chapter IV: Duration and effect of registration and benefit sharing

**25. Publication of list of varieties:** The Authority shall, within such intervals as it thinks appropriate, publish the list of varieties which have been registered during that intervals.

**26. Determination of benefit sharing by Authority:** (1) On receipt of a copy of the certificate of registration under sub-section (8) of section 23 or

sub-section (2) of section 24, the Authority shall publish such contents of the certificate and invite claims of benefit sharing to the variety registered under such certificate in the manner as may be prescribed; (2) On invitation of the claims under sub-section (1), any person or group of persons or non-governmental; organisation shall submit its claim of benefit sharing to such variety in the prescribed form within such period, and accompanied with such fee, as may be prescribed; (3) On receiving a claim under subsection (2), the Authority shall send a copy of such claims to breeder of the variety registered under such certificate and the breeder may, on receipt of such copy, submit his opposition to such claim within such period and in such manner as may be prescribed; (4) The Authority shall, after giving an opportunity of being heard to the parties' dispose of the claim received under sub-section (2) (5) While disposing of the claim under sub-section (4), the Authority shall explicitly indicate in its order the amount of the benefit sharing, if any, for which the claimant shall be entitled and shall take into consideration the following matters, namely: (a) the extent and nature of the use of genetic material of the claimant in the development of the variety relating to which the benefit sharing has been claimed, (b) the commercial utility and demand in the market of the variety relating to which the benefit sharing has been claimed; (6) The amount of benefit sharing to a variety determined under this section shall be deposited by the breeder of such variety in the manner referred to under clause (a) of sub-section (1) of section 45 in the National Gene Fund; (7) The amount of benefit sharing determined under this section shall, on a reference made by the Authority in the prescribed manner, be recoverable as an arrear of land revenue by the District Magistrate within whose local limits of jurisdiction the breeder liable for such benefit sharing resides.

**27. Breeder to deposit seeds or propagating material:** (1) The breeder shall be required to deposit such quantity of seeds or propagating material including parental line seeds of registered variety in the National Gene Bank as may be specified in the regulations for reproduction purpose at the breeder's expense within such time as may be specified in that order; (2) The seeds or propagating material or parental line seeds to be deposited under sub-section (1) shall be deposited to the National Gene Bank specified by the Authority.

**28. Registration to confer right:** (1) Subject to the other provisions of this Act, a certificate of registration for a variety issued under this Act shall confer an exclusive right on the breeder or his successor, his agent or licensee,

to produce, sell, market, distribute, import or export the variety. Provided that in the case of an extant variety, unless a breeder or his successor establishes his right, the Central Government, and in cases where such extant variety is notified for a State or for any area thereof under section 5 of the Seeds Act, 1966 the State Government, shall be deemed to be the owner of such right.

**29. Authorization of breeder:** (2) breeder may authorize any person to produce, sell, market or otherwise deal with a variety registered under this Act subject to such limitations and conditions as may be specified in the regulations; (3) Every authorization under this section shall be in such form as may be specified by regulations; (4) Where an agent or a licensee referred to in sub-section (1) becomes entitled to produce, sell, market, distribute, import or export a variety, he shall apply in the prescribed manner and with the prescribed fee to the Registrar to register his title and the Registrar shall on receipt of application and on proof of title to his satisfaction, register him as an agent or a licensee, as the case may be, in respect of the variety for which he is entitled for such right, and shall cause particulars of such entitlement and conditions or restrictions, if any, subject to which such entitlement is made, to be entered in the Register: Provided that when the validity of such entitlement is in dispute between the parties, the Registrar may refuse to register the entitlement and refer the matter in the prescribed manner to the Authority and withhold the registration of such entitlement until the right of the parties in dispute referred to has been determined by the Authority.

(5) The Registrar shall issue a certificate of registration under sub-section (4) to the application after such registration and shall enter in the certificate the brief conditions of entitlement, if any, in the prescribed manner, and such certificate shall be the conclusive proof of such entitlement and the conditions or restriction thereof, if any.; (6) Subject to any agreement subsisting between the parties, an agent or licensee of a right to a variety registered under sub-section (4) shall be entitled to call upon the breeder or his successor thereof to take proceedings to prevent infringement thereof, and if the breeder or his successor refuses or neglects to do so within three months after being so called upon, such registered agent or licensee may institute proceedings for infringement in his own name as if he were the breeder, making the breeder or his successor a defendant; (7) Notwithstanding anything contained in any other law, a breeder or his successor so added as defendant shall not be liable for any costs unless he

enters an appearance and takes part in the proceedings; (8) Nothing in this section shall confer on a registered agent or registered licensee of a variety any right to transfer such a right further thereof; (9) Without prejudice to the registration under sub-section (4), the terms of registration—(a) may be varied by the Registrar as regards the variety in respect of which, or any condition or restrictions subject to which, it has effect on receipt of an application in the prescribed manner of the registered breeder of such variety, or his successors; (b) may be cancelled by the Registrar on the application in the prescribed manner of the registered breeder of such variety or his successor or of the registered agent or registered licensee of such variety; (c) may be cancelled by the Registrar on the application in the prescribed manner of any person other than the breeder, his successor, the registered agent or the registered licensee on any of the following, grounds, namely:—(i) that the breeder of a variety or his successor or the registered agent or registered licensee of such variety, misrepresented, or failed to disclose, some fact material to the application for registration under sub-section (4) which if accurately represented or disclosed would have justified the refusal of the application for registration of the registered agent or registered licensee; (ii) that the registration ought not to have effected having regard to the right vested in the applicant by virtue of a contract in the performance of which he is interested; (d) may be cancelled by the Registrar on the application in the prescribed manner of the breeder of a registered variety, or his successor on the ground that any stipulation in the agreement between the registered agent or the registered licensee, as the case may be, and such breeder or his successor regarding the variety for which such agent or licensee is registered is not being enforced or is not being complied with; (e) may be cancelled by the Registrar on the application of any person in the prescribed manner on the ground that the variety relating to the registration is no longer existing; (10) The Registrar shall issue notice in the prescribed manner of every application under this section to the registered breeder of a variety or his successor and to each registered agent or registered licensee (not being the applicant) of such variety; (11) The Registrar shall before making any order under sub-section (9) forward the application made in that behalf along with any objection received by any party after notice under subsection (10) for the consideration of the Authority, and the Authority may, after making such enquiry as it thinks fit, issue such directions to the Registrar as it thinks fit and the Registrar shall dispose of the application in accordance with such directions.

**29. Exclusion of certain varieties:** (1) Notwithstanding anything contained in this Act, no registration of a variety shall be made under this Act in cases where prevention of commercial exploitation of such variety is necessary to protect public order or public morality or human, animal and plant life and health or to avoid serious prejudice to the environment; (2) The Central Government shall, by notification in the Official Gazette, specify the genera or species for the purposes of registration of varieties other than extant varieties and farmers' varieties under this Act; (3) Notwithstanding anything contained under sub-section (2) above and sub-sections (1) and (2) of section 15, no variety of any genera or species which involves any technology including which is injurious to the life or health of human beings, animals or plants shall be registered under this Act.; Explanation—For the purpose of this sub-section; the expression any “technology” includes genetically use restriction technology and terminator technology; (4) The Central Government shall not delete any genera or species from the list of genera or species specified in a notification issued under sub-section (2) except in public interest; (5) Any variety belonging to the genera or species excluded under subsection (4) shall not be eligible for any protection under this Act.

**30. Researcher's Rights:** Nothing contained this Act shall prevent: (a) the use of any variety registered under this Act by any person using such variety for conducting experiment or research; and (b) the use of a variety by any person as an initial source of variety for the purpose of creating other varieties: Provided that the authorization of the breeder of a registered variety is required where the repeated use of such variety as a parental line is necessary for commercial production of such other newly developed variety.

### **31. Special provisions relating to applications for registration from citizens of convention**

**Countries:** (1) With a view to the fulfillment of a treaty, convention or arrangement with any country outside India which affords to citizens of India similar privileges as granted to its own citizen, the Central Government may, by notification in the Official Gazette, declare such country to be a convention country for the purposes of this Act; (2) Where a person has made an application for the granting of a breeder's right to a variety or for entering such variety in the official register of varieties in a convention country and that person or any person entitled to make application on his behalf under section 14 or section 23 makes an application for the

registration of such variety in India within twelve months after the date on which the application was made in the convention country, such variety shall, if registered under this Act, be registered as of the date on which the application was made in the convention country and that date shall be deemed for the purposes of this Act to be the date of registration; (3) Where applications have been made for granting of a breeder's right to a variety or for entering such variety in the official register of varieties in two or more convention countries, the period of twelve months referred to in the last preceding sub-section shall be reckoned from the date on which the earlier or earliest of those application was made; (4) Nothing in this Act shall entitle the breeder of a registered variety to infringement of rights other than protected under this Act which took place prior to the date of application of registration under this Act.

**32. Provisions as to reciprocity:** Where any country specified by the Central Government in this behalf by notification in the Official Gazette under sub-section (1) of section 31 does not accord to citizens of India the same rights in respect of the registration and protection of a variety, as it accords to its own nationals, no nationals of such country shall be entitled, either solely or jointly with any other person, to apply for the registration of a variety or be entitled to get a variety registered under this Act.

## Chapter V: Surrender and revocation of certificate and rectification and correction of register

**33. Surrender of certificate of registration:** (1) A breeder of a variety registered under this Act may, at any time by giving notice in the prescribed manner to the Registrar, offer to surrender his certificate of registration; (2) Where such an offer is made, the Registrar shall notify in the prescribed manner every registered agent or registered licensee relating to such certificate; (3) Any of such agent or licensee may within the prescribed period after such notification give notice to the Registrar of his opposition to the surrender and where any such notice is given, the Registrar shall intimate the contents of such notice to the breeder of such variety; (4) If the Registrar is satisfied after hearing the applicant and all the opponents, if desirous of being heard that the certificate of registration may properly be surrendered, he may accept the offer and by order revoke the certificate of registration;

**34. Revocation of protection on certain grounds:** Subject to the provisions contained in this Act, the protection granted to a breeder in respect of a

variety may, on the application in the prescribed manner of any person interested, be revoked by the authority on any of the following grounds, namely:—(a) that the grant of the certificate of registration has been based on incorrect information furnished by the applicant;

(b) that the certificate of registration has been granted to a person who is not eligible for protection under this Act; (c) that the breeder did not provide the Registrar with such information, documents of material as required for registration under this Act; (d) that the breeder has failed to provide all alternative denomination of the variety which is the subject matter of the registration to the Registrar in case where the earlier denomination of such variety provided to the Registrar is not permissible for registration under this Act; (e) that the breeder did not provide the necessary seeds or propagating material to the person to whom compulsory license has been issued under section 48 regarding the variety in respect of which registration certificate has been issued to such breeder; (f) that the breeder has not complied with the provisions of this Act or provisions of rules or regulations made there under; (g) that the breeder has failed to comply with the directions of the Authority issued under this Act; (h) that the grant of the certificate of registration is not in the public interest. Provided that no such protection shall be revoked unless the breeder is given a reasonable opportunity to file objection and of being heard in the matter.

**35. Payment of annual fee and forfeiture of registration in default thereof:** (1) The Authority may, with the prior approval of the Central Government and after notification in the Official Gazette, impose a fee to be paid annually, by every breeder of a variety, agent and licensee thereof registered under this Act determined on the basis of benefit or royalty gained by such breeder, agent or licensee, as the case may be, in respect of the variety, for the retention of their registration under this Act; (2) If any breeder, agent or licensee fails to deposit the fee referred to in sub-section (1) imposed upon him under that sub-section in the prescribed manner up to two consecutive years, the Authority shall issue notice to such breeder, agent or licensee and on service of such notice if he fails to comply with the direction in the notice, the Authority shall declare all the protection admissible under registration certificate issued to such breeder or agent or licensee forfeited; (3) the arrears of fee imposed under sub-section (1) shall be deemed to be arrears of land revenue and shall be recoverable accordingly.

**36. Power to cancel or change registration and to rectify the Register:** (1) On an application made in the prescribed manner to the Registrar by any person aggrieved, the Registrar may make such order as he may think fit for cancelling or changing any certificate of registration issued under this Act on the ground of any contravention of the provisions of this Act or failure of observe a condition subject to which such registration certificate is issued; (2) Any person aggrieved by the absence or omission from the register of any entry, or by any entry in the register without sufficient cause, or by any entry wrongly remaining on the register, may apply in the described manner to the Registrar and the Registrar may make such order for making, expunging or varying the entry as he may think fit; (3) The Registrar may in any proceeding, under this section decide any question that may be necessary or expedient to decide in connection with the rectification of the register; (4) The Registrar, on his own motion may, after giving notice in the prescribed manner to the parties concerned and after giving them an opportunity of being heard make any order referred to in sub-section (1) or sub-section (2).

**37. Correction of register:** (1) The Registrar may, on an application in the prescribed manner by the breeder of a variety registered under this Act— correct any error in the register in the name, address or description of such breeder or any other entry relating to such variety; (b) enter in the register any change in the name, address or description of such breeder; (c) cancel the entry in the register of the variety in respect of which such application is made; and make any consequential amendment or alteration in the certificate of registration and for that purpose require the certificate of registration to be produced to him. (2) The Registrar may, on application made in the prescribed register by a registered agent or a registered licensee of a variety and after notice to the registered breeder of such variety, correct any error, or enter any change, in the name, address or description of such registered agent or registered licensee, as the case may be, in the register or certificate of registration under this Act.

**38. Alteration of denomination of a registered variety:** (1) The breeder of a variety registered under this Act may apply in the prescribed manner to the Registrar to delete any part or to add to or alter the denomination of such variety in any manner not substantially affecting the identity thereof, and the Registrar may refuse, leave or may grant it on such terms and subject to such limitations as he may think fit to avoid any conflict with the rights of other breeders of the varieties registered under this Act; (2) The Registrar may cause an application under this section to be advertised in the prescribed



manner in any case where it appears to him that it is expedient so to do, and where he does so, if within the prescribed time from the date of the advertisement any person gives notice to the Registrar in the prescribed manner of opposition to the application, the Registrar shall, after hearing the parties if so required, decide the matter; (3) Where leave is granted under this section, the denomination of the variety as altered shall be advertised in the prescribed manner, unless the application has already been advertised under sub-section (2).

## Chapter VI

**39. Farmers rights:** (1) Notwithstanding anything contained in this Act, a farmer (i) who has bred or developed a new variety shall be entitled for registration and other protection in like manner as a breeder of a variety under this Act: (ii) the farmers' variety shall be entitled for registration as specified in the Article 18(h); (iii) who is engaged in the conservation of genetic resources of land races and wild relatives of economic plants and their improvement through selection and preservation shall be entitled in the prescribed manner for recognition and reward from the National Gene Fund; Provided that material so selected and preserved has been used as donors of genes in varieties remittable under this Act; (iv) Shall be deemed to be entitled to save, use, sow, re-sow, exchange, share or sell his farm produce including seed of a variety protected under this Act in the same manner as he was entitled before the coming into force of this Act; Provided that the farmer shall not be entitled to sell branded seed of a variety protected under this Act.

Explanation: For the purpose of clause (iv) branded seed means any seed put in a package or any other container and labeled in a manner indicating that such seed is of a variety protected under this Act; (2) Where any propagating material of a variety registered under this Act has been sold to a farmer or a group of farmers or any organisation of farmers, the breeder of such variety shall disclose to the farmer or the group of farmers or the organisation of farmers, as the case may be, the expected performance under given conditions, and if such propagating material fails to provide such performance under such given conditions as the farmer or the group of farmers or the organisation of farmers, as the case may be, may claim compensation in the prescribed manner before the Authority and the Authority shall after giving notice to the breeder of the variety and after

providing him an opportunity to file opposition in the prescribed manner and after hearing the parties, it may direct the breeder of the variety to pay such compensation as it deems fit, to the farmer or the group of farmers or the organisation of farmers, as the case may be.

**40. Certain information to be given in application registration:** (1) A breeder or other person making application for registration of any variety under chapter III shall disclose in the application the information regarding the use of genetic material conserved by any tribal or rural families in the breeding or development of such variety; (2) If the breeder or such other person fails to disclose any information under sub-section (1), the Registrar may after being satisfied that the breeder or such person has willfully and knowingly concealed such information reject the application for registration.

**41. Rights of communities:** (1) Any person, group of persons (whether actively engaged in farming or not) or any governmental or non-governmental organisation may on behalf of any village or local community in India, file in any centre notified, with the previous approval of the Central Government by the Authority in the Official Gazette any claim attributable to the contribution of the people of that village or local community as the case may be in the evolution of any variety for the purpose of staking a claim on behalf of such village or local community; (2) Where any claim is made under sub-section (1), the centre notified under that sub-section may verify the claim made by such person or group of persons or such governmental or non-governmental organisation in such manner as it deems fit and if it is satisfied that such village or local community has contributed significantly to the evolution of the variety which has been registered under this Act, it shall report its findings to the Authority; (3) When the Authority, on a report under sub-section (2) is satisfied, after such enquiry as it may deem fit, that the variety with which the report is related has been registered under the provision of this Act, it may issue notice in the prescribed manner to the breeder of that variety and after providing opportunity to such breeder to file objection in the prescribed manner and of being heard, it may subject to any limit notified by the Central Government, by order, grant such sum of compensation to be paid to a person or group of persons or governmental or non-governmental organisation which has made claim under sub-section (1) to the Authority, as it may deem fit; (4) Any compensation granted under sub-section (3) shall be deposited by the breeder of the variety in the Gene Fund; (5) The compensation granted under sub-section (3) shall be deemed to be an arrear of land revenue and shall be recoverable by the Authority accordingly.

**42. Protection of innocent infringement:** Notwithstanding anything contained in this Act—(i) a right established under this Act shall not be deemed to be infringed by a farmer who at the time of such infringement was not aware of the existence of such right; and (ii) a relief which a court may grant in any suit for infringement referred to in section 65 shall not be granted by such court nor any cognizance of any offence under this Act shall be taken for such infringement by any court against a farmer who proves, before such court, that at the time of the infringement he was not aware of the existence of the right so infringed.

**43. Authorization of farmer's variety.:** Notwithstanding anything contained in section 28 and sub-section (6) of section 23, where an essentially derived variety is derived from a farmers' variety, the authorization under sub-section (1) of section 28 shall not be given by the breeder of such farmers' variety except with the consent of the farmers or group of farmers or community of farmers who have made contribution in the preservation or development of such variety.

**44. Exemption from fee:** A farmer or group of farmers or village community shall not be liable to pay any fee in any proceeding before the Authority or Registrar or the Tribunal or the High Court under this Act and the rules made there under: *Explanation:* For the purposes of this section, fee for any proceeding includes any fee payable for inspection of any document or for obtaining a copy of any decision or order or document under this Act or the rules made there under.

**45. Gene Fund:** (1) The Central Government shall constitute a Fund to be called the National Gene Fund and there shall be credited thereto—(a) the benefit sharing received in the prescribed manner from the breeder of a variety or an essentially derived variety registered under this Act or propagating material of such variety or essentially derived variety, as the case may be; (b) the annual fee payable to the authority by way of royalty under subsection (1) of section 35; (c) the compensation deposited in the Gene Fund under sub-section (4) of section 41; (d) the contribution from any national and international organisation and other sources; (2.) The Gene Fund shall in the prescribed manner be applied for meeting— (a) any amount to be paid by way of benefit sharing under sub-section (5) of section 26; (b) the compensation payable under sub-section (3) of section 41; (c) the expenditure for supporting the conservation and sustainable use of genetic resources including *in-situ* and *ex-situ* collections and for strengthening the

capability of the Panchayat in carrying out such conservation and sustainable use; (d) the other expenditures of the schemes relating to benefit sharing, framed under section 46.

**46. Framing of schemes etc:** (1) The Central Government shall, for the purposes of section 41 and clause (d) of sub-section (2) of section 45 frame by notification in the Official Gazette, one or more schemes. (2) In particular and without prejudice to the generality of the provisions of sub-section (1), the scheme may provide for all or any of the following matters, namely:—(a) the registration of the claims for the purposes of section 41 under the scheme and all matters connected with such registration; (b) the processing of such claims for securing their enforcement and matters connected therewith; (c) the maintenance of records and registers in respect of such claims; (d) the utilisation, by way of disbursal (including apportionment) or otherwise, of any amounts received in satisfaction of such claims. (e) the procedure for disbursal or apportionment by the Authority in the event of dispute regarding such claims; (f) the utilisation of benefit sharing for the purposes relating to breeding, discovery or development of varieties; (g) the maintenance and audit of accounts with respect to the amounts referred to in clause (d).

## Chapter VII: Compulsory License

**47. Power of Authority to make order for compulsory license in certain circumstances:** (1) At any time, after the expiry of three years from the date of issue of a certificate of registration of a variety, any person interested may make an application to the Authority alleging that the reasonable requirements of the public for seeds or other propagating material of the variety have not been satisfied or that the seed or other propagating material of the variety is not available to the public at a reasonable price and pray for the grant of a compulsory license to undertake production, distribution and sale of the seed or other propagating material of that variety; (2) Every application under sub-section (1) shall contain a statement of the nature of the applicant's interest together with such particulars as may be prescribed and the facts upon which the application is based; (3) The Authority, after consultation with Central Government, and if satisfied after giving an opportunity to the breeder of such variety, to file opposition and after hearing the parties, on the issue that the reasonable requirements of the public with respect to the variety have not been satisfied or that the variety is

not available to the public at a reasonable price, may order such breeder to grant a license to the applicant upon such terms and conditions as it may deem fit and send a copy of such order to the Registrar to register such license under sub-section; (3) or section 29 on payment of such fee by the applicant as is referred to in that sub-section.

**48. When requirement of public deemed to have not been satisfied:** In determining the question as to whether the reasonable requirements of the public for seeds of a variety or its propagating material as referred to in sub-section (1) or sub-section(3) of section 47, the Authority shall take into account—(i) the nature of the variety, the time which has elapsed since the grant of the certificate of registration of the variety, price of the seed of the variety and the measures taken by the breeder or any registered licensee of the variety to meet the requirement of the public; and (ii) the capacity, ability and technical competence of the applicant to produce and market the variety to meet the requirement of the public.

**49 Adjournment of application for grant of compulsory license:** (1) If the breeder of a variety registered under this Act in respect of which any application has been pending before the Authority under section 47 makes a written request to the Authority on the ground that due to any reasonable factor, such breeder has been unable to produce seed or other propagating material of the variety on a commercial scale to an adequate extent till the date of making such request, the Authority may on being satisfied that the said ground is reasonable, adjourn the hearing of such application for such period not exceeding twelve months in aggregate as it may consider sufficient for optimum production of the seed or propagating material of such variety or essentially derived variety, as the case may be, by such breeder; (2) No adjournment of the application under sub-section (1) shall be granted unless the Authority is satisfied that the breeder of the variety registered under this Act in respect of which such application is made has taken immediate measures to meet the reasonable requirements of the public for the seeds or other propagating material of such variety.

**50. Duration of compulsory license:** The Authority shall determine the duration of the compulsory licenses granted under this Chapter and such duration may vary from case to case keeping in view the gestation periods and other relevant factors but in any case shall not exceed to the total remaining period of the protection of that variety and when a compulsory license is granted the prescribed authority shall in the prescribed manner

make available to the licensee of such compulsory licence, the reproductive material of the variety relating to such compulsory licence stored in the National Gene Bank or any other centre.

**51. Authority to settle terms and conditions of licence:** (1) The Authority shall, while determining the terms and conditions of a compulsory licence under the provisions of this Chapter, endeavour to secure—(i) reasonable compensation to the breeder of the variety relating to the compulsory licence having regard to the nature of the variety, the expenditure incurred by such breeder in breeding the variety or for developing it and other relevant factors; (ii) that the compulsory licensee of such variety possesses the adequate means to provide to the farmers, the seeds or its other propagating material of such variety timely and at reasonable market price; (2) No compulsory licence granted by the Authority shall authorize the licensee to import the variety relating to such licence or any seed or other propagating material of such variety from abroad where such import would constitute an infringement of the rights of the breeder of such variety.

**52. Revocation of compulsory licence:** (1) The Authority may on its own motion or on application from an aggrieved person made to it in the prescribed form, if it is satisfied that a compulsory licensee registered under this Chapter has violated any terms or conditions of his licence or it is not appropriate to continue further such licence in public interest, it may after giving such licensee an opportunity to file opposition and of being heard make order to revoke such licence; (2) When a licence is revoked under subsection (1) by an order of the Authority, the Authority shall send a copy of such order to the Registrar to rectify the entry or correct the register relating to such revocation and the Registrar shall rectify the entry or correct the register accordingly.

**53. Modification of compulsory licence:** The Authority may on its own motion or on application from the licensee of a compulsory licence, after providing the opportunity of being heard to the breeder of the variety registered under this Act relating to such compulsory licence, if it considers, in public interest, so to do, modify, by order, such terms and conditions as it thinks fit and send a copy of such order to the Registrar to correct the entries and register according to such modification and the Registrar shall ensure such corrections to be made accordingly.

## Chapter VIII: Tribunal

**54. Tribunal:** The Central Government may, by notification in the Official Gazette, establish a Tribunal to be known as the Plant Varieties Protection Appellate Tribunal to exercise the jurisdiction, powers and authority conferred on it by or under this Act.

**55. Composition of Tribunal:** (1) The Tribunal shall consist of a Chairman and such number of Judicial Members and Technical Members as the Central Government may deem fit to appoint; (2) A Judicial Member shall be a person who has for at least ten years held a judicial office in the territory of India or who has been a member of the Indian Legal Service and has held a post in Grade-II of that service or any equivalent or higher post for at least three years or who has been an advocate for at least twelve years; Explanation:—For the purposes of this sub-section (1),—(i) in computing the period during which a person has held judicial office in the territory of India, there shall be included any period, after he has held any judicial office, during which the person has been an advocate or has held the office of a member of a tribunal or any post, under the Union or a State, requiring special knowledge of law; (ii) in computing the period during which a person has been an advocate, there shall be included any period during which the person has held judicial office or the office of a member of a tribunal or any post, under the Union or a State, requiring special knowledge of law after he became an advocate; (3) A Technical Member shall be a person who is an eminent agricultural scientist in the field of plant breeding and genetics and possesses an experience of at least twenty years to deal with plant variety or seed development activity, or who has held the post in the Central Government or State Government dealing with plant variety or seed development equivalent to the Joint Secretary to the Government of India for at least three years and possesses the special knowledge in the field of plant breeding and genetics; (4) The Central Government shall appoint a Judicial Member of the Tribunal to be the Chairman thereof; (5) The Central Government may appoint one of the members of the Tribunal to be the Senior Member thereof; (6) The Senior member or a Member shall exercise such of the powers and perform such of the functions of the Chairman as may be delegated to him by the Chairman by a general or special order in writing.

**56. Appeals to the Tribunal:** (1) An appeal shall be preferred to the Tribunal within the prescribed period from any—(a) order or decision of the

Authority or Registrar, relating to registration of a variety; or (b) registration as an agent or a licensee of a variety; or (c) determining the benefit sharing by the Authority; (d) order or decision of the Authority regarding revocation of compulsory licence or modification of compulsory licence; or (e) order or decision of Authority regarding payment of compensation, made under this Act or rules made there under; (2) Every such appeal shall be preferred by petition in writing and shall be in such form and shall contain such particulars as may be prescribed; (3) The Tribunal in disposing of an appeal under this section shall have the power to make any order which the Authority or the Registrar could make under this Act.

**57: Orders of the Tribunal:** (1) The Tribunal may, after giving both the parties to the appeal an opportunity of being heard, pass such orders thereon as it thinks fit; (2) The Tribunal may, at any time within thirty days from the date of the order, with a view to rectifying the mistake apparent from the record, amend any order passed by it under sub-section (1), and shall make such amendment if the mistake is brought to its notice by the appellant or the opposite party; (3) In every appeal, the Tribunal, where it is possible, hear and decide such appeal within a period of one year from the date of filing the appeal; (4) The Tribunal shall send a copy of any orders passed under this section to the Registrar; (5) The orders of the Tribunal under this Act shall be executable as a decree of a civil court.

**58. Procedure of Tribunal:** (1) The powers and functions of the Tribunal may be exercised and discharged by Benches constituted by the Chairman of the Tribunal from among the Members thereof; (2) A bench shall consist of one Judicial Member and one Technical Member; (3) If the members of a Bench differ in opinion on any point, the point shall be decided according to the opinion of the majority, if there is a majority, but if the members are equally divided, they shall state the point or points on which they differ, and the case shall be referred to the Chairman for hearing on such point or points by one or more of the other Members and such point or points shall be decided according to the opinion of the majority of the Members who have heard the case, including those who first heard it; (4) Subject to the provision of this Act, the Tribunal shall have power to regulate its own procedure and the procedure of Benches thereof in all matters arising out of the exercise of its powers or the discharge of its functions, including the places at which the Benches shall holding their sitting; (5) The Tribunal shall, for the purpose of discharging its functions, have all the powers which are vested in the Registrar under section 11, and any proceeding before the Tribunal shall



deemed to be judicial proceeding within the measuring of sections 193 and 228 and for the purposes of section 196 of the Indian Penal Code, and the Tribunal shall be deemed to be a civil court for all the purposes of section 195 and Chapter XXXV of the code of Criminal Procedure, 1973; (6) Notwithstanding anything contained in any other provisions of this Act or in any other law for the time being in force, no interim order (whether by way of injunction or stay or any other manner) shall be made on, or in any proceedings relating to an appeal unless—(a) copies of such appeal and of all documents in support of the plea for such interim order are furnished to the party against whom such appeal is made or proposed to be made; and (b) opportunity is given to such party to be heard in the matter.

**59. Transitional provision:** Notwithstanding anything contained in this Act, till the establishment of the Tribunal under section 54, the Intellectual Property Appellate Board established under section 83 of the Trade Marks Act, 1999 shall exercise the jurisdiction, powers and authority conferred on the Tribunal under this Act subject to the modification that in any Bench of such Intellectual Property Appellate Board constituted for the purpose of this section, for the Technical Member referred to in subsection (2) of section 84 of the Trade Marks Act, 1999, the Technical Member shall be appointed under this Act and he shall be deemed to be the Technical Member for constituting the Bench under the said sub-section (2) of section 84 for the purposes of this Act.

## Chapter IX: Finance, accounts and audit

**60. Grants by Central Government:** The Central government may, after due appropriation made by Parliament by law in this behalf, make to the Authority grants and loans of such sums of money as the Central Government may think fit for being utilized for the purposes of this Act.

**61. Authority Fund:** (1) There shall be constituted a fund to be called the Protection of Plant Varieties Authority Account and there shall be credited thereto—(a) all grants and loans made to the Authority by the Central Government under section 60; (b) all fees received by the Authority and the Registrars except the annual fee determined on the basis of benefit or royalty under subsection (1) of section 35; (c) all sums received by the Authority from such other sources as may be decided upon by the Central Government; (2) The Protection of Plant Varieties Authority Account shall be applied for meeting—(a) the salaries, allowances and other remuneration

of the Chairperson, officers and other employees of the Authority and allowances, if any, payable to the members; (b) the other expenses of the Authority in connection with the discharge of its functions and for purposes of this Act.

**62. Budget, accounts and audit.24:** (1) the Authority shall prepare a budget, maintain proper accounts and other relevant records (including the accounts and other relevant records of the Gene Fund) and prepare an annual statement of account in such form as may be prescribed by the Central Government in consultation with the Comptroller and Auditor-General of India; (2) The accounts of the Authority shall be audited by the Comptroller and Auditor-General of India at such intervals as may be specified by him and any expenditure incurred in connection with such audit shall be payable by the Authority to the Comptroller and Auditor-General of India; (3) The Comptroller and Auditor General of India and any other person appointed by him in connection with the audit of the accounts of the Authority shall have the same right and privileges and authority in connection with such audit as the Comptroller and Auditor General generally has in connection with the audit of the government accounts and, in particular, shall have the right to demand the production of books, accounts, connected vouchers and other documents and papers and to inspect any of the offices of the Authority; (4) The accounts of the Authority as certified by the Comptroller and Auditor General of India or any other person appointed by him in his behalf together with the audit report thereon shall be forwarded annually to the Central Government and that Government shall cause the same to be laid before each House of Parliament.

**63. Financial and administrative powers of the Chairperson:** The Chairperson shall exercise such financial and administrative powers over the functions of the Authority as may be prescribed: Provided that the Chairperson shall have the authority to delegate such of his financial and administrative powers as he may think fit to a member or any other officer of the Authority subject to the condition that the member or such officer shall, while exercising such delegated powers, continue to be under the direction, control and supervision of the Chairperson.

## Chapter x

**64. Infringement:** Subject to the provisions of this Act, a right established under this Act is infringed by a person—(a) who, not being the breeder of a

variety registered under this Act or a registered agent or registered licensee of that variety, sells, exports, imports or produces such variety without the permission of its breeder or within the scope of a registered licence or registered agency without permission of the registered licensee or registered agent, as the case may be; (b) who uses, sells, exports, imports or produces any other variety giving such variety, the denomination identical with or deceptively similar to the denomination of a variety registered under this Act in such manner as to cause confusion in the mind of general people in identifying such variety so registered.

**65. Suit for infringement etc.:** (1) No suit—(a) for the infringement of a variety registered under this act; or (b) relating to any right in a variety registered under this Act, shall be instituted in any court inferior to a District Court having jurisdiction to try the suit; (2) For the purpose of clauses (a) and (b) of sub-section (1), “District court having jurisdiction” shall mean the District Court within the local limit of whose jurisdiction the cause of action arises.

**66. Relief in suits for infringement..25:** (1) The relief which a court may grant in any suit for infringement referred to in section 65 includes an injunction and at the option of the plaintiff, either damages or a share of the profits; (2) The order of injunction under sub-section (1) may include an ex-parte injunction or any interlocutory order for any of the following matters, namely:—(a) for discovery of documents; (b) preserving of infringing variety or documents or other evidence which are related to the subject matter of the suit; (c) attachment of such property of the defendant which the court deems necessary to recover damages, costs or other pecuniary remedies which may be finally awarded to the plaintiff.

**67. Opinion of scientific adviser:** (1) When the court has to form an opinion upon any question of fact or a scientific issue, such court may appoint an independent scientific adviser to suggest it or to enquire and report upon the matter to enable it to form the desired opinion; (2) The scientific adviser may be paid such remuneration of expenses as the court may fix.

## B. Offences, penalties and procedure

**68. Prohibition to apply the denomination of a registered variety:** (1) No person other than the breeder of a variety registered under this Act or a

registered licensee or registered agent thereof shall use the denomination of that variety in the manner as may be prescribed; (2) A person shall be deemed to apply the denomination of a variety registered under this Act who— (a) applies it to the variety itself; or (b) applies it to any package in or with which the variety is sold, or exposed for sale, or had in possession such package for sale or for any purpose of trade or production; or (c) places, encloses or annexes the variety which are sold, or exposed for sale, or had in possession for sale or for any purpose of trade or production, in or with any package or other thing to which the denomination of such variety registered under this Act has been applied; or (d) uses the denomination of such variety registered under this Act in any manner reasonably likely to lead to the belief that the variety or its propagating material in connection with which it is used is designated or described by that denomination; or (e) in relation to the variety uses such denomination in any advertisement, invoice, catalogue, business letter, business paper, price list or other commercial document and such variety is delivered to a person in pursuance of a request or order made by reference to the denomination as so used; (3) A denomination shall be deemed to be applied to a variety whether it is woven in; impressed on, or otherwise worked into, or annexed or affixed to, such variety or to any package or other thing;

**69. Meaning of falsely applying the denomination of a registered variety:** (1) A person shall be deemed to falsely apply the denomination of a variety registered under this Act who, without the assent of the breeder of such variety—(a) applies such denomination or a deceptively similar denomination to any variety or any package containing such variety. (b) uses any package bearing a denomination which is identical with or deceptively similar to the denomination of such variety registered under this Act, for the purpose of packing, filling or wrapping therein any variety other than such variety registered under this Act; (2) any denomination of a variety registered under this Act falsely applied as mentioned in sub-section (1), is in this Act referred to as false denomination; (3) In any prosecution for falsely applying a denomination of a variety registered under this Act, the burden of proving the assent of the breeder of such variety shall lie on the accused.

**70. Penalty for applying false denomination etc.** - (1) Any person who— (a) applies any false denomination to a variety; or (b) indicates the false name of a country or place or false name and address of the breeder of a variety registered under this Act in course of trading such variety; Shall unless he proves that he acted, without intent to defraud, be punishable— (i) With

imprisonment for a term which shall not be less than three months but which may extend to two years; or (ii) fine which shall not be less than fifty thousand rupees but which may extend to five lakh rupees; or (iii) both.

**71. Penalty for selling varieties to which not authorized or to which false denomination is applied, etc. :** Any person who sells, or exposes for sale, or has in his possession for sale or for any purpose of trade or production any variety to which any false denomination is applied or to which an indication of the country or place in which such variety was made or produced or the name and address of the breeder of such variety registered under this Act has been falsely made, shall unless he proves—(a) that having taken all reasonable precautions against committing an offence against this section, he had at the time of commission of the alleged offence no reason to suspect the genuineness of the denomination of such variety or that any offence had been committed in respect of indication of the country or place in which such variety registered under this Act, was made or produced or the name and address of the breeder of such variety; (b) that, on demand by or on behalf of the prosecutor, he gave all the information in his power with respect to the person from whom he obtained such variety; or that otherwise he had acted innocently, be punishable— (i) with imprisonment for a term which shall not be less than six months but which may extend to two years; or (ii) with fine which shall not be less than fifty thousand rupees but which may extend to five lakh rupees; or (iii) both;

**72. Penalty for falsely representing a variety as registered:** Whoever makes any representation with respect to the denomination of a variety or its propagating material or essentially derived variety or its propagating material not being variety or its propagating material or essentially derived variety or its propagating material registered under this Act to the effect that it is a variety or its propagating material or essentially derived variety or its propagating material registered under this Act or otherwise represents any variety, or its propagating material or essentially derived variety or its propagating material not registered under this Act to the effect that it is registered under this Act shall be punishable— (i) with imprisonment for a term, which shall not be less than six months and may extend to three years; or (ii) with fine which shall not be less than one lakh rupees but which may extend to five lakh rupees; or (iii) both;

**73. Penalty for subsequent offence:** Whoever, having already been convicted of an offence under this Act is again convicted of such offence shall

be punishable for the second and for every subsequent offence— (i) with imprisonment for a term which shall not be less than one year but which may extend to three years; or (ii) with fine which shall not be less than two lakh rupees but which may extend to twenty lakh rupees; or (iii) both.

**74. No offence in certain cases:** The provisions of this Act relating to offences shall be subject to the right created as recognized by this Act and no act or omission shall be deemed to be an offence under the provisions of this Act if such act or omission is permissible under this Act.

**75. Exemption of certain persons employed in ordinary course of business:** Where a person accused of an offence under this Act proves that in the ordinary course of his employment, he has acted without any intention to commit the offence and having taken all reasonable precautions against committing the offence charged, he had, at the time of the commission of the alleged offence, no reason to suspect the genuineness of the act so charged as an offence and on demand made by or on behalf of the prosecutor, he gave all the information in his power with respect to the persons on whose behalf the offence was committed, he shall be acquitted.

**76. Procedure where invalidity of registration is pleaded by the accused:**

(1) Where the offence charged under this Act is in relation to a variety or its propagating material or essentially derived variety or its propagating material registered under this Act and the accused pleads that the registration of such variety or its propagating material or essentially derived variety or its propagating material, as the case may be, is invalid and the court is satisfied that such offence is *prima facie* not tenable, it shall not proceed with the charge but shall adjourn the proceedings for three months from the date on which the plea of the accused is recorded to enable the accused to file an application before the Registrar under this Act for the rectification of the register on the ground that the registration is invalid; (2) If the accused proves to the court that he has made such application within the time so limited or within such further time as the court for sufficient cause allow, the further proceedings in the prosecution shall stand stayed till the disposal of such application for rectification; (3) If within a period of three months or within such extended time as may be allowed by the court, the accused fails to apply to the Registrar for rectification of the register, the court shall proceed with the case as if the registration were invalid; (4) Where before institution of a complaint of an offence referred to in subsection (1), any application for the rectification of the register concerning the registration of

the variety or its propagating material or essentially derived variety or its propagating material, as the case may be, in question on the ground of invalidity of such registration has already been properly made to and is pending before the Registrar, the court shall stay the further proceedings in the prosecution pending the disposal of the application aforesaid and shall determine the charge against the accused in conformity with the result of the application for rectification.

**77. Offences by companies:** (1) If the person committing an offence under this Act is a company, the company as well as every person in charge of, and responsible to, the company for the conduct of its business at the time of the commission of the offence shall be deemed to be guilty of the offence and shall be liable to be proceeded against and punished accordingly; Provided that nothing contained in sub-section shall render any such person liable to any punishment, if he proves that the offence was committed without his knowledge or that he exercised all due diligence to prevent the commission of such offence; (2) Notwithstanding anything contained in subsection (1), where an offence under this Act has been committed by a company and it is proved that the offence has been committed with the consent or connivance of, or that the commission of the offence is attributable to any neglect on the part of, any director, manager, secretary or other officer of the company, such director, manager, secretary or other officer shall also be deemed to be guilty of that offence and shall be liable to be proceeded against and punished accordingly; Explanation — For the purpose of this section—(a) “company” means any body corporate and includes a firm or other association of individuals; and (b) “director”, in relation to a firm, means a partner in the firm.

## Chapter XI: Miscellaneous

**78. Protection of security of India:** Notwithstanding anything contained in this Act, the Authority or the Registrar shall—(a) not disclose any information relating to the registration of a variety or any application relating to the registration of a variety under this Act, which is considered prejudicial to the interest of the security of India; and (b) take any action regarding the cancellation of registration of such varieties registered under this Act which the Central Government may by notification in the Official Gazette specify in the interest of the security of India. Explanation:— For the purpose of this section, the expression “security of India” means any action necessary for the security of India which relates to the use of any produce of any variety

registered under this Act directly or indirectly for the purposes of war or military establishment or for the purposes of war or other emergency in international relations.

**79. Implied warranty on sale of registered variety, etc.:** Where a denomination of a variety or its propagating material or essentially derived variety or its propagating material registered under this Act has been applied to the variety or its propagating material or essentially derived variety or its propagating material, as the case may be, on sale or in the contract for sale of such variety or its propagating material or essentially derived variety or its propagating material, as the case may be, seller shall be deemed to warrant that the denomination is a genuine denomination and not falsely applied, unless the contrary is expressed in writing signed by or on behalf of the seller and delivered at the time of the sale of the variety or its propagating material or essentially derived variety or its propagating material, as the case may be, on contract to and accepted by the buyer.

**80. Death of party to a proceeding:** If a person who is a party to a proceeding under this Act (not being proceeding in a court) dies pending the proceeding, the Authority or the Registrar, as the case may be, may, on request, and on proof to the satisfaction of such Authority or Registrar, of the transmission of the interest of the deceased person, substitute in the proceedings his successor in interest in his place, or, if the Authority or the Registrar is of opinion that the interest of the deceased person is sufficiently represented by the surviving party, permit the proceedings to continue without the substitution of his successor in interest.

**81. Right of registered agent and registered licensee to institute suit:** The registered agent or the registered licensee of a variety or its propagating material or essentially derived variety or its propagating material registered under this Act may institute appropriate proceedings in the court under this Act on behalf of the breeder of such variety or its propagating material or essentially derived variety or its propagating material, as the case may be, if such agent or licensee has been authorized in the prescribed manner by such breeder for doing so.

**82. Evidence of entry in register, etc., and things done by authority and the registrar.29:** (1) A copy of any entry in the register, or of any document issued under this Act purporting to be certified by the Authority or the Registrar and sealed with the seal of such Registrar or the Authority, as the case may be, shall be admitted in evidence in all courts and in all proceedings



without further proof or production of the original; (2) A certificate purporting to be under the hand of the Authority or the Registrar, as the case may be, as to any entry, matter or things that such Authority or the Registrar is authorized by this Act or the rules to make or do shall be *prima facie* evidence of the entry having been made, and of the content thereof, or of the matter or things having been done or not done.

**83. Authority and registrar and other officers not compellable to production of register, etc.:** The Authority or the Registrar or any officer working under the Authority or the Registrar, as the case may be, shall not, in any legal proceedings be compelled to produce the register or any other document in its or his custody, the content of which can be proved by the production of a certified copy issued under this Act in the prescribed manner or to appear as a witness to prove the matter therein recorded unless by order of the court, as the case may be, made for special case.

**84. Document open to public inspection:** Any person may, on an application to the Authority or the Registrar, as the case may be, and on payment of such fee as may be prescribed, obtain a certified copy of any entry in the register or any other document in any proceedings under this Act pending before such Authority or Registrar or may inspect such entry or document.

**85. Report of the Authority and the Registrar to be placed before Parliament:** The Central Government shall cause to be placed before both Houses of Parliament once a year a report regarding the performance of the Authority under this Act.

**86. Government to be bound:** The provisions of this Act shall be binding on the Government.

**87. Proceedings before authority:** All proceedings before the Authority or the Registrar, as the case may be, relating to registration of variety or essentially derived variety, registration of agent, registration of licence or registration of compulsory licensing under this Act shall be deemed to be judicial proceedings within the meaning of section 193 and 228 and for the purpose of section 196 of the Indian Penal Code and the Authority or the Registrar, as the case may be, shall be deemed to be a civil court for the purpose of section 195 and Chapter XXVI of the Code of Criminal Procedure, 1973.

**88. Protection of action taken in good faith:** No suit, prosecution or other legal proceedings shall lie against the Central Government, or against the

Chairperson, or members, or the Registrar or any person acting under such Government, Authority, or Registrar under the provisions of this Act, for anything which is done in good faith or intended to be done in pursuance of this Act or any rule, regulation, scheme or order made thereunder.

**89. Bar of jurisdiction:** No civil court shall have jurisdiction in respect of any matter which the Authority or the Registrar or the Tribunal is empowered by or under this Act to determine.

**90. Member and staff of Authority etc. to be public servants:** The Chairperson, members and the officers and other employees of such Authority and the Registrar-General and the officers and other employees working under him shall be deemed to be public servants within the meaning of section 21 of the Indian Penal Code.

**91. Exemption from tax on wealth and income:** Notwithstanding anything contained in the Wealth-tax Act, 1957, the Income-tax Act, 1961, or any other enactment for the time being in force relating to tax on wealth, income, profits or gains, the Authority shall not be liable to pay wealth tax, income tax or any other tax in respect of their wealth, income, profits or gains derived.

**92. Act to have overriding effect:** The provisions of this Act shall have effect notwithstanding anything inconsistent therewith contained in any other law for the time being in force or in any instrument having effect by virtue of any law other than this Act.

**93. Power to remove difficulties:** (1) If any difficulty arises in giving effect to the provisions of this Act, the Central Government may, by order, published in the Official Gazette, make such provisions not inconsistent with the provisions of this Act as may appear to be necessary for removing the difficulty;

Provided that no order shall be made under this section after the expiry of two years from the date of commencement of this Act. (2) Every order made under sub-section (1) shall be laid before each House of Parliament.

**94. Power to make regulations:** (1) The Authority may, with the previous approval of the Central Government, by notification in the Official Gazette make regulations consistent with this Act and the rules made thereunder to carry out the provisions of this Act; (2) In particular, and without prejudice to the generality of the foregoing power, such regulations may provide for all or any of the following of this Act.

(a) duties and jurisdiction of Registrars under sub-section (4) of section 12; (b) the terms of office and the conditions of service of the Registrars under sub-section (5) of section 12; (c) the criteria of distinctiveness, uniformity and stability for registration of extant variety under sub-section (2) of section 15; (d) the manner in which a single and distinct denomination to a variety shall be assigned by the applicant under sub-section (1) of section 16; (e) matters governing the assignment of denomination of variety under sub-section (2) of section 17; (f) the time within which the Registrar may require the applicant to propose another denomination under sub-section (3) of section 17; (g) the form of application under clause (d) of sub-section (1) of section 18; (h) the standards for evaluating seeds during tests under sub-section (1) of section 19; (i) to specify the quantity of seeds or other propagating material including parental line seeds to be deposited by a breeder under section 27; (j) the limitations and conditions subject to which a breeder may authorise a person to sell, market or otherwise deal with variety under sub-section (2) of section 28; (k) the form for authorisation under sub-section (3) of section 28.

**95. Power of the Central Government to make rules:** (1) The Central Government may, by notification in the Official Gazette, make rules to carry out the provisions of this Act; (2) In particulars, and without prejudice to the generality of the foregoing powers, such rules may provide for all or any of the following matters, namely—(i) the terms of office of the Chairperson and the manner of filling the post under sub-section (6) of section 3; (ii) the salary and allowances of the Chairperson and his conditions of service in respect of leave, pension, provident fund and other matters under sub-section (7) of section 3; (iii) the time and place of meetings of the Authority and the rules of procedure in regard to the transaction of business at its meetings (including the quorum at its meetings) and the transaction of business of its Standing Committee appointed under sub-section (7) of section 3 under sub-section (1) of section 4; (iv) the control and restriction regarding appointment of the officers and employees of the Authority and the method of such appointment, scale of pay and allowances and other conditions of service under section 6; (v) the powers and duties of the chairperson under section 7; (vi) the terms and conditions subject to which and the manner in which the measures referred to in sub-section (1) of section 8 may provide for the registration of extant or new varieties under clause (a) of subsection (2) of that section; (vii) the manner for arranging production and sale of the seeds under clause (d) of sub-section (2) of

section 8; (viii) the salary and allowances of Registrar-General of Plant Varieties and the conditions of service in respect of his leave, pension, provident fund and other matter under sub-section (3) of section 12; (ix) the matters to be included in the National Register of Plant Varieties under sub-section (1) of section 13; (x) the manner of authorising a person under clause (e) of sub-section (1) of section 16; (xi) the fee under clause (g) and the other particular under clause (i) which shall accompany the application under sub-section (1) of section 18; (xii) the period within which after making application a proof of the right to make the application is to be furnished under sub-section (3) of section 18; (xiii) the form of application under provision to section (1) of section 18; (xiv) the fee to be deposited by applicant under sub-section (2) of section 19; (xv) the manner and method of conducting the tests referred to in sub-section (1), under sub-section (3) of section 19; (xvi) the manner of advertising specifications of variety for registration including its photograph or drawing under sub-section (1) of section 21; (xvii) the manner of making application and the fee payable for allowing further period to give notice and the manner of giving notice under sub-section (2) of section 21; (xviii) the manner of sending counter statement under sub-section (4) of section 21; (xix) the manner of submitting evidence and the time within which such evidence may be submitted under sub-section (6) of section 21; (xx) the documents and the fee which shall accompany the application under sub-section (2) of section 22; (xxi) the tests to be conducted and the procedure to be followed under sub-section (4) of section 23; (xxii) the form of a certificate of registration and the other authority to which a copy thereto shall be sent under sub-section (9) of section 24; (xxiii) the form of a certificate of registration and the other authority to which a copy thereto and the maximum time for issuing the certificate of registration shall be sent under sub-section (2) of section 24; (xxiv) the manner of giving notice to the applicant under sub-section (3) of section 24; (xxv) the contents of the certificate and the manner of publishing such contents and inviting claim of benefits sharing under sub-section (1) of section 26; (xxvi) the form for submitting claims of benefit sharing and the fee to be accompanied therewith under sub-section (2) of section 26; (xxvii) the manner in which and the time within which opposition to claims shall be submitted under sub-section (3) of section 26; (xxviii) the fee payable for renewal or further renewal of period of validity of certificate of registration under sub-section (6) of section 26; (xxix) the manner of making reference under sub-section (7) of section 26; (xxx) the manner of making an application for registration for title and the fee to be

accompanied therewith under sub-section (4) of section 28; (xxxii) the manner of referring the disputes regarding registration of entitlement under sub-section (4) of section 28; (xxxiii) the manner to enter into a certificate the brief conditions of entitlement under sub-section (5) of section 28; (xxxiv) the manner of making an application for varying the terms of registration under clause (a), of sub-section (9) of section 28; (xxxv) the manner of making an application by the registered breeder and certain others for cancellation of terms of registration under clause (b) of sub-section (9) of section 28; (xxxvi) the manner of application by any person other than the breeder, his succession, the registered agent or the registered licensee for cancellation of terms of registration under clause (c) of sub-section (9) of section 28; (xxxvii) the manner of application for cancellation of the terms of registration under clause (d) of sub-section (9) of section 28; (xxxviii) the manner of application for cancellation of the terms of registration under clause (e) of sub-section (9) of section 28; (xxxix) the manner to issuing notice to Registered breeder, and certain others under sub-section (10) of section 28; (xl) the manner of giving notice to the Registrar under sub-section (1) of section 33; (xli) the manner of notifying to the registered agent or registered licensee under sub-section (2) of section 33; (xlii) the period within which the notice of opposition under sub-section (3) of section 33 may be given; (xliii) the manner of making application under section 34; (xliv) the manner of depositing fee payable under sub-section (2) of section 35; (xlv) the manner of making application under sub-section (1) of section 36; (xlvi) the manner of applying to the Registrar under sub-section (2) of section 36; (xlvii) the manner of giving notice under sub-section (4) of section 36; (xlviii) the manner of application under sub-section (1) of section 37; (xlix) the manner of making application under sub-section (2) of section 37; (l) the manner to apply to the Registrar under sub-section (1) of section 38; (li) the manner of advertising application and to give notice to the Registrar, and the time from the date of the advertisement within which a person may give such notice under sub-section (2) of section 38; (lii) the manner of advertising the denomination of the variety under sub-section (3) of section 38; (liii) the manner of claiming compensation and filing of opposition under sub-section (2) of section 39; (liiii) the manner of recognition and reward from the National Gene Fund under clause (2) of section 42; (liv) the particulars to be contained in the application under sub-section (2) of section 47; (lv) the authority and the manner in which such authority shall make available to the compulsory licensee the reproduction material of the variety under section 50; (lvi) the form for making application under sub-section (1)

of section 52; (lvii) the period within which an appeal shall be preferred under section 56; (lviii) the form of petition and the particulars which such petition shall contain under sub-section (3) of section 56; (lix) the manner of issuing notice and filing objection under sub-section (3) of section 41; (lx) the manner of receiving benefit sharing under clause (9) of subsection (I) of section 45; (lxi) the manner for applying Gene Fund under sub-section (2) of section 45; (lxii) the period within which an appeal shall be made under sub-section (1) of section 60; (lxiii) the form of petition and the particulars which such petition shall contain under sub-section (2) of section 60; (lxiv) the form for preparing annual statement of accounts under sub-section (1) of section 62; (lxv) the financial and administrative powers which the Chairperson shall exercise under section 63; (lxvi) the manner of using the denomination of a variety under sub-section (1) of section 68; (lxvii) the manner of authorising registered agent or registered licensee under section 81; (lxviii) the manner of issuing certified copy of Register, or any other document under section 83; (lxix) the fee payable for obtaining a certified copy of any entry in the Register, or any other document under section 84; (lxx) any other matter which is to be , or may be, prescribed or in respect of which this Act makes no provision or makes insufficient provision and provision, is, in the opinion of the Central Government, necessary for the proper implementation of this Act.

**96: Rules, regulations and schemes to be laid before Parliament:** Every rule and every regulation and every scheme made under this Act shall be laid, as soon as may be after it is made, before each House of Parliament, while it is in session, for a total period of thirty days which may be comprised in one session or in two or more successive session, and if, before the expiry of the session immediately following the session or the successive sessions aforesaid, both Houses agree in making any modification in the rule or regulation or scheme or both Houses agree that the rule or regulation or scheme should not be made, the rule or regulation or scheme shall thereafter have effect only in such modified form or be of no effect, as the case may be; so, however, that any such modification or annulment shall be without prejudice to the validity of anything previously done under that rule or regulation or scheme.

## Literature cited

**Almekinders CJM, Louwaars NP and de Bruijn GH. 1994.** Local seed systems and their importance for an improved seed supply in developing countries. *Euphytica*. 78:207-216.

**Ball SS and Douglas JE. 1992.** Designing successful farmer-managed seed systems. Winrock International Institute for Agricultural Development. Development Studies Paper Series. Winrock, Arlington, USA.

**Bandyopadhyay, R., D.R. Butler, A. Chandrashekar, R.K. Reddy, and S. S. Navi. 2000.** Biology, epidemiology, and management of sorghum grain mold. Pages 34-71 *in* Technical and Institutional Options for Sorghum Grain Mold Management: proceedings of an international consultation, 18–19 May 2000, ICRISAT, Patancheru, India (Chandrashekar, A., Bandyopadhyay, R., and Hall, A.J., eds) Patancheru 502 324, Andhra Pradesh, India. International Crops Research Institute for the Semi-Arid Tropics.

**Bandyopadhyay, R., L. K. Mughogho, and K. E. P. Rao. 1988.** Sources of resistance to sorghum grain molds. *Plant Disease*. 72:504–508.

**Barnett, H. L., and B. B. Hunter. 1972.** Illustrated genera of imperfect fungi. Minneapolis, Minnesota, USA: Burgess Publishing Co. 241 pp.

**Barron, G. L. 1968.** The genera of hyphomycetes from soil. New York, USA: Robert E Krieger Publishing Co. 364 pp.

**Bhat R. V., H. P. K. Shetty, and S. Vasanthi. 2000.** Human and animal health significance of mycotoxins in sorghum with special reference to Fumonisin. Pages 107-115 *in* Technical and Institutional options for sorghum grain mold management: Proceedings of an international consultation, 18–19 May 2000, ICRISAT, Patancheru, India (Chandrashekar, A., Bandyopadhyay, R., and Hall, A.J., eds.). Patancheru, 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics.

**Camargo, C.P., Braganton C. & Monares A. (1989).** Seed production systems for small farmers: a non-conventional perspective CIAT, Cali, Columbia

**Champ, B. R., E. Highley, A. D. Hocking, and J. I. Pitt. (eds.). 1991.** Fungi and mycotoxins in stored products: Proceedings of an international conference, Ban kok, Thailand 23-26 April 1991. ACIAR proceedings No. 36 Australia: The Griffin press ltd. 270 pp.

**Christensen, C. M., and R. A. Meronuck. 1986.** Quality maintenance in stored grains and seeds, University of Minnesota Press, Minneapolis, 138 pp.

**Cormwell E, Friis-Hansen E and Turner M. 1992.** The seed sector in developing countries: A framework for performance analysis. ODI, London.

**Cromwell, E.** (ed.). 1990. Seed diffusion mechanisms in small farmer communities: Lessons from Asia, Africa and Latin America. ODI, London

**Dixit S, Wani SP, Ravinder Reddy Ch, Roy S, Reddy BVS, Sridevi TK, Chourasia AK, Pathak P, Rama Rao M and Ramakrishna A.** 2005. Participatory varietal selection and village seed banks for self-reliance: Lessons learnt. Global Theme on Agroecosystems, Report No 17. Patancheru, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics. 20 pp.

**Ellis, M. B.** 1971. Dematiaceous hyphomycetes. Kew, Surrey, England: Commonwealth Mycological Institute. 608 pp.

**Ellis, M. B.** 1976. More dematiaceous hyphomycetes. Kew, Surrey, England: Commonwealth Mycological Institute. 507 pp.

**FAO.** 1995. Sorghum and millets in human nutrition. FAO Food and Nutrition Series, No. 27. Food and Agriculture Organization of the United Nations, Rome, 1995

**Feistritzer, W.P. and A.F. Kelly.** 1978. Improved Seed Production: A Manual on the Formulation, Implementation and Evaluation of Seed Programs and Projects. FAO, Rome.

**Fodder Innovation Project.** 2006. Groundnut-Livelihoods. An Impact pathways analysis of groundnut innovation system. Working document of the project. "Enhancing Livelihoods of poor livestock keepers through increasing use of fodder (DFID-DF1039)". International Livestock Research Institute (ILRI). Hyderabad, India.

**Geervani, P., and V. Vimala.** 1993. Rural food enterprises: Operational research on development of sorghum food enterprises for alternate uses and supplementary feeding. Hyderabad 500 004, Andhra Pradesh, India: College of Home Science, Acharya N.G. Ranga Agricultural University. 126 pp.

**González, H. H. L., E. J. Martínez, and S. L. Resnik.** 1997. Fungi associated with sorghum grain from Argentina. Mycopathologia. 139: 35–41.

**Grossman, T. A. Linnemann, H. Wierema.** 1991. Seed industry development in North-South perspective. Wageningen: Pudoc.

**Gwinner, J., R. Harnisch, and O. Mück.** 1996. Manual of the prevention of post-harvest grain losses. Eschborn, 1996 Published in 1996 by: Post-Harvest Project, Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH, Postfach 5180, D - 65726 Eschborn, pages 338. FRG© 1996 GTZ

**Hanlin, R. T.** 1990. Illustrated genera of Ascomycetes. St. Paul, Minnesota, USA: American Phytopathological Society. 263 pp.

**Hawksworth, D. L., P. M. Kirk, E. C. Sutton, and D. N. Pegler.** 1995. Ainsworth & Bisby's dictionary of the fungi. 8<sup>th</sup> edition. Surrey, UK: International Mycological Institute.



**Hodges, R. J., A. J. Hall, K. Jayaraj, P. Jaiswal, N. Potdar, B. Yoganand and S. S. Navi.** 1999. Quality changes in farm-stored sorghum grain grown in wet or dry season in South India – A technical and social study, NRI Report 2412, Natural Resources Institute, Central Avenue, Chatham Maritime, Kent ME4 4TB, U.K. and DFID April 1999. Pp33.

**Jaffe, S. and J. Srivastava.** 1992. Seed system development: The appropriate role of the private and public sectors. World Bank Discussion Paper 167. World Bank, Washington D.C. USA

**Jaffee S and Srivastava J.** 1994. The role of the private and public sectors in enhancing the performance of seed systems. The World Bank Research Observations. 9:97-117.

**Kelly A.E and R.A.T George** 1998. Encyclopedia of seed production of world crops. Chicester: John Wiley and sons

**Lewis L and Mulvany PM.** 1996. A typology of community seed banks. Natural Resources Institute, University of Greenwich, UK.

**Linnemann, A.R. and G.H. de Bruijn.** 1987. Traditional seed supply for food crops. ILEIA Newsletter 3(2):10-11.

**Monyo ES, Mgonja MA and Rohrbach DD.** 2003. An analysis of seed systems development, with special reference to smallholder farmers in southern Africa: Issues and challenges. Paper presented at the workshop on Successful community based seed production strategies, co-organised by CIMMYT and ICRISAT, 3-6 August 2003, Harare, Zimbabwe.

**Mugedeza C.** 1996. Local knowledge and systems of on-farm seed production and maintenance in Ward 21, Chivi District-Masvingo. ITDG, Zimbabwe.

**Navi, S. S. and S. D. Singh.** 2000. Identification and control of seed mycoflora on sorghum grain. VIII<sup>th</sup> Vasantrao Naik memorial national agriculture seminar on Sorghum under different agro-ecological systems and its industrial utilization March 1-2, 2000. (Abstract) p. 48.

**Navi, S. S. and S. D. Singh.** 2003. Effects of pounding and garlic extract on sorghum grain mold and grain quality. *International Sorghum and Millets Newsletter* 44: 122-124.

**Navi, S. S., R. Bandyopadhyay, A. J. Hall, and Paula Bramel-Cox.** 1999. A pictorial guide for the identification of mold fungi on sorghum grain. *Information Bulletin no* 59 (in En, Fr). Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics. 118 pp.

**Navi, S. S., R. Bandyopadhyay, M. Blümmel, R. K. Reddy, and D. Thomas.** 2003. Maize stripe virus: a disease of sorghum emerging in south India. *International Sorghum and Millets Newsletter* 44:126-129.

- Navi, S. S., R. Bandyopadhyay, R. K. Reddy, R. P. Thakur, and X. B. Yang.** 2005. Effects of wetness duration and grain development stages on sorghum grain mold infection. *Plant Disease* 89:872–878.
- Navi, S. S., S. D. Singh, V. Gopal Reddy, N. Kameswara Rao, and J. Bramel Paula.** 2002. New Sources of resistance to grain mold in converted zerazera sorghum. *International Sorghum and Millets Newsletter*. 43:77–80.
- Navi, S. S., X. B. Yang, R. P. Thakur, P. A. Murphy and R. Bandyopadhyay.** 2005a. Fumonisin in molded sorghum grain. *Phytopathology* 95:S74.
- Navi, S.S.** 2005. Fungi associated with sorghum grain in rural Indian storages. *Journal of New Seeds* 7:51–68.
- Navi, S.S., Yang, X.B., Rao, V.P. and Thakur, R.P.** 2005b. Association of fumonisin producing *Fusarium* spp. in sorghum grain mold complex in India. Page#101 in Abstracts of the Global Conference II on Plant Health-Global Wealth, November 25–29, 2005, Dept of Plant Pathology, Rajasthan College of Agriculture, Maharana Pratap University of Agriculture & Technology, Udaipur, India 313 001.
- Nelson, R. R.** 1959. *Cochilobolus carbonum*, the perfect stage of *Helminthosporium carbonum*. *Phytopathology* 49:807–810
- Pitt, J. I.** 1991. Penicillium toxins. Pages 99–103 in Fungi and mycotoxins in stored products: Proceedings of an international conference, Bangkok, Thailand, 23-26 April 1991 (Champ, B.R, Highley, E., Hocking, A.D., and Pitt, J.I., eds). ACIAR Proceedings No. 36. Australia: The Griffin Press Ltd.
- Prasad,VL, Bezkorowajnyj PG, Nigam SN, Hanson J and Romney D** 2006. Participatory varietal selection of multiple actors orientation-case study of groundnut in Anantapur, Andhra Pradesh, paper presented at the International conference of social science perspectives in Agriculture Research and Development, February 15-18, 2006, Indian council of agricultural Research, New Delhi, India.
- Raghavendra Rao, S. N., and H. S. R. Desikachar.** 1964. Pearling as a method of refining jowar and wheat and its effect on their chemical composition. *Journal of Food Science and Technology* 1:40–42.
- Rao, K. E. P., S. D. Singh, and J. W. Stenhouse.** 1995. Grain mold resistance in guinea sorghum germplasm. *International Sorghum and Millets Newsletter* 36:94–95.
- Raper, K. B., and D. I. Fennel.** 1973. The genus *Aspergillus*. New York, USA: Robert E Kreiger Publishing Co. 686 pp.
- Ravinder Reddy, Ch.** 2004a. Alternative seed delivery systems – Village based seed banks. In ICRISAT-Asia in-house review held at ICRISAT, Patancheru, 24-26 November 2004.

**Ravinder Reddy, Ch.** 2004b. Seed systems in the semi-arid tropics of Andhra Pradesh. *In* Enhanced livelihoods of poor livestock keepers through increasing use of fodder, 2-3 September 2004. ICRISAT, Patancheru, India.

**Ravinder Reddy, Ch.** 2005. Alternative informal seed systems models for seed security. *In* National partners workshop of fodder innovation project, 25 February 2005. ILRI, ICRISAT Centre, Patancheru, India.

**Ravinder Reddy, Ch., Tonapi, V.A. Prasad, V. L and Peter Bezkorowajnyj.** 2006. Integrated seed systems for sustainable food, feed and fodder security in semi-arid tropics of India. *In*: Strategies for millets development and utilization. 2006. (Editors: Drs. N Seetharama & Vilas A Tonapi). P 143-152 Society for Millets Research, 11-127, National Research Centre for Sorghum, Rajendranagar, Hyderabad 500 030, Andhra Pradesh, India. 232 pp. ISBN 81-89335-12-X.

**Ravinder Reddy Ch, K Gurava Reddy, G Thirupathi Reddy, and SP Wani** 2006. Increased Adoption of seed treatment for groundnut disease management through farmers participatory evaluation': A Micro study in Kurnool District of Andhra Pradesh, India. *Manage Extension Research Review* 7(1): 101-109.

**Ravinder Reddy Ch, Ashok S Alur, Belum V S Reddy, P. ParthasarathyRao and CLL Gowda** 2007. Building human and social capital for improving the livelihoods of small and marginal farmers in SAT regions of Asia. Paper presented in International conference on "Ethnographic Discourse of the others" during 3-5<sup>th</sup> July 2007 at University of Hyderabad, APIndia.

**Reichert, R. D., C. G. Youngs, and D. Oomah.** 1982. Measurements of grain hardness and dehulling quality with a multisample tangential abrasive dehulling device (TADD). Pages 186–193 in Proceedings of the International Symposium on Sorghum Grain Quality, 28–31 October 1981, ICRISAT, Patancheru, India. Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics.

**Rodriguez-Herrera, R., W. L. Rooney, D. T. Rosenow, and R. A. Frederiksen.** 2000. Inheritance of grain mold resistance in grain sorghum without a pigmented testa. *Crop Science* 40:1573–1578.

**Rohrbach DD, Mtenga K, Kiriwaggulu JAB, Monyo EU, Mwaisela F and Saadan HM.** 2002. Comparing community seed projects in Tanzania. Local seed systems News-SADC/GTZ, Small-scale seed production project, Harare. Vol.7, No.1.

**Shetty, H. S., K. L. Patkar, C. M. Usha, N. Paster, R. Kennedy, and J. Lacey.** 1995. Effect of Propionic acid on the incidence of storage fungi in stored rice, sorghum and groundnut under tropical conditions. *Tropical Science*, 35:40–48.

**Singh V.** 1999. Traditional agro biodiversity re-introduced by farmers. LEISA, ILEIA Newsletter. Vol. 15, No. 3/4.

- Singh, S. D. and S. S. Navi.** 2000. Garlic as a bio-control agent of sorghum ergot. *Journal of Mycology and Plant Pathology*. 30:350–354.
- Singh, S. D., S. S. Navi, J. W. Stenhouse, and K. E. Prasada Rao.** 1995. Grain mold resistance in white grain sorghum. *International Sorghum and Millets Newsletter*. 36: 95–96.
- Sivanesan, A.** 1987. Graminicolous species of *Bipolaris*, *Curvularia*, *Drechslera*, *Exserohilum* and their teleomorphs. Mycological paper No. 158. Wallingford, Oxon, UK: CAB International.
- Standen, J. H.** 1945. *Nigrospora oryzae* (B and Br.) Petch on maize. *Phytopathology* 35:552–564.
- Stenhouse, J. W., R. Bandyopadhyay, S. D. Singh, and V. Subramanian.** 1998. Breeding for grain mold resistance in sorghum. Pages 326-336 in Proceedings of the International Conference on Genetic Improvement of Sorghum and Pearl Millet, 23 to 27 Sep 1996, Lubbock, Texas, USA. USA: International Sorghum/Millets Collaborative Research Support Program.
- Sutton, B. C.** 1980. The Coelomycetes- Fungi Imperfecti with pycnidia, acervuli and stromata. Kew, Surrey, UK: Commonwealth Mycological Institute. 696 pp.
- Tonapi VA, Elangovan M, Kalpana Sastry R, Varanavasiappan S, Visharada KBRS and Seetharama N.** 2004. Legislative mechanisms for conserving biodiversity and protection of IPR in India. National Research Centre for Sorghum, Rajendranagar, Hyderabad, Andhra Pradesh, India. 649 pp. ISBN 81-09335-03-0.
- Tripp R.** 2003. How to cultivate a commercial seed sector. Paper presented for symposium Sustainable Agriculture in the Sahel, 1-5 December 2003 Bamako, Mali.
- Turner M.** 1994. India debates expanding seed legislation. *Seed World*. December 1994.
- Van Amstel, H., J.W.T. Bottema, M. Sidik and C.E. van Santen (ed.)** 1996. Integrating Seed Systems for Annual Food Crops. In: Proceedings of a Workshop, 24-27 Oct 1995, Malang, Indonesia. CGPRT Center, Bogor, Indonesia.
- Vasanthi, S., and R. V. Bhat.** (1998). Mycotoxins in food: Occurrence, health and economic significance and food control measures. *Indian Journal of Medical Research* 108:212–222.
- Von Lossau A.** 2000. Support of the informal seed sector. GTZ and Center for Genetic Resources, The Netherlands (CGN).

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