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

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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 aswell 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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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 appoaches 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
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Part II: Seeds for Livelihood Security

CHAPTER II: The Role of Seeds in Achieving Livelihood Security

Chapter II

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^{-1} 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^{-1}) 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^{-1} 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[1].

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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[1] 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 safty net and therefore should be given more consideration than it is at present.

About ICRISAT®

The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) is a nonprofit, non-political organization that does innovative agricultural research and capacity building for sustainable development with a wide array of partners across the globe. ICRISAT's mission is to help empower 600 million poor people to overcome hunger, poverty and a degraded environment in the dry tropics through better agriculture. ICRISAT belongs to the Alliance of Future Harvest Centers of the Consultative Group on International Agricultural Research (CGIAR).

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