

PART ONE

Introductory Topics

Introduction

The history of agricultural progress from the early days of man has been the history of seeds of new crops and crop varieties brought under cultivation. In the early days it was achieved through the cultivation of indigenous but useful plants and those taken through introductions. Selection of superior types from cultivated plants constituted the next stage of progress. In the course of time many useful selections were made and there was gradual but steady progress in crop improvement. Later, through the use of well-known techniques of selection, hybridisation and polyploidisation the scientists made available many new and better varieties. However, the pace of progress remained slow for a long time. It was only during the mid sixties that a revolution took place in our concept of yield potential of the major cereals and millets due to the discovery of morphological factors such as the dwarfing influence and the response of self-fertilised crops like rice and wheat to increased doses of fertilisers. Similarly, in the case of cross-fertilised crops, the exploitation of hybrid vigour became the basis for making significant advances in yield. The introduction, development and release of dwarf varieties of rice and wheat and hybrids of maize, *jowar* and *bajra* have helped to raise the sights as regards yield possibilities and consequently have stimulated interest among the farming community in a new agronomy revolving around the cultivation of high yielding varieties.

However, to the farmer all this scientific research would be of little value unless he gets seeds, which are genetically pure (true to type) and possess other desired qualities namely, high germination percentage and vigour, high purity, sound health, etc. When the farmers do not get seeds possessing these qualities the yields they obtain may not be as expected. Only seeds with

assured quality can be expected to respond to fertilisers and other inputs in the expected manner. Otherwise as has been aptly said "What are known as the seeds of hope may turn into seeds of frustration." (Sudhir Sen, 1974).

There is yet another aspect of the importance of good seed. Among the inputs used by farmers, seed is the cheapest. It is a basic input and forms only a small part of the total cultivation expenses. Yet, without good seed the investment on fertiliser, water, pesticides and other inputs will not pay the required dividends.

The indifference towards quality seed which hitherto prevailed should, however, cause no surprise. It epitomised the more general indifference towards scientific agriculture. Since it is a biological industry, good agriculture depends upon good seed and vice versa. One cannot exist or advance without the other (Sudhir Sen, 1974). The pace of progress in food production, therefore, will largely depend upon the speed with which we are able to multiply and market good quality seeds of high yielding varieties.

Concept of Seed Technology

The distinction between seed and grain is vital, being of semi-importance to agriculture. A seed, strictly speaking, is an "embryo", a living organism embedded in the supporting or the food storage tissue. The business of Seed Technology is to protect this biological entity and look after its 'welfare', while the focus of Food Technology is on the second component—the supporting tissue.

DIFFERENCE BETWEEN SEED AND GRAIN

A seed, stands for any of the following used for sowing or planting.

- i. Seeds of food crops including edible oil seeds and seeds of fruit and vegetables
- ii. Cotton seeds
- iii. Seeds of cattle fodder
- iv. Jute seeds
- v. Seedlings, tubers, bulbs, rhizomes, roots, cuttings, all types of grafts and other vegetatively propagated material for food crops or cattle fodder.

It can be clearly seen from the above that the seed pertains to material (seed, fruit or vegetatively propagating material) meant for sowing/planting purposes; the essential function being the reproduction.

Table 1.1. Difference between scientifically produced seed and the grain (used as seed)

Scientifically produced seed	grain (used as seed)
1. It is the result of well planned seed programme.	It is the part of commercial produce, saved for sowing/ planting purposes.
2. It is the result of sound scientific knowledge, organized effort, investment on processing, storage and marketing facilities.	No such knowledge or effort is required.
3. The pedigree of the seed is ensured. It can be related to the initial breeders seed.	Its varietal purity is unknown.
4. During production effort is made to rogue out off types, diseased plants, objectionable weeds and other crop plants at appropriate stages of crop growth which ensures satisfactory seed purity and health.	No such effort is made. Hence, the purity and health status may be inferior.
5. The seed is scientifically processed, treated and packed and labelled with proper lot identity.	The grain used as seed may be manually cleaned. In some cases, prior to sowing it may also be treated. This is not labelled.
6. The seed is tested for planting quality, namely, germination, purity admixture of weed seeds and other crop seeds, seed health and seed moisture content.	Routine seed testing is not done.
7. The seed quality is usually supervised by an agency not related with production (Seed Certification Agency).	There is no quality control.
8. The seed has to essentially meet the "Quality Standards." The quality is therefore well known.	No such standards apply here. The quality is non-descript and not known.
9. The labels/certification tags on the seed containers serves as quality marks.	

The seed, when scientifically produced (such as under seed certification) is distinctly superior in terms of seed quality, namely, the improved variety, varietal purity, freedom from admixtures of weeds and other crop seeds, seed health, high germination and vigour, seed treatment and safe moisture content etc. Its quality and thus expected performance is known. A grain, on the other hand, includes cereals and pulses, meant for human consumption. The major differences between scientifically produced seed and the grain (when used as seed) are listed in Table 1.1

SEED QUALITY

Seed Quality Characteristics:

Improved variety: The variety must be truly superior than existing ones. It must be the latest and the best variety suited to the area in regard to production potential and other desirable characteristics.

Genetic purity: Genetic purity of seeds refers to the trueness to type. If the seed possesses all the genetic qualities that breeder has placed in the variety, it is said to be genetically pure. The genetic purity has direct effect on ultimate yields. If there is any deterioration in the genetic make up of the variety during seed multiplication and distribution cycle, there would definitely be proportionate decrease in its performance e.g. yield, disease resistance, etc. It is, therefore, necessary to ensure genetic purity during production cycles.

Physical purity: Physical purity of a seed lot refers to the physical composition of seed lots. A seed lot is composed of pure seeds - the seeds of same kind, inert matter, broken grains less than half in size, soil and dust particles, chaff etc., weed seeds and other crop seeds. Higher the content of pure seed the better would be the seed quality. Pure seed considered together with seed germination determine the planting value of the seed.

Seed germination and vigour: Seed germination refers to the ability of a seed when planted under normal sowing conditions to give rise to a normal seedling. The seed vigour refers to the sum total of all the attributes that gives effective plant stand in the field.

High germination percentage and vigour results into raising of an excellent crop having adequate plant population and uniform

growth. Both of these have profound effect upon the ultimate yields and also determines the planting value of the seed.

Planting value: Planting value is the real worth of a seed lot for raising the crop. It is determined by calculating pure live seed percentages as follows:

$$\text{Pure live seed (P.L.S.)} = \frac{\text{Pure seed\%}}{100} \times \frac{\text{Germination\%}}{100} \times 100$$

Freedom from weeds and other crop seeds: This is an extension of the physical purity described earlier. There are certain species of weeds which are very harmful to the cause of agriculture in general. These includes mostly the perennial species and such species which once established are difficult to eradicate. Absolute freedom from seeds of such species is highly desirable and is one of the important criterion of determining planting quality of seeds.

Seed health: The health of seed refers to the presence or absence of disease organisms/insect pests on seeds. The quality of a seed lot very much depends on its health.

Seed Moisture: The seed moisture is the most critical factor in the maintenance of seed germination and viability during storage. The seed must be dried to safe moisture content.

Other Characteristics:

a. **Seed size, weight and specific gravity:** The seed size, weight and its specific gravity has been found to have positive correlation with seed germination and vigour in many crops. The seed lots having smaller seeds, lower specific gravity or hundred seed weight may perform poorly when compared with lots having higher specific gravity and hundred seed weight.

b. **Seed Colour:** The colour of seeds often reflects the conditions during seed maturation. Good normal colour and shine have been regarded as invaluable quality guides by the farmers from the time immemorial. The colour of seed and shine deteriorate only when the weather conditions are adverse during maturation, the crop is infested by insects and or when the seed has been handled badly.

Concept of seed quality:

It is the degree of excellence in regard to the characteristics

referred to above that determines the seed quality. If the seed lots possess high genetic purity and high germination percentage and a minimum of inert, weed and other crop seeds and are free from diseases, it is said to have high quality. If it is lacking in any of these, it is said to be of low quality. Generally, the standards fixed for certified seeds are considered quality standards. It implies that if a seed lot meets the certification standard, it is good quality seed and if it does not meet the certification standards, it is obviously of a lower seed quality.

DEFINITIONS OF SEED TECHNOLOGY

Cowan (1973) identified Seed Technology as "that discipline of study having to do with seed production, maintenance, quality and preservation."

Feistritzer (1975) defined Seed Technology as the methods through which the genetic and physical characteristics of seeds could be improved. It involves such activities as variety development, evaluation and release, seed production, processing, storage and certification.

Thus, Seed Technology is essentially an interdisciplinary science which encompasses a broad range of subjects. In its broadest sense, "Seed Technology includes the development of superior crop plant varieties, their evaluation and release, seed production, seed processing, seed storage, seed testing, seed certification, seed quality control, seed marketing and distribution and research on seed physiology, seed production and seed handling based upon modern botanical and agricultural sciences."

In a narrow sense "Seed Technology comprises techniques of seed production, seed processing, seed storage, seed testing and certification, seed marketing and distribution and the related research on these aspects."

THE RELATIONSHIP OF SEED TECHNOLOGY TO THE OTHER SCIENCES

Genetics and Plant Breeding. The plant breeders and geneticists evolve new crop varieties which are high yielding and superior in resistance to diseases and pests as compared to existing varieties. They are also associated with the maintenance of nucleus and breeders seed, grow out tests etc.

Agronomy. The agronomists provide suitable package of practices for growing, harvesting and handling of seed crops in order to obtain maximum seed yields and best possible seed quality.

Horticulture. The horticulturists provide the suitable package of practices for growing, harvesting and handling vegetable, flower and other horticultural crops to ensure maximum seed yields and best possible seed quality.

Plant Pathology. The role of plant pathologists in seed production has greatly increased in recent years owing to increased consciousness to produce and distribute disease free seed. The plant pathologists provide the package in regard to seed treatment, plant protection measures and prophylactic measures that should be adopted in seed crops to ensure maximum possible control of diseases carried by/and or through the seed. They are also involved in the development of seed health testing techniques, including testing of seed samples for detection of seed borne diseases, besides plant quarantine.

Entomology. Like plant pathologist, the entomologists provide the package in regard to pest control during crop production and seed storage etc. to ensure good seed quality and minimum losses during storage. They are also involved in the development of seed health testing techniques, including testing of seed samples for the detection and determination of insect infestation in seed samples, besides plant quarantine.

Taxonomy. The taxonomists provide the information necessary for identification of various crop and weed seeds and cataloguing of germplasm, varieties etc.

Plant/Seed Physiology. The physiologists help in understanding/diagnosing various planting seed quality problems, seed development and maturation, seed storage problems and provide deep insight and solutions to these problems. They are also associated with the development of seed germination, seed vigour, and seed viability testing techniques.

Agricultural Economics. The agricultural economists provide the necessary guidance in relation to seed marketing problems and thus help in devising a suitable marketing and distribution system. They should be associated with the management aspects and in the determination of cost/benefit ratio, seed price fixation etc.

Agricultural Engineering. The agricultural engineers are as-

sociated with the development of technology to manufacture indigenously the suitable seed planting, harvesting, machinery for seed crops and also the seed drying, seed processing machinery, seed handling and seed testing equipment.

Agricultural Extension. The extension agencies are involved in popularising the use of high quality seeds of high yielding varieties amongst the farming community.

Role of Seed Technology

Feistritzer (1975) outlined the following roles of improved seed:

1. Seed—a carrier of new technologies.
2. Seed—a basic tool for secured food supply.
3. Seed—the principal means to secure crop yields in less favourable production areas.
4. Seed—a medium for rapid rehabilitation of agriculture in cases of natural disaster.

1. *Improved seed—a carrier of new technologies.* The introduction of quality seeds of new varieties wisely combined with other inputs significantly increase yield levels. Feistritzer (1975) reported yield increases to the extent of 112 per cent in cereals, 124 per cent in potatoes and 142 per cent in sugar beet in Central Europe through the use of improved seeds and agricultural inputs. In the U.S.A., the results achieved were still better. In India for instance, the cultivation of high yielding varieties have helped to increase food production from 52 million tonnes to nearly 180 million tonnes over a period of 40 years. It is therefore, evident that the introduction of seeds of new varieties raises the effects of traditional inputs and increase their ultimate consumption as well.

2. *Improved seed—a basic tool for secured food supply.* The successful implementation of the high yielding varieties programme in India has led to a remarkable increase in production and to a new assessment of future development potential. As a result, food imports from other countries have been substantially brought down inspite of the rapid population increase.

3. *Improved seed—the principal means to secure crop yields in less favourable areas of production.* The supply of good quality seeds of improved varieties suitable to these areas is one of the few important immediate contribution that Seed Technology can make to secure higher crop yields.

4. *Improved seed—a medium for rapid rehabilitation of agriculture in cases of natural disaster.* Widespread floods and droughts in various parts of the country and elsewhere have focussed attention on these recurrent crises and the accompanying threats of famine and starvation. The relief operations by F.A.O. show that it would be much more economical if the Governments had National Seed Reserve Stocks at their disposal. The establishment of National Seed Reserve Stocks should receive high priority for meeting such natural calamities (Feistritzer, 1975).

National Seed Stocks would have a twofold role to play:

1. They would provide improved seeds in emergency periods to production areas for rapid production of food grains.
2. They would supply seeds to disaster regions for resowing, as no seed would normally be available in such regions.

Goals of Seed Technology

The major goal of Seed Technology is to increase agricultural production through the spread of good quality seeds of high yielding varieties. It aims at the following:

1. *Rapid multiplication.* Increase in agricultural production through quickest possible spread of new varieties developed by the plant breeders. The time taken to make available the desired quantities of seeds of improved varieties to farmers should be considered as a measure of efficiency and adequacy in the development of Seed Technology in the country.

2. *Timely supply.* The improved seeds of new varieties must be made available well in time, so that the planting schedule of farmer is not disturbed and they are able to use good seed for planting purposes.

3. *Assured high quality of seeds.* This is necessary to obtain the expected dividends from the use of seeds of improved varieties.

4. *Reasonable price.* The cost of high quality seed should be within reach of the average farmer.

OPPORTUNITIES FOR SEED TECHNOLOGISTS

The wide-diversity of agro-climatic conditions, large size, cheap labour—both skilled as well as unskilled, a high level of technology in almost all fields, easy availability of technical staff and training facilities coupled with the enormous potential internal

demand and exports potential India can and should become one of the world's biggest seed producing country and capture export market. The diversity of agroclimatic conditions means not only that almost any kind of seed can be produced under optimal conditions in the country, but also that it can be done at a faster rate because we can take two or three crops in a single year by growing them in different agroclimatic regions in quick succession. This would indeed improve the country's agriculture and economy, and thus could vastly improve the well being of Indian people.

The future development of the seed industry and the seed programme in the country rests more on seed technologists than any other single factor. The National Commission on Agriculture (1976) has estimated that the area under seed crops by 2000 A.D. shall be around 2.4 million hectares. Real professionals, that is, well trained seed technologists shall find good opportunities in the following ways.

- Management of seed enterprise (Govt./semi govt. undertakings and private seed companies)
- Seed Testing Laboratories
- Seed Certification Agencies
- Seed Law Enforcement Agencies
- Training/Extension centers (for seed growers)
- Research Institutes (where seed technology research is being done)

Seed Industry in India

SEED INDUSTRY BEFORE INDEPENDENCE

In the early years of the twentieth century, as a result of the beginning of agricultural research at agricultural colleges and research stations, a few improved strains of cotton, wheat, groundnut and sugarcane came into existence. The State Department of Agriculture adopted two methods for the distribution of seeds of these improved varieties. By the first method the seeds of improved varieties were multiplied at one location and distributed over a larger area so that the area under local varieties could be replaced by improved varieties. By the second method the seed was distributed in small packets to a maximum number of farmers and it was expected that farmers would multiply their own seed. However, when the second method was tried in Bengal by distributing packets of jute and paddy seeds, it was found that this did not increase the spread or coverage under new strains. As a result this practice was discontinued and attention was concentrated only on the first method (Howard, 1928).

In the United Provinces (U.P.) the responsibility for replacing old varieties was placed on the State Department of Agriculture. Several seed multiplication laboratories were set up in the State to achieve these goals. The seeds multiplied at these laboratories were further multiplied on the farms of landlords. This marked the beginning of the distribution of good quality seed. To encourage the use of good quality seed further, provisions for liberal loans were also made. Loans were granted for the purchase of good seed particularly during crop failures due to natural disaster. With these developments, the Govern-

ment of the United Provinces in 1922 agreed to establish one seed store in each tehsil. Since then, the State Department of Agriculture has been steadily increasing the number of seed stores.

The Royal Commission on agriculture constituted in 1925 examined inter alia the introduction and spread of improved varieties and the progress of seed distribution. It made the following suggestions for improvement:

1. There should be a separate organisation within agriculture departments to deal with seed distribution and seed testing.
2. The seed distribution enterprise should be self-sustaining.
3. Seed distribution should be organised through cooperatives, other associations, seed merchants (whenever they are available), through seed agents, as well as through agricultural department staff and any other agency which could be considered suitable.
4. Seed merchants of proven enterprise should be given every encouragement.

Following the suggestions of the Royal Commission, the Government of India and several State Governments established a number of research institutes. With increased efforts several improved strains of cash crops namely, sugarcane, cotton, jute and food crops like wheat and paddy were developed. However, the work of seed multiplication and distribution did not keep pace with the research developments.

After the review by the Royal Commission several similar analyses on seed status were made. Notable are those by Sir John Russell (1937), ICAR (1940), Dr. Burns (1944), Famine Enquiry Commission (1944), and Food Grains Policy Committee (1944). These reviews revealed that:

1. Crop botanists were involved in the evolution of improved varieties, their testing and demonstrations.
2. The initial seed was multiplied on seed farms of agriculture department and subsequent increases, if necessary, were made on the farms of registered seed growers under the close supervision of the agriculture department.
3. The agriculture department purchased seeds from growers at a premium price and subsequently distributed these to farmers, sometimes even at concessional rates.

4. Right up to the War (1939), vegetable seeds, other than those peculiarly Indian, were obtained from abroad. The cessation of supplies resulted in hardships to seedsmen and vegetable growers in India.

5. A well organised scheme did not exist to spread improved maize varieties.

The situation with regard to vegetable seeds, however, was somewhat different. Over a period of years, several private entrepreneurs designed vegetable seed programmes. By 1945, the private vegetable seed companies had developed facilities for producing seeds of temperate vegetables in Quetta and the Kashmir valley. In 1946, the seedsmen handling vegetable seeds organised themselves into an association—The All India Seed Growers, Merchants and Nurserymen's Association with the objectives of ensuring the rapid development of the vegetable seed industry.

SEED INDUSTRY AFTER INDEPENDENCE

First Five Year Plan (1951–56)

Greater emphasis was placed on the development of seed programmes during the First Plan period. The use of improved seed was made the basis for calculating the additional production potential of food grains.

The Grow More Food Enquiry Committee (1952) constituted during the period revealed that by and large seed of requisite purity was not available to farmers. An Expert Standing Committee was also set up in 1952 by ICAR to formulate concrete proposals for the seed improvement programme.

As a result of these developments the schemes for seed multiplication and distribution came into existence in all the States of India. These schemes proved useful in following manner:

1. The system of distribution of improved seeds of food grains came into existence.

2. The experience gained in the operation of these schemes was helpful in coordinating agricultural work.

In spite of this, the progress made during the First Plan period on the whole was poor, and the seed programmes were confined primarily to seed distribution often with subsidy.

Second Five Year Plan (1956–61)

As in the First Plan, the use of improved seed was made the basis for ten per cent additional food grain production. Many important developments having far reaching significance took place during this Plan period. Notable among these developments was the setting up of the All India Coordinated Maize Programme. The Second Plan attached special importance to the multiplication of nucleus seed into foundation seed at Block level and recognised it as a basis for further multiplication and eventual distribution of improved seeds to farmers. A policy that each National Extension Service Block should have a seed farm and seed store was laid down during this period.

During the Second Five Year Plan setting up of 4328 farms of 10 hectares each was envisaged for seed multiplication. However, only 2551 seed farms could commence functioning during the Second Plan Period. In addition to these, plans for setting up seed testing laboratories and cooperative stores were also drawn up.

Coordinated Crop Improvement Schemes

The setting up of the first All India Coordinated Maize Improvement Programme by the ICAR in collaboration with the Rockefeller Foundation can rightly be considered as a most significant turning point in Indian agriculture. This marked the beginning of an intensive, multi-disciplinary and integrated approach to crop improvement and brought the first glimmer of change. Within four years of its inception the project made available the first four maize hybrids. Encouraged by results of this approach the ICAR simultaneously introduced in 1960 similar projects for sorghum and bajra, which released the first sorghum and bajra hybrids in 1964 and 1965 respectively. Since then, this approach has been gradually extended to almost all the crops of economic importance.

Agricultural Production Team (1959)

The First Indo-American Agricultural Production team, headed by Dr. Sherman E. Johnson of the Ford Foundation examined India's food production problems. The team suggested that Village, Block and District level extension workers should be made primarily responsible for educating farmers in the use of im-

proved seed; the State Agricultural Departments for seed certification; and, the cooperatives and private growers for seed supply. The team further recommended the setting up of seed testing laboratories in the States, development of uniform Seed Certification Standards and Seed Laws and creation of favourable economic climate. Towards the end of the Second Plan period the second joint Indo-American team (1960) headed by Dr. Randhawa endorsed the first team's observations.

Towards the end of 1959, Prof. A.S. Carter, TCM expert, visited India and provided useful plans for developing a sound seed programme in India. He also furnished a model State Seed Law which inspired subsequent attempts on this aspect.

Review by "Programme Evaluation Organisation (1960)"

The review of seed status by the Programme Evaluation Organisation (PEO), at the end of 1960, made the following important observations:

1. In reality the policy of setting up a 10 hectare farm per Block was not strictly followed in many States. Most of these farms were run by non-agricultural graduates and ran into losses each year.

2. On only five per cent of the seed farms, the precautions necessary for maintaining purity were taken.

3. A high proportion of the improved seed produced by registered growers was not used for sowing.

In spite of the significant developments the desired satisfactory progress during the Second Plan period could not be achieved for the following reasons:

1. The requisite quantities of breeders seed were not made available each year.

2. Only important cereals, hybrid maize, bajra, etc. were included in the seed programmes.

3. Several varieties of the same crop were raised at the same farm.

4. The foundation seed production programme of particular varieties keeping in view the needs of Community Development Blocks was not organised .

5. The foundation seed was not fully utilised.

6. Timely inspections for roguing of undesirable plants on fields of registered growers were not made.

7. Marketing of improved seed was largely left to seed producers.

8. Large quantities of improved seed were not used for planting purposes.

9. The seed procurement was also unsatisfactory for want of adequate provisions.

10. Seed processing was defective.

11. There were a large number of complaints regarding purity and germination of seeds.

12. Neither were the records of various stages of seed multiplication maintained nor was the seed multiplication programme properly organised.

13. The cooperative societies were not interested in the sale of improved seed, since it offered little profit to them.

Seed Multiplication Team Review (1961)

Almost simultaneous with PEO's revelations in 1961, the Seed Multiplication Team of the Committee on Plan Projects evaluated the seed multiplication schemes and made the following recommendations:

1. *Seed multiplication.*

- a) An intensive seed multiplication and distribution programme for millet, oilseeds and pulses with available improved varieties should be carried out;
- b) Production of breeder's seed in adequate quantities under the control of crop specialists should be taken up; and
- c) Planning of seed multiplication and distribution to cover the area of all the important crops over a period of five years must be drawn.

2. *Seed distribution.* The team observed that the main handicap in the coverage of improved varieties was the poor distribution of registered seed and suggested that adequate provisions be made to see that registered growers make full use of the seed supplied to them.

3. *Maintenance of quality.* The team stressed that all States should prescribe suitable schedules for improved seed with specifications for purity and germination and for purity refractions to maintain quality. It suggested precautions to be taken during harvesting, seed drying and storage of seeds, as well as peri-

odical checks of standing crops in field and seed samples by specialists and also stressed the importance of seed treatment. Certification of seed potatoes, supply of disease-free sugarcane and establishment of seed testing laboratories was also suggested.

Third Five Year Plan (1961–66)

Serious efforts were made during the Plan period to overcome the shortcomings of the seed programmes. The release of the first four hybrids of maize in 1961 necessitated the creation of a separate organisation for seed production in order to exploit the full production potential of these hybrids. This necessity led to the development of blueprints by the Ministry of Agriculture to assure rapid multiplication and distribution of pure hybrid maize seed and ultimately gave birth to the Central Seeds Corporation (National Seeds Corporation) in 1963. The important considerations in establishing the Central Seed Corporation were:

1. It would establish foundation and certified seed corporation;
2. Encourage and assist in the development of seed production and marketing of seeds;
3. Encourage and assist in development of Seed Certification Programmes, Seed Law and Seed Law Enforcement Programmes;
4. Train personnel involved in seed programmes; and
5. Coordinate the improved seed programmes.

National Seeds Corporation Limited

The conception of the idea of the Central Seeds Corporation led to the formation of National Seeds Corporation Limited (NSC) in 1963. The NSC was looked upon as an agency which would promote the healthy development of the seed industry in India, initiate measures leading to production of high quality seeds and, in particular, produce, process and market single crosses of hybrid maize. It was also given principal responsibility for establishing an adequate system of quality control inspection and for promoting scientific seed processing, storage and marketing. This marked the beginning of systematic seed production based on scientific principles. Initially, it was envisaged, that the NSC would function as a Foundation seed stock organisation for hybrids and would foster and aid the establishment of appropriate

agencies and programmes to carry out the various phases of seed production programme. However, over the years, because no alternative competent agencies existed, the NSC shouldered the major responsibility of foundation seed production, certified seed production, seed certification and seed marketing. In addition to these activities it also assisted in the setting up of seed processing plants, creating of a hard core of private producers and in the training of individuals involved in seed production programmes. The most significant achievements of the National Seeds Corporation in the development of the seed industry in India are:

1. Establishment of a scientific seed industry in the country;
2. Encouragement to Indian manufacturers of seed processing equipment;
3. Development of field inspection methods and seed standards for seed certification and labelling;
4. Multiplication of pre-released varieties of all-India importance; and
5. Foundation seed production of varieties of all-India importance.

Role of State Departments of Agriculture after NSC's Establishment

During this same period the role of the State Departments of Agriculture have undergone a considerable change. The existing small, scattered Block level farms were not economically viable units for undertaking high quality seed production in view of the sophistication and strict control of quality required in the production of new hybrids. While many States nevertheless continued to grow improved seeds on these farms, other States initiated a system of contract production of seeds through private seed growers. Foundation seeds were obtained either from their own State Seed Farms or from the National Seeds Corporation. They paid attractive prices to seed growers and undertook most of the commercial and storage risks. However, this policy was largely abandoned for several reasons.

High Yielding Varieties Programme (HYVP)

Launching of HYVP by Governments of India in 1966 was another most significant milestone in the development of seed

industry. This programme envisaged a coverage of 9.2 million hectares of food crop area by 1968 to 1969 and 25 million hectares by 1973 to 1974 under high yielding varieties of *bajra*, maize, paddy, sorghum and wheat. This programme had an almost explosive effect on the seed industry and necessitated huge efforts in seed production, processing, certification, testing, storage and seed distribution, etc.

The NSC, the State agricultural departments and private entrepreneurs cooperated excellently and ensured that seed did not become a limiting factor in the successful implementation of HYVP.

Developments in the Private Seed Industry

Over the years the Private Sector participation enlarged considerably and to date there are over two hundred medium and large sized private seed companies, corporations, firms, societies etc. The development of private enterprise in southern and western India is very encouraging.

Annual Plans (1966 to 1969)

Serious efforts towards the rapid development of seed programmes continued during this period. Notable developments during this period were enactment and enforcement of Seed Legislation, review of Seed Status by a Seed Review Team constituted by the Government of India in 1968.

Unlike the previous reviews on the subject the Seed Review Team dealt in detail with a wide range of topics, namely, registration and release of varieties, seed production, processing, storage, marketing and distribution, quality control, training, role of various agencies and provisions for finance and credit. The team made 101 recommendations. Some of the most important recommendations of the team were:

1. Compulsory registration of varieties marketed as seeds.
2. Elimination of varieties of doubtful value.
3. Prerelease publicity to be avoided and adequate arrangements for prerelease multiplication of promising varieties be made.
4. Persons/institutions interested in plant breeding research be required to register with ICAR.
5. NSC should continue as a national agency for foundation

seed production and other specialised agencies like Agricultural Universities should also be developed for this purpose, and that the coordination of foundation seed production among various Agencies should be carried out by the Government of India through a suitable agency.

6. Government of India should earmark a major role for the cooperative and private sectors in seed production, processing and marketing and, as these organisations develop governmental agencies, should gradually retire from these activities and concentrate on programme planning and extension.

7. NSC should assist State Governments in setting up their own certification agencies and transfer its certification work to them.

8. ICAR should lay down standards for the production of breeder's seed so as to improve their present unsatisfactory quality.

9. Purchase prices to growers and sale prices to farmers should ordinarily be regulated by market forces.

Fourth Five Year Plan (1969–74)

The central object of agricultural development in the Fourth-Plan formulated by the Government of India was to transform Indian agriculture from a predominantly traditional way of life into an industry based more on the adoption of science and technology, making efficient use of the available resources, providing necessary economic incentives for greater investment on the part of farmers and giving them a fair measure of protection against price fluctuations, unduly high costs and to the extent possible against risks of crop failure on account of natural calamities. One of the most important planks of this strategy for agricultural development in the Fourth Plan was to select a few areas with assured rainfall and/or irrigation for concentrated application of a package of practices based on improved varieties of seeds responsive to heavy doses of fertiliser and availability of all these important inputs, and to fix special targets of production of food grains for such areas. Seed being the most important key input for this strategy, it was necessary to ensure that it did not become a limiting factor. The Tarai Seed Development Project was set up to meet one-third of the requirement of the high yielding varieties programme in the Fourth Plan Period.

Tarai Development Corporation Limited (TDC)

The establishment of the Tarai Development Corporation (TDC) in 1969 with the assistance from world bank was another important landmark in the development of the seed Industry in India. The TDC has become an ideal model for corporations that were set up in other States of India under the National Seeds Programme, as well as in other developing countries. The project aimed at the integrated agricultural development of the Tarai area with the production of quality seeds as the primary objective.

The Tarai Development Corporation had been fairly successful in achieving its goals. As part of transformation under the aegis of National Seeds Projects, it has been renamed as U.P. Seeds and Tarai Development Corporation Ltd. w.e.f. 1st July, 1978.

The following are the unique features of this Corporation:

1. *Involvement of G.B. Pant University of Agriculture and Technology* in the project to provide adequate technical guidance and technical supervision to seed growers, maintenance of nucleus and breeder's seed, production of foundation seed for the entire project area and large scale production of certified seeds at the university farm. Such involvement is very necessary, since good quality seed production is a highly technical and skilled job.

2. *Integrated development approach.* The Tarai Development Corporation had laid emphasis on provisions for land levelling, farm mechanisation, irrigation development, electrification, adequate availability of other inputs necessary for raising an excellent crop; and credit facilities. Provision of all such development facilities and inputs are absolutely necessary for the production of high quality seeds.

3. *Participation of seed growers as the shareholders of the Corporation*, in contrast to the contract system of seed production followed by the National Seeds Corporation.

4. *Compact area approach.* Technical supervision, guidance and certification are highly time consuming and important tasks. They can be carried out effectively only in a compact areas, so that scientists do not have to waste much time on the road and are readily available. Moreover, it becomes easy to undertake arrangements for collective plant protection measures, training programmes, custom services, credit facilities, etc., all of which are necessary inputs for high quality seed production.

5. *Strictest quality control.* In addition to inspections made by Seed Certification Agency and certification done by them, the Corporation with assistance from G.B. Pant University of Agriculture and Technology maintained its own vigil during seed production, marketing and distribution. It maintains technical staff for foundation seed distribution, inspection during crop seasons, inspection after harvest, testing of seed samples prior to processing and after processing, and inspections during marketing and distribution. Testing of raw seed samples in the seed laboratory has been the unique feature and has helped in rejecting seed lots of low quality prior to processing. In addition, it makes sure that the foundation seed supplied to growers is of approved genetic purity and that it is treated with the best available fungicides. The basic guiding principle in quality control at Pantnagar has been to take appropriate measures in advance for problems likely to occur so that purity and quality of the seed are maintained to the best possible levels.

6. *Money-back guarantee.* The Corporation gives a money-back guarantee. The price is refunded if any lot is found to be sub-standard by the Corporation.

7. *Integrated approach for marketing seeds.* The corporation attempts to provide its consumers with an integrated supply of inputs by appointing as its dealers those who are simultaneously marketing fertiliser, pesticides, etc.

Indian Society of Seed Technology (ISST)

The formation of the Indian Society of Seed Technology in 1971 was another significant development during the Fourth Plan period. Formation of this Society provided opportunities for exchange of experience to persons engaged in the seed industry. The ISST publishes 'Seed Research' and 'Seed Technology News' and usually meets once a year.

Fifth Five Year Plan (1974–79)

The National Commission on Agriculture

A further review of the seed industry was carried out by the National Commission on Agriculture. The Commission submitted an interim report on multiplication and distribution of quality seeds in 1971 and stressed the necessity of maintaining the purity of high yielding varieties of seeds. It made the following

recommendations in its final report submitted in 1976.

1. The seed industry should be expanded on commercial lines and it was suggested that foreign collaboration could be invited if necessary.

2. A system of national registry of varieties should be developed by ICAR and the Central Seed Committee.

3. Creation of specialised committees/groups of crops/specialised wings to tackle expeditiously the various problems arising from time to time.

4. Encouragement to small participants to form compact areas of seed production.

5. Institution of promotional measures, namely, seed crop insurance, exemption of levies, taxes, octroi, etc., timely release of wagons and unobstructed rapid movement concessional air freight, etc., and stoppage of detrimental practices such as *sawai* system.

6. Formation of a network of seed processing and storage plants compatible with the magnitude of the seed industry.

7. Seed processing should be made compulsory.

8. Development and fabrication of processing equipment.

9. Research on various aspects of Seed Technology.

10. Storage of breeder, nucleus seed should be done under controlled conditions, and that of certified seed under damp-proof, insect-free ware houses.

11. Rigorous enforcement of the Seeds Act.

12. Grow-out tests should be made an integral part of seed testing.

13. Compulsory certification may be desirable for seed material of hybrids and vegetatively propagated crops.

14. Selection of congenial areas of seed production.

15. Establishment of suitable machinery for tackling seed problems of some selected crops e.g. sugarcane, fodder crops, horticultural and plantation crops, papaya, guava, banana, pineapple, mango, citrus, cashewnut, cardamom, etc.

16. Teaching of seed production technology to be introduced in agricultural universities/colleges.

17. Department of Agriculture at the Centre and in the States should have three distinct wings, each dealing respectively with

(a) Input aspect

(b) Law enforcement

(c) Certification

18. Organisation of foundation and certified seed agencies in an integrated manner.

It is in the light of these various recommendations that the Government of India decided that a number of organised seed production agencies should be set up in the country so that seed support to the planned crop production programme may be assured.

National Seeds Programme (NSP)

Following the recommendations of Seed Review Team (1968) and National Commission on Agriculture (NCA) (1971, 1976) the Government of India decided in late 1974 to reorganize and expand the seed industry and launch a National Seeds Programme with the assistance from the World Bank. NSP-Phase I was implemented in 1975–76 with the actual production starting in 1976. During the first phase, State Seed Corporation were established in four states namely, Punjab, Haryana, Maharashtra and Andhra Pradesh. This programme was further expanded during phase II and State Seed Corporation were established in another five states, namely, Karnataka, Rajasthan, Uttar Pradesh, Bihar and Orissa.

Sixth Five Year Plan (1980–85)

The seed production and distribution net work was further expanded during this period. Seed control order, 1983 was passed declaring seeds as an essential commodity.

The World Bank Supervisory Mission in 1981 noted that much have not been achieved as against a target of 3 lakh metric tonnes the actual production was only 1.72 lakh metric tonnes. The money sanctioned for NSP-phase I and II (US \$ 25 million and 16 million respectively) was not utilised. Only US \$ 2.5 million and 0.5 million were utilized during NSP-phase I and II respectively. The Mission suggested number of remedial measures, which were mostly related to the management aspects.

Seventh Five Year Plan (1985–90)

During this period still higher targets for quality seed production were fixed. The important developments during this period have been:

1. Further strengthening of infra-structure, facilities for enhanced seed production both in the public and private sectors.
2. Under the aegis of NSP-Phase III State Seed Corporations were established in another four States, namely, Assam, West Bengal, Madhya Pradesh and Gujarat.
3. Further strengthening of seed technology research and training facilities.

Eight Five Year Plan (1992–97)

The increased seed production target have been fixed for the eighth plan period. The prospects of hybrid varieties of rice and other crops and renewed emphasis on hybrid seed production is likely to give new dimensions to the Indian seed industry. Private seed sector is expected to come up in a big way and play a meaningful role.

Review of Progress in Seed Certification

Though the principles of seed certification were applied in some form to the seed multiplication programmes on State farms, and on registered grower's farms in earlier years, the systematic, large scale seed certification in the country began with the formation of the National Seeds Corporation which shouldered the responsibility. The methods of seed certification and seed certification standards evolved by NSC have been approved by the Central Seed Committee. These standards have been contained in the Indian Minimum Seed Certification Standards published by the Government of India. The seeds Act and Seeds Rules enable each State Government to establish their own Seed Certification Agencies. Consequently, States have established their own seed certification agencies.

A statutory Central Seed Certification Board to coordinate the activities of State Seed Certification Agencies has also been established.

Review of Progress in Seed Testing

Alround good progress has been made in the Seed Testing. Presently 96 seed testing laboratories spread all over the country are engaged in the analysis of seed samples where over 4 lakh samples are tested each year.

The research activities, namely, development of seed testing

procedures for the determination of genetic purity, seed health and seed vigour have also been stepped up and for few crops/hybrid varieties some of the tests have been standardized. However, much more remains to be done.

Review of Progress in Seed Law Enforcement

The existing arrangement for Seed Law Enforcement in most of the States are not satisfactory for rigorous enforcement of seed legislation. Most of the State Governments have notified the existing functionaries to perform the task of seed inspectors. This appears to be the major bottleneck in the way of Seed Law Enforcement. A separate wing for seed Law Enforcement is necessary for rigorous enforcement of the Seeds Act.

The task of overall review in this respect has been assigned to a sub-committee of the Central Seed Committee which is to go into the question of enforcement in detail and suggest suitable measures.

ROLE OF PRIVATE SEED ENTERPRISE

Until 1960's the involvement of private sector in the scientific seed production and distribution was minimal, although bulk of the seed business was in their hands. They were still adopting traditional practices. The establishment of National Seeds Corporation in 1963, and subsequently the State Seed Corporations, availability of High Yielding Varieties and hybrids, however have brought about a sea change. As a result a large number of private seed companies, many with foreign collaboration have come into being, which are now engaged in the scientific seed production. Many of these companies have dominated the hybrid seeds market, and are also exporting seeds.

The quality seed distribution by the public sector agencies has steadily increased as may be seen from the Table 2.1

Public Sector has largely concentrated on agricultural crops, mainly cereals. Much of the seeds of hybrid varieties and vegetables is produced and distributed by the Private Sector.

Future magnitude

The future of seed industry is bright. By the year 2000 A.D the estimated quality seed requirement is 12.655 lakh metric tonnes which is almost double of 1992-93. Thus there is ample

Table 2.1. Seed distribution by public sector agencies.

Year	Quantity (lakh metric tons)
1953-54	0.153
1980-81	2.500
1985-86	5.501
1990-91	5.710
1991-92	5.750
1992-93	5.300

scope for expansion.

The prospects of large scale hybrid seed production and distribution appears to be excellent. India already has the distinction of being the first in developing and exploiting hybrids in crops like pearl millet, cotton, castor and pigeonpea. Besides, hybrids in maize, sorghum, sunflower and a good number of vegetables and other horticultural crops are currently available which has significantly higher potential than the currently available varieties. Even in the crops like rice the prospects of hybrid rice has opened up new vistas. In the years to come one would expect much larger coverage under hybrid varieties.

Development of Seed Programmes

A seed programme is essentially a scheme of activities planned and implemented to secure systematically rapid and timely supply of good quality seeds in the required quantities. Its value and effectiveness, however, are wholly conditioned by the progress made in the other segments of agricultural development, namely, development of irrigation resources, provisions for supply of other inputs, namely, fertilizers, weedicides, pesticides and improved farm equipment. A seed programme therefore must be developed with relevance to overall agricultural development planning.

BASES FOR A SEED PROGRAMME

There are three bases for a Seed Programme.

1. *High level support.* The desire and determination at the decision-making level of Government, to improve agriculture and the supply of essential inputs including seeds is the first requisite. Administrative support, and an understanding and appreciation of the nature and the potential contribution of the seed programme are needed at all levels including those responsible for the planning and implementation of programmes.

2. *Productive plant breeding programme.* An active and productive plant breeding, introduction and varietal testing programme is the corner stone of the seed programme/industry. Structuring a seed programme on indigenous varieties can seldom be justified. In such instances, sporadic yield increases might result from proper seed drying, processing and storage, but the overall and long term effects are usually disappointing.

3. *Coordinated effort.* A coordinated effort to create cultivator demand, prepare a sound plan for a seed programme and establish a cadre of trained specialists is necessary for the success of a seed programme.

TYPES OF SEED PROGRAMMES

There are three types of seed programmes:

1. *Official seed programme.* In an official seed programme, the government bears the complete responsibility of developing the programme and making good quality seed available to farmer. Probably all seed programmes in the world have started with government participation.

The disadvantages of official seed production are:

- (a) There is seldom any concern for return on investment, or even for covering the costs of exercise.
- (b) Such programmes are often subject to political pressures and usually too-frequent personnel changes mars the progress.
- (c) Such programmes are not very efficient.

In view of the above the need for the private programme for initiating seed multiplication must be recognised. As the seed programme progresses and as more technicians and seed producers with better training and more experience become available, other organisations should be encouraged to assume responsibility.

2. *Semi-official seed programme.* A semi-official seed programme consists of establishing a national agency, to produce, process and distribute seed. This is a more remote form of Government participation. Such an agency may be established at the initiation of a programme or at a subsequent phase of less direct government participation. Such agencies operate as autonomous units and are usually more commercial in nature and management than governmental units, and more efficient in operation.

3. *Private seed programme.* Private enterprise, as in the United States and Western Europe, prefers to handle production and distribution of hybrid seed as private enterprises that must be able to exist and compete.

In developing countries the best approach appears to be to

involve various government, semi-government and private agencies in developing the programmes by demarcating their broad responsibilities so that there is not much duplication of effort and to ensure that the programme develops in a coordinated manner.

STEPS INVOLVED IN DEVELOPMENT OF A SEED PROGRAMME

The planning organisation and operation of a seed programme is a highly technical and time-consuming job. Once a high level decision has been taken to begin a seed programme, the blueprint should be prepared carefully. In preparing the blueprint pertinent data should be carefully examined and the various requirements worked out based on scientific and technological principles. The targets should not be inflated because the very nature of the product (seed) is perishable and excess production may lead to unsurmountable problems. The main steps in the development of a seed programme are:

The Collection of Pertinent Data

The first step in developing the programme is to collect correct statistics/or status regarding the following factors.

1. Availability of superior kinds/varieties—The importance of truly superior varieties cannot be overemphasised. The list of available varieties, their areas of adaptation and yield, or other advantages should be compiled. The information regarding promising varieties should also be compiled. In addition, information regarding farmers' preference for particular variety/varieties should be noted. Such information is invaluable for determining cultivator demand for a particular variety of seeds.

2. Availability of other inputs—The cultivator demand for good quality seed increases with increase in irrigation resources and availability of fertilisers, etc. This is because the explosive impact of good quality seed by farmers is experienced only when a complete package of practices is observed. Statistics on areas under assured irrigation, availability of inputs, etc. helps in fixing realistic targets of production.

3. Targets for acreages under high yielding varieties fixed by National Governments—This indicates the emphasis placed by the government on improved varieties and their likely demand.

4. Total acreage under various crops included in the programme, seed rate per hectare, and desired renewal period to calculate total potential demand i.e. theoretical demand of seeds of various crops.

5. Role played by extension agencies in popularising seeds of high yielding varieties. The cultivator demand generated by extension efforts.

6. Collection of climatological data—Detailed climatological data is necessary for the preparation of a calendar of operations for seed production and processing, and working out requirements of seed drying, processing, storage and movement of seeds, etc.

7. Package of practices required for raising seed crops.

8. Farm size, methods of cultivation and harvesting of farmers likely to be seed growers.

9. Financial resources of seed growers.

10. Multiplication scheme namely, two stage or three stage multiplication.

11. Any other pertinent information.

Assignment of Broad Role to Various Agencies Involved in a Seed Programme

Once the basis for developing a seed programme has been built, the best approach for seed programme development in developing countries would be to involve a large number of agencies. The National Government after taking necessary steps to enact seed legislation, should assign to the State Government or itself assume the responsibility of establishing a seed certification agency, seed law enforcement agency, seed testing laboratories, maintenance of breeder's and foundation seed, planning of seed production, etc. The large scale certified seed multiplication and distribution may then be carried out by government agencies, autonomous bodies and private companies, depending upon the national policy. Each of these agencies in turn, will plan their set-up themselves and organise their work.

To avoid overlapping of activities a broad role for each of the agencies involved should be demarcated. To illustrate the above points, the broad role of various agencies involved in one or more aspects of the seeds programme in India is described below.

The Department of Agriculture of the Government of India has the overall responsibility of planning on a national scale to ensure uniform standards and procedures in enforcement of Seeds Act and Seed Certification, and the maintenance of research and testing facilities on a national scale. It must keep in touch with the requirements of the State Governments and assist them both in regard to the supply of the seeds to meet urgent requirements, and in hastening the adoption of new technologies of seeds.

The Indian Council of Agricultural Research has the function of guiding, coordinating and promoting agricultural research. It must pay special attention to the introduction of new varieties and to the strengthening of research in plant breeding and allied subjects. It has the overall responsibility of breeder's seed production of each crop and must allocate clear cut responsibilities to different research stations for maintaining breeder stock of particular varieties.

The Central Seed Testing Laboratory has been assigned the responsibility of providing leadership to other seed testing laboratories in India to ensure accuracy and uniformity of testing.

The role of the National Seeds Corporation is to act as promoter of seed enterprise in India. Its main function is to serve as a foundation seed agency, and to function as a prerelease multiplication agency for all-India varieties as well as a seed certification agency until the State Governments assume this responsibility. It has also been assigned the responsibility of setting up a technical design-cum-engineering division to assist seed producers in resolving their problems of seed processing, and to develop good quality processing machinery within the country.

The State Governments have the major responsibility of drawing up the seed programme within the State and ensuring the achievement of the programme and the plan targets. In addition, they must set up certification agencies, strengthen their seed testing laboratories and take other necessary steps to implement the Seeds Act.

The State Agricultural University, State and Central research institutes should provide training at the State level and offer specialised courses in Seed Technology. Further, they should participate effectively in the State Seed Certification Programmes.

The cooperatives and other marketing organisations should make significant contributions in retail distribution. They can also develop seed production-cum-processing cooperatives.

The private industry and seed growers' associations should also come forward and associate themselves in certified seed multiplication and distribution work.

Basic Strategy of Seed Production

The basic strategy should be comprehensive in scope and should provide for the adequate development of the physical infrastructure and the various facilities required for producing and marketing high quality seed. This involves six principles.

1. Integrated development—The production of quality seeds is possible only when all necessary inputs are made available to seed growers and all development works e.g., land levelling, development of irrigation resources, etc., for raising an excellent crop are carried out at the seed producer's farm. Either the area where a seed programme is being launched should already be well-developed and only inputs are to be made available in time, or the blueprint for a seed programme should include provisions for development works along with the supply of other necessary inputs.

The integrated development strategy involves provisions for farm mechanisation, land development, development of irrigation resources, electrification, adequate availability of fertilisers, herbicides, insecticides or other chemicals, credit facilities, arrangement for collective plant protection measures, custom services, etc.

2. Compact area approach—while developing seed programme, the seed production should be concentrated in compact areas suitable for high quality but low cost seed production. The various advantages of a compact area approach are:

- (a) It is easy to provide technical guidance, supervision and training to seed producers and inspectors engaged in seed production work. The staff requirements and expenses incurred, are also fairly low.
- (b) The integrated development discussed above can be executed easily.
- (c) Avoids isolation and roguing problems to a considerable extent.

- (d) Facilitates seed certification, seed sampling, seed testing, seed processing, storage, movement and seed distribution.
- (e) Substantially lowers the overhead expenses.

At times, a diffused programme, confined to small pockets with small-sized plants, is advocated on the ground that this would save on transport cost, and that the smaller plants would be easier to manage. The small advantages, however, are more than counterbalanced by the economy of scale of large-sized plants and, above all, the overwhelming advantage in quality control.

3. Organisation of production—Seed production can be organised in one of the following ways:

- (a) Through selected growers on contract basis.
- (b) By making the seed producer farmers shareholders of the seed companies/corporations.

In a contract system of seed production, the seed agencies are naturally interested in keeping the contract price as low as possible, thus allowing limited profits to seed producers and itself taking the lion's share of the profit. The contract seed producers, on the other hand, are interested in maintaining only 'just quality' so that their lots are not rejected. The maintenance of the best possible quality in such a system is often difficult to achieve.

In a shareholder system, the seed companies/corporations charge only service charges and the remainder is paid to seed producers after deducting incurred expenditure. Under such a system the payments made to seed producers are invariably higher than in the contract system. The main advantage is the better seed quality, since the seed producers are the owner shareholders of the companies and their interests are best served only if the best possible quality of seed is maintained.

Regardless of the system, the selected seed producers/shareholders should possess technical ability and personal reliability. Other factors to be considered are their farm size, cropping system, size of the seed multiplication fields, and in particular, previous crops and available facilities for mechanisation, transport and storage.

4. Criteria for site selections—In selecting suitable sites for seed production the following criteria should be observed:

- (a) The area selected for development of seed programmes

must have favourable agroclimatic conditions for high quality seed production, preferably in more than one season, as well as favourable conditions for seed storage. Areas with high monsoon rainfalls and high humidity should be avoided.

- (b) Given the need for maximising seed multiplication ratios, the area must have the proven ability to produce crops with well-above-average yields. Areas with assured irrigation should be preferred.

5. Technical guidance—The association or active involvement of the agricultural universities/research institutes with seed programmes should be preferred because they are the sources of (a) breeding and screening of new varieties; (b) multiplication of nucleus/breeder's and foundation seed; (c) technical guidance; and (d) can help the programmes by providing service facilities e.g., seed certification and seed testing, etc.

6. Choice of varieties—Only truly superior varieties adapted to the agroclimatic conditions of the selected area for seed production should be selected, and for which a cultivator demand exists, or is being generated through constant efforts.

Planning and Organisation of Seed Programme

One of the first acts in planning a seed programme is to determine its scope. Once the goals and scope of the programme have been established, the seed programme can be planned, developed on the basis of following general guidelines. No general plan and easy formulae, however, can be suggested to prepare the plan.

General guidelines for planning the seed programme

1. Decide the basic strategy and specific roles of the various agencies discussed earlier. Fix the targets of production on the basis of pertinent data and cultivator demand.

2. Calculate the production requirements for each seed generation i.e., breeder's seed, foundation seed and certified seed in terms of land required for seed production and total production requirements. This can be calculated by taking into account the seed rate per hectare, seed yield per hectare and total production requirements e.g., if the multiplication ratio is 1 : 25 the area under breeders, foundation and certified seed

should be in the proportion of 1 : 25 : 625 respectively. The total area required for targeted production should be four per cent of the production target fixed e.g., if the target is to produce 25,000 quintals of seed, the area required under seed production should be 1,000 hectares.

3. Keeping in view the basic strategy and roles assigned to various agencies prepare a flow chart of general production system to include where produced, by whom produced, by whom inspected, where tested, etc.

4. Work out the facilities and equipment needed for producing reasonably good quality seed. The principles studied in regard to production, drying, processing, storage and marketing should be kept in view while calculating the requirements of facilities and equipment. If the work is to be performed by several agencies, prepare a structural plan for each agency and calculate their requirement separately.

5. Work out the cost of equipment and structural facilities.

6. Determine the personnel requirement e.g., field personnel, plant personnel, laboratory personnel, administrative personnel, etc.

7. Chalk out seed marketing and pricing structures.

8. Prepare a schedule of production of clean seed for a four year period.

9. Prepare a detailed calendar of operations.

10. Detail any other anticipated special situation.

Necessary precautions in planning the programme

The plan for a seed programme should be prepared by a group of knowledgeable seed technologists, in coordination with other specialists (e.g. engineers) and agencies involved in the programme. After the blueprint has been prepared, it should be subjected to serious competent review before actual execution. Further, the plan should not be hastily made or made piecemeal.

Organisation of the programme

The organisation of the programme could be official, semi-official or private. In India, greater stress is being placed on organising seed programmes (seed corporations) as autonomous bodies (semi-official) registered under the Companies Act. The typical organisational chart for such a corporation has been

shown in Fig. 3.1

Various modifications in the above scheme can be made to suit the requirements of the programme.

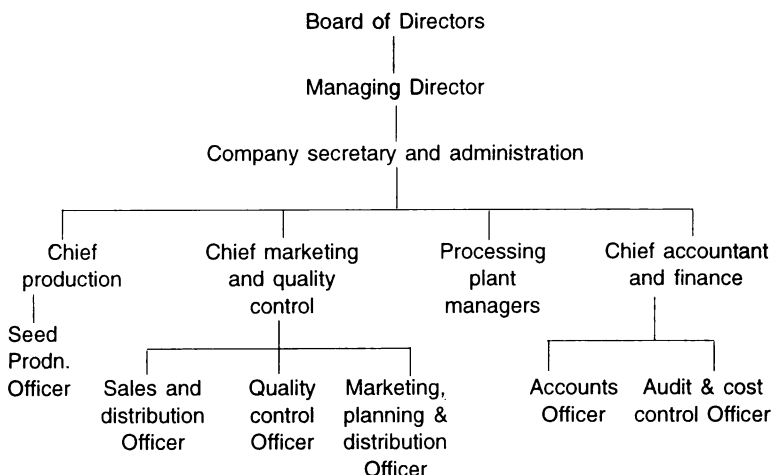


Fig. 3.1. Organisational chart of a seed corporation.

Problems experienced in developing seed programmes

Delouche (1969) described the following types of problems usually experienced in developing seed programmes.

1. Problems associated with planning and organisation.
2. Problems resulting from insufficiently trained personnel.
3. Technical and operational problems.

1. *Problems associated with planning and organisation.* The problems experienced in this group are:

Lack of coordination. Lack of coordination amongst various agencies involved in seed programmes often leads to the development of essentially rival programmes.

Faulty planning. What often happens is that an administrator or an adviser determines that a seed programme is needed. He assigns an agronomist/breeder to develop it and provide little or no further instructions. The agronomist/breeder gets the best advice he can, develops a plan and organisation and specifies facilities needed. Without serious competent review, the plan might be implemented, equipment purchased and facilities

developed. By chance these may or may not correspond to actual needs. Sometimes the Seed Programmes are planned by thumbing through equipment catalogues and preparing a list of equipment that looked like it might be needed. The important contributing factor to such faulty planning may be the lack of time for carefully considered planning.

Incomplete programmes. In many instances, a few elements of a seed programme are actively promoted, supported and highly developed while other remain unattended. In other instances, the various elements of the programme are unevenly developed, and the one least developed becomes a 'bottleneck' to further progress.

Conflicting advice. Seed advisers/consultants from the U.S.A. or West Europe are often associated with developing seed programmes in developing countries. Basically, the predominant philosophy among the U.S. advisers is that a seed programme ought to be developed primarily in the Private Sector, and that the competition and regulation of the type and validity of claims made pertaining to quality of seed marketed are sufficient to protect the interests of the cultivator. The seed philosophy of Western Europe is much more paternalistic and 'protective' as far as the cultivator is concerned. Private enterprise participation is permitted and even encouraged, but very tightly regulated. Certification regulations and seed marketing regulations are considered to be synonymous. Government agencies are assigned a leading role in seed production and marketing.

These differences in philosophy among advisers and consultants can be confusing and disconcerting to the workers in a developing country and may impede progress.

Non-concern about seed. Inability or refusal on the part of key officials and/or advisers to recognize that a seed programme can play an important role in agricultural development must be counted as one of the most frustrating of problems. Until this barrier is penetrated nothing can be done in the area of seed programme development.

2. Problems resulting from insufficiently trained personnel. Insufficiently trained, or untrained personnel contribute in a major way to many of the problems associated with the establishment of a seed programme.

The always complex problems associated with seed

programme/industry development become nearly hopeless when there are no trained, knowledgeable, experienced specialists around to guide the programme in the proper direction, and to ensure that a proper balance exists among its various elements.

Insufficient training of personnel is reflected in problems arising during planning, organisation, implementation and operation of the seed programme.

3. *Technical and operational problems.* In developing seed programmes several technical and operational problems are experienced, some of these are discussed below:

Tropical climates. The tropical and sub-tropical climates characterised by alternating wet and dry seasons, and by high temperatures and humidities, pose serious and difficult problems particularly in seed drying and storage. In such climates seeds are difficult to dry, deteriorate rapidly in storage, and may be severely infested with insects or destroyed by rodents, even before harvest. Devising solutions to these problems are not easy.

Facilities, equipment and repairs. Operations in a seed programme/industry require that seed production be concentrated in a few areas. This contrasts with the traditional methods of saving seeds, wherein 'seed production' is part of the grain production of each farmer and thus scattered over the whole area. Concentration of seed production in manageable units and at convenient locations results in rather large quantities of seed that have to be handled, dried, cleaned, treated and packaged in a short period and stored away. Traditional hand operations are simply not sufficient to properly handle the large quantities of seed produced. Sun drying is too risky and slow and offers too many opportunities for admixing. Thus heated air dryers have to be used. The other operations in a seed plant must be accomplished with efficiency.

The general unfamiliarity of labour, and other supervisory personnel, with seed drying, handling, treating and packing equipment and particularly with continuous flow mechanical operations and the management of the same constitutes a major technical problem. The only solution is training, specifically on-the-job training.

The manufacture of indigenous equipment suitable for the needs of the seed programme is very much limited. The equip-

ment, particularly for high capacity operations, has to be purchased abroad. This in itself is a major problem because of shortages of foreign exchange. Once the equipment is purchased and installed, operational maintenance and repair become problems. The red tape involved in ordering spare parts from abroad is such that it may take months and even years between the time an item of equipment breaks down and its repair.

Equipment used in the seed operations not only must be maintained but also be of the needed capacity and type. The seed plant with equipment of inadequate capacity or of the wrong type, is inherently inefficient and most often also ineffective. Poor quality seed is the result. Competent assistance should be obtained to determine equipment needs and to draft specifications for equipment to be ordered, or fabricated locally. A little forethought and extra effort will facilitate operations and allow for expansion.

Lack of competent supervision. The management and supervision of a seed facility are critical. The most modern facility and the best of equipment cannot compensate for deficiencies in management of supervision. Proper management and supervision cannot be effected from an office located in district headquarters, or even from a well appointed office in the facility itself. Nor, can it be exercised by administrative personnel, regardless of their seniority or experience in the Civil Service. Former British belief to the contrary, the civil servant is not automatically qualified for all positions. Rather, emphasis in the appointment of supervisors and managers ought to be on qualifications, enthusiasm and willingness to do a bit of manual labour when needed.

Small production units. One of the seed programme problems unique to many developing countries arises from the small size of seed production units. If the programme has to depend on contract producers, and the land holdings of the cultivators are small, then problems are unavoidable. Small production units are inherently inefficient. When the units are not located in a block, just keeping track of their location is a major task. The time and effort required for inspections is greatly increased, and the scheduling of harvest and delivery is never entirely satisfactory. Generally speaking, the larger the production unit, the more efficient are operations, and quality is more uniform and higher.

Another problem of small holdings is that seed are packaged in two, four, and six kilogramme bags. Packaging seeds in containers of this size, and handling and distributing them is not efficient.

Low quality seed. The end product of facility, technical and operational deficiencies is low quality seed. The cultivator who purchase improved seed, perhaps for the first time, expects it to look improved. Its cleanliness and overall appearance needs to be better than that of seeds he saves. By just looking at the seed the cultivator cannot see high yield potential, disease resistance, short stiff straw, high protein content, etc. He just sees seeds. And, if the seeds are badly weathered, insect damaged, mechanically injured and variable in size, etc., he might not purchase the seed, or if he does, he might discard them and plant the seeds he saved. Further, if the seeds are low in germination and fail to produce stand, his confidence in improved seed cannot but be totally destroyed.

The adversity of the climate in many countries works against quality seed production. But quality seed can be produced provided the producers, inspectors, technicians, and managers are knowledgeable and willing to put forth the extra effort.

There is no better or more effective promotional programme for improved seed than the production and marketing of an adequate supply of consistently high quality seed.

Marketing and distribution. After other operations in a seed programme/industry are going smoothly, seed marketing and distribution can become that main bottleneck in the programme. The various factors related to marketing and distribution problems have been discussed in Chapter 21.

Inexperience. Problems arising from inexperience, insufficient training, and relative unfamiliarity with operational procedures are unavoidable in any new programme. Some period of time is necessary before all the 'bugs' can be removed from the system and the personnel can become familiar with their tasks. Thus, only time, training and retraining, and close competent supervision can relieve the trials associated with the development of a new programme.

When personnel become well-trained and experienced, work well together, and perform their tasks efficiently every effort should be made to maintain the team. Rapid turnover of personnel impedes progress and should therefore, be avoided.