GROWTH REGULATORS AND CHEMICALS. Seed dormancy may be broken with the application of low levels of growth regulators and chemicals. Gibberellic acid (GA_3) and kinetins, potassium nitrate (KNO_3), thiourea, ethylene chlorohydrin, hydrogen peroxide, and sodium hypochlorite in low concentrations have proved very useful.

6.4 Seed production

New varieties seldom occur as a result of chance; they are usually produced by knowledgeable and skillful plant breeders, but the amount of seed produced is usually small, sometimes a handful of seed (Carter 1965). Seed obtained from selected individual plants of a particular variety needs to be purified and multiplied in such a way as to maintain its genetic purity. This handful of seed, called **nucleus seed**, provides the basis for breeding and production programmes. The varietal purity of prebasic, basic, and certified seed classes largely depends upon the quality of the nucleus/breeder seed.

Since breeder seed is the source for the initial and recurring increase of seed of a newly developed or introduced variety, it has to pass through several stages of multiplication to reach the level of certified seed. Certification begins with breeder seed and ends several generations later with **certified class** seed in a continuous cycle. Thus seed production is *limited* to a restricted number of generations from the original seed stock (breeder seed).

6.4.1 Breeder-seed production in self-pollinated crops

In order to maintain the genetic purity of a promising line, off-type seeds are removed by negative selection during mass increase. It is very easy to select good plants, check their progenies, and bulk the seed of those progenies which are pure and true to type. The seed thus obtained is called breeder seed. The method of producing it is explained below using wheat as an example.

Selection and multiplication.

1. SELECTION OF EARS

a. In a plot laid out for seed multiplication of a promising line, some 300–5000 ears are selected based upon the unique characters of the varieties.

b. These ears are threshed individually and examined for colour, shape, and size. Seed from any ears which are not true to type is rejected.

2. BREEDER-SEED PRODUCTION

a. A 3 m row is sown from the seed of each selected ear. This is called the 'ear row'.

b. About 300–5000 ear rows are sown per variety.

c. The ear rows are examined periodically, particularly at:
   i. Early tillering
   ii. Before ear emergence
   iii. At ear emergence
   iv. At dough stage (milky grain stage), and
   v. At maturity

   The characters to be examined and compared within an accepted range of variation are: Initial growth habit, auricle colour, waxy bloom on leaf/sheath/blade, colour of leaves, days to flowering, plant height, ear character, awning, density, colour, spikelets, and seed colour.

d. Based on these characters, ear rows which are segregating for one or several characters are rejected. Ear rows which possess the typical characters of the variety and show uniformity with regard to the aforementioned characters are harvested and threshed individually.

e. Each selected ear row (nucleus seed) is planted the following year in progeny blocks of 6 rows, 5 m long and 30 cm apart. Those progeny blocks which do not conform to the variety characters are removed. The selected progeny blocks are bulk harvested and threshed. This seed is called breeder/nucleus seed.

Planting and cultural practices.

A. LAND AND ISOLATION REQUIREMENTS

- Breeder seed should be raised on clean, fertile, well-prepared and levelled soil at an experiment station in the region for which the seed is being produced.
- Soil should be free from weeds, crops of the same species, seeds, or pollen transported by wind, water, or birds.
- The plot should have not produced the same species for at least two years. Distance between upland rice, wheat, and other crop species should be at least 2–3 m.

B. SOWING

- Breeder seed may be sown with a small-scale planter since production areas are small.
- The rows should be spaced 30 cm apart.
- The plants should be spaced far enough apart to allow them to express their characteristics.
- Dormancy will be a problem in seed such as freshly harvested rice when it is sown for prebasic seed production.

C. ROGUING

- **Roguing** means removal of contaminants—unwanted cultivars, other species, or weeds—from the crop. Seed production plots of breeder seed must be carefully rogued to remove any off-type plants or any admixture.
- Plots should be rogued before pollination.

D. HARVESTING/THRESHING. Breeder seed should not be harvested with large-scale equipment because of the smallness of the plots and poor cleaning of field-size equipment. Since every grain of prebasic seed is precious, threshing and harvesting must be done carefully by hand.

6.4.2 Prebasic, basic, and certified seed production

Prebasic seed is the progeny of nucleus/breeder seed, and is handled so as to maintain specific genetic purity and identity as completely as possible. Prebasic seed should be produced in the defined region (geographical area) of adaptation for that variety so that there is no change in the genetic and phenotypic stability of the population due to climatic pressure. It must be approved by the Federal Seed Certification Department.

Basic seed is the progeny of prebasic seed produced so as to maintain genetic purity and identity. It may be produced on extension farms, research farms, and by progressive farmers depending on the demand of the region of adaptation. The seed must be certified by the Federal Seed Certification Department.

Certified seed is the progeny of basic seed and is produced by registered growers of seed-producing agencies. Quality is controlled by the Federal Seed Certification Department.

Planting and cultural practices.

ISOLATION

- Isolation requirements must be in conformity with internationally accepted standards.

- The isolation distance for prebasic seed is greater than for basic seed; and that for basic seed is certainly greater than that for certified seed.
- Isolation is also important for the control of some diseases like loose smut on wheat and barley.

SOWING

- Sowing should be done in rows to facilitate roguing.
- Wider than normal spacings have given greater harvests of basic seeds.
- Fields for the production of certified seed are normally sown at the seeding rate recommended for that locality or country.
- Sufficient space between the rows should be allowed for the movement of the roguing party.

ROGUING. Roguing is an integral part of basic and certified seed production programmes.

- Roguing is more effective in small areas of production and uneconomical and less effective on the thousands of hectares required for production of certified seed. Maximum attention should therefore be given to roguing at the prebasic and basic seed production stages. The amount of roguing required later on will depend on how the prebasic seed plots were rogued. If roguing has been done carefully at the early stages, there should be little need for roguing in certified seed fields of genetically stable varieties.
- All distinct types of plants and weeds should be removed. For this purpose several rapid passes are more effective than one prolonged operation which aims at removing everything at one time.

HARVESTING

- A successful long-term, large-value seed programme cannot be based on animal power and manual labour. With basic and certified seed production in advanced countries, fields are large enough to allow the efficient use of combine harvesters.
- Precautions must be taken to prevent mixture during harvesting. Proper cleaning and adjustment of harvesters and threshers is essential.

6.4.3 Seed production in cross-pollinated crops

Inbred lines (pure lines) are genetically homozygous genotypes of species which are developed as a result of self-pollination (inbreeding) and selection for specific characteristics. Inbred lines of maize, for example, are developed

after at least five successive generations of controlled self-pollination, following selection from suitable but diverse open-pollinated varieties, composites, synthetics, or multiple crosses. After developing inbred lines with consistent desirable characters, the maize breeder evaluates them in various hybrid combinations in yield trials.

Production of single-cross seed. Single-cross seed is the first generation (F_1) which is produced by the controlled crossing of two inbred lines. The male and female are selected on the basis of their superior combining ability, vigour, height, flowering period, pollen-producing capacity, ear placement, and yield. It is desirable that the male parent be taller and a good pollen producer, while the female parent should be vigorous and high-yielding. If the male is designated as 'A' and the female as 'B', then the single-cross is designated as 'A × B'.

Single-cross seed may be used as (a) certified seed, or (b) parent components for the production of certified seed of three-way and double crosses.

Production of three-way cross seed. Three-way cross seed (hybrid seed) is produced when a single cross (A × B) is crossed with another inbred line C. The A × B should be used as female and the C as male, provided it is a good pollen producer which synchronizes with silking of the female. The single-cross seed (female parent = A × B) is planted in six rows while the male parent (inbred line = C) is planted in two rows (Fig. 6.3.). Produce from the detasseled female parent is commercial seed of a three-way cross.

Double-cross seed production. The production of certified seed of double-cross hybrids is based on crossing two single-cross hybrids, one of which serves as seed parent (♀) and the other as pollen parent (♂). These parents are selected on the basis of their combining ability and coincidence of flowering period, height, pollen-producing capacity, and yield. This method has certain advantages: (1) minimum risk involved; (2) high yield of seed per unit area; and (3) lowest production costs.

In this method the male:female ratio should be 1:3 or 2:6, or 2:8. The other procedures and requirements are the same as for single-cross seed production, i.e.:

- Satisfactory isolation.
- Timely removal of off-type and doubtful plants, with both the parents.
- Regular detasseling of the female parent before pollination.
- Inspection of the crop during the growing season and roguing of diseased plants before pollination.

Seed production of open-pollinated varieties (local and introduced), synthetics, and composites is carried out with the idea of maintaining most of the characters for which these varieties are grown for as long as possible. For each such variety, true-to-type ears are selected in the field. These ears are shelled and the seed is divided into two groups. Seed from the two

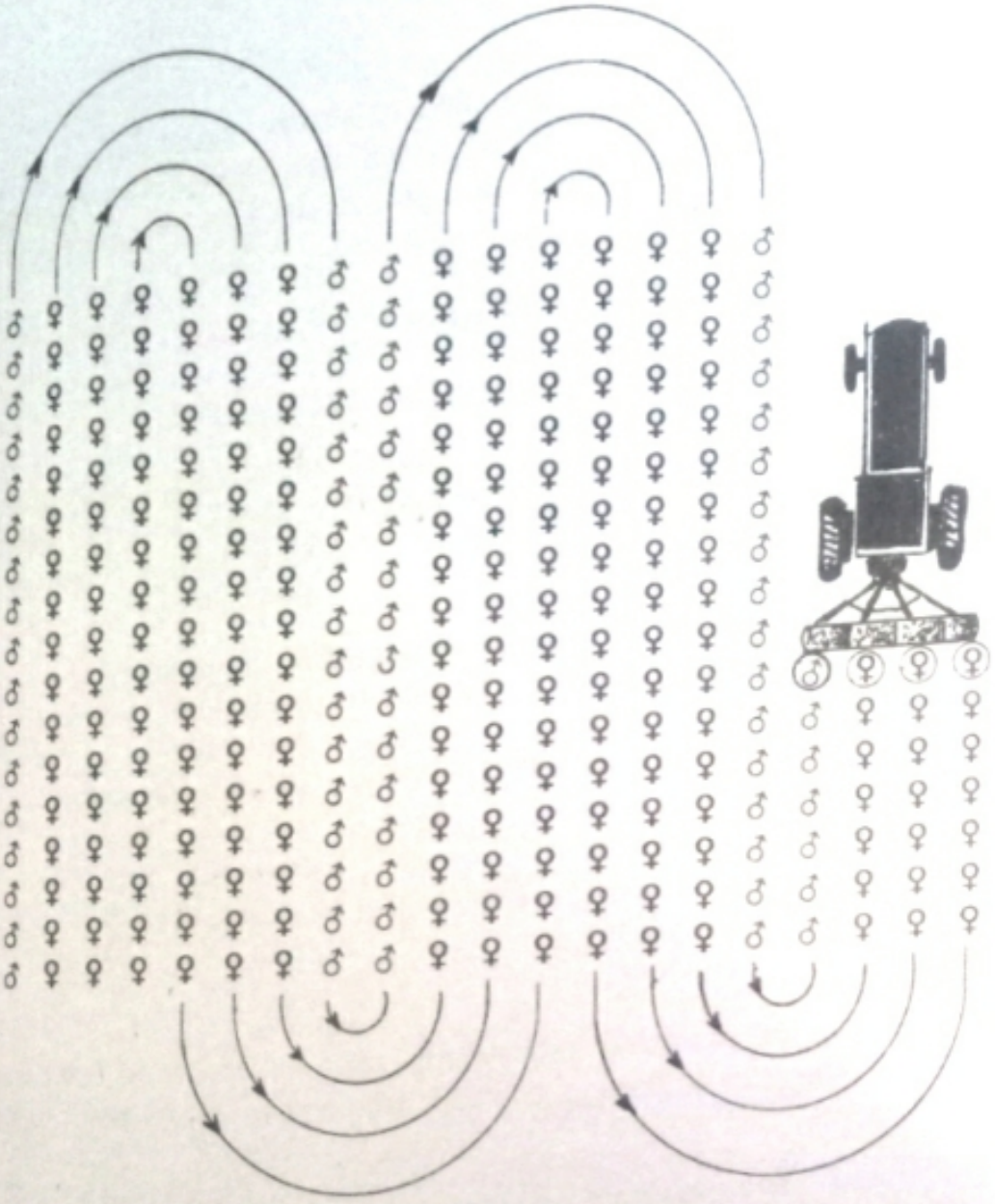

Figure 6.3 Example of 6:2 ratio of seed-parent to pollen-parent rows. After Feistritzer (1982:67).

groups is planted in alternate rows. Fifty of the plants are detasseled before pollination, preferably all the plants in every second row, and only the detasseled rows are harvested for seed.

During the process, all the necessary steps for the production of certified seed (prebasic or basic seed) are taken, i.e. isolation of plots (250 m), and roguing of diseased, off-type and low-yielding ears. The bulk of this seed is prebasic seed and must be used in seed production programmes.