Chapter 2

Maize Hybrid Seed Production

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Hybrid varieties

- Hybrids are the first generation offspring of a cross between inbred line parents, openpollinated varieties and other populations used for commercial planting.
- The greatest development of hybrids has been the use of inbred lines.
- Inbred lines are developed by several generations of inbreeding followed by tests for combining ability.

Two important characteristics of hybrids are their high yields due to hybrid vigor, and outstanding uniformity.

- To ensure the purity and uniformity that hybrids are known for, their seeds must be produced under special care.
- Seeds harvested from a field planted to hybrids must not be saved for use in planting in subsequent seasons as such practice will result in substantial reduction in yield and non-uniformity.

Hybrid varieties (Cont'd)

- **Hybrid types differ in:**

– yield potential,
–uniformity,
–number of plantings (seasons) needed for seed production,
– potential seed productivity,
–cost of seed production and seed sales price.

When maize is self-pollinated, each generation becomes weaker.

- **Self-pollination is the process of taking the pollen from a single plant and applying this to the silks of the same plant (inbreeding).**
- **Successive generations of inbreeding leads to weakened plants called inbred lines.**
- **Inbred lines are small in size, have small cobs and reduced yields.**

Hybrid varieties (Cont'd)

- When two inbred lines are crossed, the vigor is restored in the resulting seed, and the yield of the plants grown from the seed is greatly increased (heterosis).
- Heterosis has been exploited to develop hybrid cultivars that are now widely grown by farmers.
- Hybrid vigor occurs as a result of the interaction between the sets of genes obtained from the two different inbreds.
- The effect of some of the harmful genes expressed in one of the inbred lines will be masked by more beneficial ones found in the other parent plant (heterosis).

The characteristics of hybrid maize

- It is uniform in appearance
- It has vigour
- It is high yielding
- A particular hybrid can be selected for specific pest and disease resistance or drought tolerance.

Types of Hybrids

- Crosses between males and females can be made in four different ways to give rise to different kinds of hybrids:
- Single-Cross Hybrids (A x B)

–Crosses between two unrelated inbred lines.

–A field planted with single-cross seed is impressive because plant height, ear height, tasseling, silking, pollen shedding and all other characteristics are extremely uniform.

Three-Way Cross Hybrids (A x B) x C

- Three parents are involved in three-way cross hybrid formation.
- The female of a three-way hybrid is a single-cross hybrid (AxB), while the male is an inbred line (C).
- Three-way hybrid seed is produced on single-cross plants so that yield and quality may be equal, or nearly so, to double-cross hybrid seed.
- Three way crosses are more variable than single crosses and less variable than double-crosses.
- Advantages and disadvantages of three way crosses are between those of double and single crosses.

Advantages of Double Cross Hybrids

– Double cross hybrid seed production is a practical and economical way of producing adequate seeds for farmers because both parents are hybrids.

– They are also more variable than single or 3-way crosses thus allowing breeders to bring more different desirable characteristics together into one hybrid than is possible in a single cross.

Double cross plants have a longer pollination period, a condition that tends to provide more complete filling of the ear with seed, often resulting in higher yields.

• Double cross hybrids have a lower seed cost advantage because their yield is equal or better than the best single crosses.

Double- cross hybrids are produced by crossing two different single crosses, giving the pedigree [(AxB)x(CxD).].

Disadvantages of Double Cross Hybrids

Fields of double-cross hybrids do not possess the “eye appeal” of single cross hybrids because the plants and ears tend to be more variable and they may be more difficult to obtain a high level of disease and insect resistance compared to single-crosses.

Top-Cross Hybrids

- one of the parents is an open-pollinated variety and the other is a single-cross hybrid or an inbred line.
- Top- cross hybrids are very useful at the initial stages of hybrid seed production when seed companies are still learning the rudiments of hybrid seed production

Hybrid Seed Production

- **Hybrids are chosen based on performance, disease resistance, drought tolerance, and days to maturity.**
- **Hybrid seed production must be strictly monitored in order to avoid contamination.**
- **Male and female parents are inter-planted in alternating rows.**
- **There are normally 3 to 6 female rows and 1 or 2 male rows.**
- **The female plants are de-tasseled before they shed any pollen.**

Inspectors check to see that all emerging female tassels are removed and that neighboring maize plants are at least 400 m away.

- **This is to ensure that pollen from nearby crops do not fall on to the silks of the female plants.**

Hybrid seed production (Cont'd)

Female plants are fertilized by pollen that comes only from the male plants.

- **Once the male plants have provided the pollen, they are removed from the field to ensure there is no mixing of seed between the male and female plants.**

It is important that the male and female plants flower at the same time and that the pollen is shed from the male plants when the female silks are receptive, in order to produce a maximum amount of seed.

- **This is called nicking**

Stages in commercial hybrid seed production

Production of the Breeder

- The breeder selects and produces the seed for the inbred lines.
- Breeder seed is used for foundation or basic seed production.

Production of Foundation or Basic Seed

- Foundation seed is the first multiplication of the breeder seed (inbred lines).
- This is also the stage in which the single-cross hybrid will be produced for the three-way or double-cross hybrids.
- Enough seed of the parents should be produced in order to produce the hybrid seed.

Production of Certified Seed is the last stage in seed multiplication.

- Seed companies usually contract approved and capable farmers to plant the foundation seed to ensure: – genetic purity –to produce enough seed for the farmers.

Stages in commercial hybrid seed production (Cont'd)

- Throughout the production of hybrid seed, the seed company and the seed producer have to adhere to strict but standardized certification standards.
- The seed fields are constantly checked for:
  - –isolation,
  - –off-types and purity,
- Harvested seed is verified for defects, adequate germination rate and freedom from pests and diseases. Any crop that fails to meet the standards is rejected and may not be sold as seed.
- Seed that has been certified by the authorizing agency is labeled accordingly and may be sold.

Advantages of Growing Hybrid Maize

- Hybrids are generally higher yielding than openpollinated varieties, if grown under suitable conditions.
- Hybrids are uniform in color, maturity, and other plant characteristics, which enables farmer to carry out certain operations, such as harvesting at the same time.
- The uniformity of the grain harvested from hybrids can also have marketing advantages when sold to buyers with strict quality standards.

Disadvantages of growing Hybrid Maize

- Hybrid seed is more expensive than open-pollinated maize seed.
- The farmer needs to have yields of 3-5 t/ha in order to justify the cost of the seed.
- Farmers situated in a low potential environment and who cannot afford extra inputs such as fertilizer will not recover the costs of the hybrid seed.
- Fresh hybrid seed needs to be bought every planting season.
- The farmer cannot replant grain as seed without major reductions in yield, which might be a decrease of 30 % or more.
- The farmer might not always be able to source new seed in time for the planting season.

Choice of Parental Lines

- Several factors have to be taken into consideration in choosing the parental lines of commercial hybrids :

–Parental lines must have good pollen shed-silking synchrony.

–For this, accurate assessment of days to tasselling and silking of the parental lines is required.

Inbred lines that shed pollen a few days after the silking of the female lines may be suitable for use as male parents.

- The male parent should be as tall, or taller than the female parent for effective pollination under isolation.
- For three-way crosses, vigorous inbred lines with good pollen production should be used as the male line while the single cross is used as the female parent

Number of Female to Male Rows

- Seed is harvested from the female parent.
- Therefore, the number of rows of the female parent is directly related to seed yield.
- The number of female to male rows depends on:

–the type of hybrid to be produced,

–pollen production potential of the male parent

–duration of pollen supply by the male parent.

- If detasseling is practiced, it is desirable to plant male rows around the field to minimize contamination from neighboring fields.