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Commerical Plant Breeding in Vegetables and Outcomes

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ABSTRACT

Demand-Led Plant Breeding is an emerging approach that enables Plant Breeding to develop higher performing varieties/hybrids that meet customer requirements on time and as market demand. Developing the objectives of Plant Breeding progograms requires the breeders the breeders to get an absolute clarity on the various traits he/she is planning to incorporate in new varieties/ hybrids. Several aspects of the traits are to be considered plant breeding goals and targets depend on the company's, business strategies, opportunities, and several other considerations. The plant breeder is at the core of these planning exercise, and is also the person responsible for delivering these objectives Designing of objectives of plant breeding programs are different in public and in private plant breeding programs. The goals and objectives are to be set with SMART target and the performance indicators, which are clearly definable and measurable. During this process, crop breeding aims either to exploit maximum of hybrid vigor or least compromise with hybrid vigor when another trait is commercially more relevant.

Keywords: Plant breeding, Commercial, Public, Private, Varieties

INTRODUCTION

Designing Plant Breeding programs would require a deeper understanding of developments in the science of plant breeding in a historical perspective. Humans moved from their hunter-gatherer stage to settler's stage, and from settler's stage to a life when conventional agriculture started. Evolution of plants have happened both with and without human intervention during these phases. Plant Breeding took on a scientific base once Mendel enunciated the laws of genetics. The biotech breeding era started when the molecular structure of DNA was discovered by Watson and Crick in 1953, and achieved a historical milestone in 1990 when the GMO was released for commercial usage. In general, plant (crop) breeding refers to the scientific approach of selection and crossing of plants and integration of cutting-edge tools and technologies to carry out a "targeted" crop improvement for a single trait or combination of traits.

Research and Development in Private seed industries focuses on targeted-plant breeding of a given crop as it is crucial for the commercial subsistence of the product to thrive in the competitive market scenario. By using the term target, I try to convey the "needs" of farmers and consumers that largely varies geographically and with usage (*viz.* as fresh, processed etc.). From nursery to the market, it takes a team-effort and economic use of resources so that right product reaches to farmer's field addressing several issues and the targets. With the setup of first private seed company (Mahyco) in India during early 1960s and since then, practice of subsistence farming steadily shifted to commercial farming in field crops, vegetables, flower/medicinal and forage crops for which hybrid and open pollinated varieties (OPVs) have had a major role. This was possible due to government's progressive policies, advancements in plant research, more investments, increased per capita income and consequently increasing consumer's demand. Hybrids and OPVs having commercially viable traits released by different seeds companies provides the farmers with more stable production and income. Since, four decades, the seed industry has steadily grown such that there are about 150 seed companies in Indian market serving Indian farmers with their innovations and technologies of plant breeding. Presently, seed industry in India of worth Rs. 310.7 billion (as per 2018 report) stands at fifth position in world's seed market while the share of seed market for vegetables is only Rs. 40 billion (as per 2018 report) that is expected to double in the next five years to be around Rs 80 billion worth by the year of 2020 [1].

COMMERICAL PLANT BREEDING

Selection criterion for parents and selection methods

Selection criterion and selection methods are critical stages in ant plant breeding program. They define the success of the program in the long term. Selection criterions are defined in terms of the combination of traits required in the end product. These include yield,

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yield stability, quality, resistance, special adaptation traits, etc. The selection methods are determined based on whether the breeder is selecting in the existing variability or selecting after creating new variability. The selection methods like pure line and mass selection, pedigree selection, bulk breeding, SSD, back cross selection, recurrent selection and clonal selection are used in breeding programs in different situations [2].

Heterosis and inbreeding depression

Heterosis is one of the most effective phenomenon's which has delivered historical progresses in crop improvement. The basic idea of hybrid vigour, which is the external manifestation of heterosis, the genetic phenomenon behind increased vigour and yield, was enunciated by GH Shull more than a century back in maize. The main goal of hybrid breeding, which brings together two divergent inbred lines, is to exploit heterosis. Hybrid breeding involves development of inbred lines, usually derived from opposite heterotic pools. Hundreds of hybrids are tested every year in hybrid breeding programs over a range of environments to identify those hybrids which exhibits environmental stability. Inbreeding depression is the opposite of hybrid vigour, due to much there is loss of vigor, yield resistances, etc on continous selfing or sib mating in naturally out coming species, due to increase of homozygocity. Heterosis restores the loss of vigour due to inbreeding depression. In different crops, different heterotic pools are indentified, which when crossed between them gives heterosis. In developing hybrids, heterotic pools have to be kept in mind and lines have to be developed in opposite pools. In those species, where male sterility system is used, usually heterotic pools are positioned on female and male sides. The commercial hybrids today are single crosses, three-way crosses, and double crosses. The male sterility system is the bed rock of hybrid breeding as it facilitates seed production on a large scale.

Designing and layout of crossing blocks, and breeding nursery management

Crossing blocks and Breeding Nurseries are integral parts of all breeding programs which get planted every season after a lot of planning. A crossing block is an area where parental lines are planted and pollinations made to produce crossed seed for further testing and new breeding crosses are made for further breeding work. A breeding nursery is an area where segregating material, stabilized lines, test cross hybrids, first time observation hybrids, newly introduced line, etc., are planted to observe and make selection in them. To generate new breeding material, specific mating designs are used which create new breeding population to work with in further seasons. Important mating designs used are Bi-parental mating, Triple test crosses, pure line progenies, NC designs 1&2, Diallel mating design, etc. Lot of planning is involved in finalizing the details of crossing block and breeding nurseries taking into account practical consideration and breeding requirements [3].

Data management and interpreting results

Plant Breeding routinely involves collecting varying types and quantities of data from different sources spread over time and locations. Data is collected in labs, fields, storage locations, trail sites, etc. Data is also imported from other external sources. Data, generally, includes Pedigree=Parentage+Selection history, Traits measurements- over seasons and locations, field plantating plans & Label Printings, Crossing lists, Seed stock records, Trails management, Statistical analysis, Trials- single site, multi- year multi-site analysis, Genomics- Markers, Traits assays, Traits transfer tracking, etc. Data, in well-established Plant breeding programs, are routinely handled by plant breeding software's, which brings in high levels of efficiencies and time savings. They also avoid human mistakes in data handling. These software are available both as generalized or customized versions. One such publicy available software is used to explain the intricacies of data management in plant breeding.

Regulatory approvals

Seed businesses in India, like in all countries, operate under the ambit of number of regulation. These regulations are defined in various Acts, Rules, Order, Notifications, Policies, etc enacted by the Central and State authorities. These are regularly modified to suit the emerging needs of the seed business environment. Hence, keeping abreast of the latest in the area of regulations is compulsory for any plant breeder. Approvals are required for varieties, hybrids, lines, population, etc and for their seeds to be sold commercially. An approval for sale of seed is required at the State as well as Central level. Approvals are required, also for the R&D facilities, both from state and central levels. In addition, the plant breeder should be aware that he or she is creating an Intellectual Property, which has legal recognition today. While several forms of IP are legally recognized in India, Plant Varieties (Plant Breeder's Rights and Farmer's Rights), Geographical Indication, Patents, Copyrights etc, are some of the forms of IPR, which the plant breeder will be working with in the profession.

VEGETABLE OUTCOMES

Looking at the contributions of commercial plant breeding and product development efforts especially in vegetables, traits of interest mainly depend on the interest of farmers such as pest and disease resistance/tolerance, better shelf life for transportation and offseason sale ability fetching better price, enhancement of nutrition and quality parameters. The most important of all being increase in production due to higher yield in response to per unit application of input, thus farmers realizing higher profit per unit of their investment. There are interesting achievements of efforts of commercial crop breeding programs and product development, notable being: availability of crops [4].

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Hot pepper

Chilli/hot pepper hybrids have been in the market that have requisite color and pungency depending on the requirement as table purpose or for different processing industries, aesthetic shiny fruits, dandi-cut types, most hybrids having resistance to powdery mildew and tolerant to viruses. Also, there are pepper hybrids high in demand because of early yielding, fetching good price in the market and escape the infestation of pests and diseases [5].

- India hybrid vegetables market value:- 3300 crore INR
- CAGR growth in value @ 8%
- Chilli production India contributes 38%
- Chilli F1 market value- 313.8 crore.

Okra

Okra hybrids that are tolerant to OELCV and YVMV, multiple pickings, fruit availability throughout the year, new hybrids being lined up that have purple pigmentation having anti-oxidant properties:

- Okra Market value Hybrids & OP
- 500 crore market value in okra (hybrids)
- 247 crore market value in okra (OP).

Tomato

Tomato hybrids are available throughout the year especially in summer season because they are tolerant / resistant to pest and disease infestation, firm fruits suitable for long distance transportation and long shelf life, delayed ripening quality. There are tomato hybrids that are categorically suitable for different purposes such as for salads, curries preparation, processing etc.

Current tomato seeds market-2000 crore-3000 crore

- Segments-Flat rounds summer (30 MT), Oval rainy (18 MT), Flat round (20 MT) and Oval / square round summer (08 MT).
- It was suggested in meeting that again segments should be divided according to the determinate / indeterminate.

Cucurbits

Among the Cucurbits, watermelons with high brix value are available in different shapes, size, rind pattern and the most popular one being sugar baby for nuclear family consumption. There are muskmelon and watermelon products that are sweet, crispy flesh and available in different colors. Breeding for gourds such as luffa and bitter gourds have contributed to development of hybrids that are suitable for different locations, available in different shapes and length, and where flowering types have been wisely exploited. Gourds 8% seed market value in India [6].

Appreciation to pioneering work is private seed companies that have introduced sweet corn with high brix value and high sugar retention properties that are delightful to taste buds.

Cauliflower

Research in cauliflower has made it possible to grow throughout the year unlike earlier when it was considered only a winter (cole) crop.

In some vegetables such as peas, spinach etc. where we rarely get heterotic vigor from crossing, OPVs are popular too sold by seed companies and opted for by the farmers than their own saved seeds because OPVs are comparatively more uniform, have unique traits and are high yielding.

CONCLUSION

Many more examples can be added to the outcomes of systematic, market-oriented crop improvement activities of private seed companies and the list will continue to grow till challenges will come to the farmers, currently the most important ones to be addressed are climate change effects, occurrence of new pests and diseases due to mutation- a continuous process, improvement in fruit qualities etc. we are committed to fulfill farmer's expectation by offering them with products that earns more return with every unit of their investment.

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