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Organic Breeding: Next Generation Breeding Approach to Improve Crop Varieties for Organic Farming

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Introduction:

The organic farming system differs fundamentally from conventional agriculture techniques in the management of soil fertility, weeds, diseases and pests. Most of the organic farmers use varieties supplied by conventional seed companies which are suitable for farming systems which widely utilize artificial fertilizers and agro-chemicals. Organic farming, however, refrains from use of agro- chemical inputs and applies agro – ecological strategies for production. Since, organic agriculture is not just product oriented but also a production controlled agricultural production system, apart from the ecological characteristics of the varieties, the process of breeding and propagation of these varieties in relation to the principles of organic agriculture is also very important. In that context, IFOAM (International Federation for Organic Agricultural Movements) gave the concept of organic plant breeding.

Organic Breeding: An Integration of Culture and Nature

The prevailing farming systems are required to be sustainable and multifunctional while focusing on regional development and biodiversity. This explains the increased focus on organic agriculture. Organic agriculture is a sustainable and environment friendly approach.The three criteria of organic production are closed production cycles, natural self – regulation and agro – biodiversity which are applicable to farm functioning. Accordingly, at the plant level, the criteria for organic plant breeding include preserving the integrity of the plant by taking into account the natural reproductive ability, ability to adapt independently to the environment by assessment of interactions of the plant with the living soil and climate, and increasing the genetic diversity with respect for natural species authenticity and species characteristics and respecting the crossing barriers. The compatibility of the breeding techniques which result in production of genetic variation for selection and propagation with

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organic farming has been central to any discussion on breeding varieties suitable for organic farming. Modern techniques like genetically modified organisms (GMOs) where isolated DNA is exchanged within or across species are excluded from organic farming as it does not occur under natural conditions. Other techniques like protoplast fusion, in vitro propagation, induced mutations and hybrid breeding are critically being discussed for development of varieties suitable for organic farming. The complex nature of the modern breeding techniques may cause a great amount of apprehension by consumers and farmers alike who are the collaborators of organic farming. However, it is quite true that without the modern breeding techniques, the organic farming sector will not be able to take part in the breeding progress making it unable to compete with the growing challenges of sustainable food production. Therefore, it is important to define certain criteria which would ensure and objective and transparent assessment of the current as well the developing breeding techniques in the light of the principles of organic cultivation. It is required that an adapted organic breeding approach must include the techniques of production and development of improved varieties without violating the ethical and ecological principles of organic farming.

Requirements for Organic Farming:

One of the foremost requirements of organic farming is breeding programmes focusing on specific needs and objectives of organic agriculture and in accordance with the cultivation methods of organic agriculture in order to increase the efficiency and yield stability in the production of organic food. Other than this, numerous regionally - adapted cultivars should be developed in order to fulfill the necessity of growing wide range of crops suitable to the heterogeneous environment found in organic farming systems with regard to field conditions, crop rotations, marketing options etc. These varieties must also have sufficiently high and stable yields obtained by exploiting minimum resources and better quality in terms of nutritional requirements. Varieties for organic farming must have other additional features like:

- ✓ Resistance to soil and seed – borne diseases and pathogens
- ✓ High weed tolerance and suppression
- ✓ Good lodging resistance for longer plant heights
- ✓ Rapid development
- ✓ Increased nutrient use efficiency

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- ✓ Quality related traits

Aims of Organic Plant Breeding:

- ➢ To formulate breeding goals that aim at the sustainable use of natural resources and at the same time maintain equilibrium in the agro-ecosystem.
- ➢ To satisfy nutritional and quality needs of the society while accounting for sustainable food production.
- ➢ To sustain and improve the genetic diversity of crop plants thereby contributing to promotion of agro-biodiversity.
- ➢ To develop crops adaptable to future growing conditions like climate change.

Choice of varieties in organic farming:

At present, any variety whose seed of propagating material has been produced under organic growing conditions can be used for cultivation in organic agriculture, the only exceptions being the varieties which have been declared as genetically modified varieties. In case of absence of any suitable variety from organic agriculture, conventionally developed varieties can be allowed to be used for propagation. Varieties used for organic farming can be distinguished as:

1. Varieties obtained through conventional breeding that are suitable for organic farming i.e., conventional breeding organically propagated or untreated except the genetically modified varieties.
2. Varieties developed through product –oriented breeding for organic farming by giving special attention to breeding goals or selection environments for organic farming and organic seed propagation.
3. Varieties developed through process – oriented organic plant breeding by focusing on breeding the varieties under organic farming conditions.

Varieties which are currently being used for organic farming are mainly derived from conventional plant breeding programmes. However, this practice or series needs to be replaced for certain crops like cotton, soybean and corn where genetic engineering is frequently exploited for crop improvement and also in crops like broccoli or cauliflower where breeding is exclusively focused on male sterile hybrids obtained by cytoplast fusion. For these crops, the choice of varieties for organic farming is already severely limited and this along with the monopolisation of few major crops on the seed market, concentration of

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breeding efforts to major crops and dominance of conventionally propagated seed further restrict the range of varieties for organic farming.

Plant Breeding Approaches & Techniques for Organic Farming:

Some of the breeding techniques which have efficiently been used for production of conventional varieties can also be used for production of organic varieties. Modern plant breeding approaches like genetic engineering, cytoplasm male sterile hybrids without restorer genes, protoplasm fusion, radiated pollen and induced mutations are forbidden for production of organic varieties as these violate the natural barriers to reproduction and affect the integrity of the plants though techniques like embryo culture, ovary culture and in – vitro pollination may be exploited in future. Some of the permitted techniques for organic agriculture are (Patil and Pawar, 2013):

1. **Hybrids:**In organic breeding, hybridization as such can be permitted, provided that the F1-offspring is fertile and the parent lines can be propagated under organic conditions.
2. **DNA marker assisted selection:**DNA marker assisted selection can be permitted in an organic breeding programme, if DNA screening is performed without enzymes originating from Genetically Modified Organisms (GMOs) and without radiation or chances of mutation.
3. **Meristem culture:** It can be used in certified organic breeding programmes, because it is considered as being close to classical and conventional breeding techniques.

Future Thrust:

With the increase in areas under organic agriculture, the need for organic seed production and organic breeding would continuously grow in order to fulfill the seed requirements of organic growers. There is now a growing interest and awareness towards breeding for organic products but the form of breeding to be followed is still an emerging concept. There are three distinct forms of plant breeding, formal, farmer and participatory (Don Burgett, 2004).

1. **Formal breeding:**Formal breeding consists of approaches which can be either public or private and are conducted by professional scientists with the aim of releasing new varieties suitable for organic market. In this breeding approach, the farmers do not

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have any real decision making power as they may or may not be involved in the evaluation of these varieties.

2. **Farmer breeding:** In this breeding the main focus is on seed saving as the farmer select the seeds of desirable qualities for future planting. The essential varietal makeup is maintained through mass selection and some occasional selection may occur.
3. **Participatory breeding:** Participatory breeding is the combination of both formal and farmer breeding in which collection with conservation of germ plasm, data collection, design, distribution and its evaluation processes follows. The advantage comes as the ability of the variety to adopt in whole farming systems and regional conditions with ensuring farmers involvement in shaping the germ plasm based on experiences with connecting crops and consumer market with each other.

Conclusion:

Organic agriculture is a multidisciplinary concept and its approach is from agro ecological, non-chemical ways in which variety improvement play an important role for organic production on its large that can be one sustainable business and is integrated in scientific discipline. Organic agriculture has emerged as a challenge and provides the scope for the researchers to develop new varieties that can be adopted in all farming systems and ensure better productivity for the crops with higher return value. The main aim is to reduce external inputs, lower cost of cultivation and better profit optimization.

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