**ORGANIC PLANT BREEDING**

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**ABSTRACT**

Currently, organic farming is subject to plant and animal products that have been developed for non-organic farming and that are often not suitable for organic farming. This condition is unreliable with a holistic approach to organic agriculture. To develop the potentials of organic agriculture and its integrity, organically bred plant varieties are needed. A novel approach to breeding for organic production has also been started now at global plate form. Further development needs a parallel approach to animal breeding for organic systems as both are interlinked.

**INTRODUCTION**

Organic/biodynamic farming differs from non-organic in a way that it aims to maximize dependence on naturally occurring biological systems which are less important in non-organic agriculture, as it is highly dependent on synthetic, external inputs and misuse of biological material at all levels. A foremost consequence of this difference is that the varieties of plants and animals best suited to this two approaches are significantly diverse. An apparent example is concerning weeds, which, in organic farming are considered as non-crop plants with some positive contributions; such plants are controlled by crop competition or by mechanical means. In non-organic farming, the positive contributions are considered less important and weeds are usually controlled rigorously by herbicides. Variety trials should be carried out under organic conditions to isolate varieties that are better suited to the needs of organic farming. This approach is helpful in the short term, but cannot allow a full expression of the potential of organic production systems because of the specific constraints of non-organic breeding programs. In the longer term, therefore, it is vital to improve varieties and populations that are bred and selected under organic conditions. At present, organic production cannot be regarded as wholly organic while the major tools in use, plant and animal varieties, are developing under non-organic conditions, often using technologies that do not fit well with organic principles.

CONCEPT OF ORGANIC PLANT BREEDING

The model of organic breeding is comparatively new and less established than the concept of participatory plant breeding. Organic agriculture is purely agricultural production without the use of synthetic inputs (e.g., pesticides, fertilizers, herbicides). To accomplish this, organic farmers apply agro ecological principles that promote the self-regulating capacity of the agro ecological system (i.e., self-regulation of the soil, plants, and animals).

CHARACTERISTICS FEATURE OF ORGANIC PLANT BREEDING:

* Organic plant breeding produces both commodities and non-commodities output for the public sector such as animal welfare and livelihood for farmers.
* It also shown the ecological perspective.
* Organic plant breeding is improving soil health, soil structure, micro-organism density in soil (flora and fauna) because, we do not apply any synthetic chemicals and any inorganic product such as insecticide, pesticide, etc.
* Its product has good marketing value.
* Farmer’s practices diversification by producing different commodities for crop and ecological aspects.
* In many places where organic plant breeding is continuing to apply, numerous bees participate in pollination to crops in larger areas.
* Furthermore, diversified crop rotation or mechanical weeding has a positive effect on the species diversity of organic farms.
* Not all taxonomic groups and some crops profit from organic plant breeding, but maximum variety exhibit production in organic plant breeding.
* Traditional farming depends on chemicals fertilizer, herbicides, and pesticides is caused the environmental hazard. The result of the non-application of chemical based fertilizers on organic crops, which leads to nitrogen leaches from crop fields to soil zones that could decrease the quality of underground and drinking water.
* In organic fields, there are no excessive nutrient elements like phosphorous and potassium that could increase their efficient use in further crops.
* In organic plant breeding continuing use of organic products to enhance soil fertility in which it does not deteriorate the physical property of soil and does not affect micro-organism such as fungus, bacteria, earthworms which is built to the soil. There is much more evidence to enhance soil property through organic plant breeding.

NEED FOR ORGANIC PLANT BREEDING

Organic plant breeding is a fairly new concept of crop improvement. Currently, organic crop producers depend on seeds and other propagules that are developed by conventional breeding procedures. If the integrity of an organic production system is to be maintained, the planting material used to initiate production should have an organic origin. There are numerous motives why organic breeding is desirable to service the organic production industry?

1. GM crop varieties are not allowed in organic crop production. Though, the trends in the production of some crops are to practice GM seed or other materials. we should focus to develop non-GM varieties for organic production.
2. Crop cultivars suitable to organic production are dissimilar from those suitable to conventional production. Successful cultivars should be adapted to specific soil and fertility conditions, be disease - and insect pest resistant, and be competitive against weeds. Organic producers depend on the natural fertility of the soil to a great extent, hence the necessity for cultivars that optimally cooperate with prevailing conditions. Crop cultivars with architecture and structure that decrease disease incidence are desirable.
3. There is a necessity to preserve the reliability of plants. Conventional plant breeding methods sometimes disrupt natural barriers (genetic engineering, wide crosses) and consequently the integrity of plants.

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| Aims of organic plant breeding | |
| * The breeding goals match the respective crop species and the needs of the complete value chain of the organic sector (producers, processors, traders, and consumers). * The breeding goals aim at the sustainable use of natural resources and at the same time account for the dynamic equilibrium of the entire agro-ecosystem. * Organic plant breeding supports sustainable food security, food sovereignty, secure supply of plant | products (e. g. fiber, medicine, timber) and the common welfare of society by satisfying the nutritional and quality needs of the animal and human beings.   * Organic plant breeding sustains and improves the genetic diversity of our crops, and thus contributes to the promotion of agro-biodiversity. * Organic plant breeding makes an important contribution to the development of our crops and their adaptation to future growing conditions (e. g. climate change). |

REQUIREMENTS FOR ORGANIC FARMING

For efficient and sustainable production of food under organic conditions, both varieties and cultivation methods must be optimized for the site. Since currently available crop varieties mainly originate from conventional breeding programs (van Bueren *et al*., 2011), the genetic potential for organic agriculture is far from being fully exploited. Characters related to organic farming, such as resistance to seed-borne diseases, weed suppression, and nutrient use efficiency, are not considered in the selection of plants grown from dressed seeds, treated with herbicides, and receiving high levels of fertilization. Thus, breeding programs that focus on the specific breeding objectives and cultivation methods of organic agriculture are urgently needed to increase efficiency and yield stability in the production of organic food.

Organic agriculture stances for a great genetic diversity at the farm level. It is necessary to grow a wide range of crops to deal with the heterogeneous environment found in organic farming systems in terms of field conditions, stocking densities, crop rotations, and marketing options. For this, common well regionally adapted cultivars should be made available.

These varieties must deliver sufficiently high and, above all, stable yields with minimal use of external resources and be of high quality concerning technical and nutritional requirements. Organic farming differs from conventional farming in many aspects, particularly regarding the type and amount of fertilizer and the approaches to weed and pest control. Thus, organic farming strives for closed loop nutrient cycles in which organic plant and animal fertilizers generated on a farm are used instead of quickly soluble mineral fertilizers. Natural resources can be utilized optimally by cultivating legumes and green manures for biological nitrogen fixation and choosing nutrient efficient crop varieties. Weed control is achieved through optimized crop rotations, mechanical methods, and fast growing competitive crop varieties rather than through the application of herbicides. Targeted support of predators, parasitoids, and symbionts is taking for controlling disease and pest (i.e. functional biodiversity) together with the cultivation of resistant varieties as an alternative of using pesticides.

In addition to the many crop characters that are important in conventional farming, varieties for organic farming must have additional features. These include:

* Resistance to soil and seed borne diseases (this is no longer considered in conventional breeding programs, since efficient synthetic chemical treatments are available)
* Rapid growth and development
* High weed suppression and tolerance
* Lodging resistance at greater plant heights
* Improved nutrient use efficacy through extensive root systems and the promotion of symbioses with soil organisms
* Quality related traits

The objectives of organic plant breeding should be personalized to the single crop and market, taking into consideration the needs of farmers, breeders, traders and consumers.

BREEDING OBJECTIVES

In spite of clear overlaps (yield, disease resistance, etc.), breeding objectives for organic production vary in range, level and priority from those in non-organic agriculture. For example, competitiveness with weeds is important for organic varieties but not considered in non-organic breeding. Height is important overall, but varieties for organic use tend to be taller than those developed for nonorganic production. Yield usually has an overriding priority in non-organic programs but will often have a lower priority in organic breeding, relative to quality, for example. The development of organic breeding programs should also provide new opportunities. In breeding for quality, one aspect that might be included in breeding plants for human health. Furthermore, to nutritional value (high protein, for example), some secondary metabolites may be valued in resistance to human diseases. Because of the current structure of variety legislation, non-organic breeding programs are directed rigorously towards genetic uniformity among the individual plants in a selected variety. This excludes any opportunity for the variety to adapt to local circumstances. For organic breeding programs, there is much greater interest in maintaining variation within varieties to allow for a buffered response to variation in the local environment. It seems most likely that the development of organic breeding programs would lead to increased differentiation of organic from non-organic crop varieties. It is also necessary that a parallel development is needed in breeding animals for organic production.

PRINCIPLES OF ORGANIC PLANT BREEDING

The reliable approach to organic agriculture does not suggest that breeders cannot manipulate plants, but rather that the tools and techniques used in breeding, propagation, and cultivation of plants should not violate this integrity. The integrity of plants pertains to characters such as their nature, wholeness, species-specific characteristics, and their being in balance with species-specific environments. Four stages of plant integrity have been suggested:

1. Integrity of life

This is defined as the state of wholeness or completeness of a living organism that allows it to perform all of its functions in a more or less autonomous fashion. Therefore, crop cultural practices that use synthetic chemicals may interfere with this self regulating capacity of the plant, and hence be unable to get along with organic farming.

1. Plant-specific integrity

This is the condition of wholeness or completeness of a plant that permits it to perform all of its plant-specific functions. Plants and animals fluctuate in specific ways at the cellular, whole organism, and functional levels. Raising plants in simulated environments (tissue culture, hydroponics) infringes on the plant’s ability to perform its natural functions (natural interaction with the soil). By means of techniques that reduce the natural reproductive capacity of plants is unacceptable practice in organic breeding. For example, using cytoplasmic male sterility (CMS) without fertility-restorer genes will cause the progeny from CMS hybrids to be sterile.

1. Genotypic integrity

This is demarcated as the condition of wholesomeness or completeness of the species-specific genome. Plant breeding depends on variability for success. Genotypic integrity is not violated as long as the variation is natural in origin. Though, genetic engineering technology, which permits the transfer of genes across natural barriers, breaches this integrity principle.

1. Phenotypic integrity

This is defined as the state of wholesomeness or completeness of an individual plant, including its health. This principle is violated when plants are developed (or cultivated) in a manner that makes them unable to maintain themselves or complete their life cycle in an organic production system without chemical protection. Chemical induced mutagenesis as a means of breeding, violates this principle simply because chemicals are used in the process.

GUIDELINES FOR ORGANIC PLANT BREEDING METHODOLOGY

Given the need for organic plant breeding, an agreed set of guidelines for breeding methodology is needed that is consistent with organic principles. Organic plant breeding should be a universal approach that respects natural crossing barriers and be based on fertile plants that can establish a viable relationship with the living soil. Organic varieties would therefore be obtained by breeding methods that comply with this concept and that derive from certified organic plant breeding programs. Methods not allowable would be those that do not respect the integrity of plants and chiefly those that operate below the level of the cell. These include GM, CMS hybridization without restorer genes and protoplast fusion. F1 hybrid production would be acceptable when the F1 offspring are fertile and that the parent lines can be propagated under organic conditions. Within the biodynamic movement, the production of open-pollinated varieties would likely be stimulated rather than hybrids. DNA marker-assisted selection would be permitted with neither GMOs nor radiation are involved in marker production. Meristem culture would be allowable predominantly because of its key role in virus elimination. Patenting of breeding material would not be allowed because of the restrictions that this places on the free exchange of material among farmers and breeders. Organic cultivars would be diverse from organic seeds and planting material. Organic seeds and planting material originate from breeding programs, organic or non-organic, and that have been multiplied or propagated for at least one generation under organic management. Some in vitro techniques would be allowed (but not, for example, GM). The separation of organic varieties and organic seeds should allow for a smooth long term transition from the current position, where few organic varieties are available but the organic seed is comparatively common, to a point where organic varieties form the main basis of organic production.

ACCEPTABLE ORGANIC PLANT BREEDING TECHNIQUES

In terms of creating variability, techniques that do not violate the integrity of plants include crossing cultivars, hybrid development with fertile F1, test crosses, backcrosses, and bridge crossing. However, techniques at the cell level (e.g., embryo cultures, somatic variation, ovary culture) and the DNA level (e.g., genetic engineering, protoplast fusion) is not acceptable. In relation to methods of selection, mass selection, pedigree selection, and even DNA diagnostics and marker-assisted selection are considered compatible with plant integrity. The analytical tools are adequate because they do not cause genetic modification of plants.

APPROACHES FOR ORGANIC PLANT BREEDING:

There are some suitable approaches for organic plant breeding which are very useful for farmers and suggested by Bueren and Struik (2004). These are the following and given below.

1. Naturalness

2. Emotive dimension

3. Normative dimension

1. Naturalness:

Verhoog *et.al.,* (2003) gives the concept of 'naturalness' which indicated that not only use the inorganic chemicals but use the organic and agroecological principles as well. Organic production is also defined as the “Natural” way of production (referring to the absence of synthetic inputs). Some researchers insist that the naturalness of organic agriculture should not be limited to the absence of synthetic inputs, or adherence to ecological principles, but also an acknowledgment of integrity and wholeness in the production system. The concept of integrity implies belonging to a specific natural entity (just like the concept of species that can freely interbreed but are genetically separated from others belonging to another natural group). To be organic, this naturalness must be accorded proper consideration in how plants are propagated, cultivated, or genetically manipulated to conform with the ideals of true organic agriculture. Further, plants are ascribed an intrinsic value that indicates that they are ethically relevant (under the attitude society has towards nature).

Naturalness is subdivided into three groups.

1.1. Nonchemical approach

1.2. Agroecological approach

1.3. Integrity approach

1.1. NON CHEMICAL APPROACH:

The Nonchemical method is one of the best methods to organic agriculture. This approach will not be used any inorganic fertilizers, chemical pesticides and synthetic chemicals. It is based on organic materials only. This is majorly focused on the use of organic substances in such a way that become healthier for humans and the environment. Consumers have some fear regarding the consumption of chemically applied based food but organic food can be utilized without any doubt. In this approach inorganic substances and chemical synthetic, have to be replaced by organic, bioproduct natural ones (e.g. seed treatment can be done with neem oil, tobacco leaf, pyrethrum) physical treatments and (e.g. hot water and solar radiation treatment) organic product, or involving bio agents (e.g. Bacillus spp.). It is the first phase of transformation or moving on from conventional or chemical based farming to organic agriculture. Ultimately, the organic grounded tactic is going on sometimes it is not possible to control the major outbreak of diseases and pests so that the alternative only chemicals. In a non-chemical approach, some traits are improved in plant breeding maximum utilization for humans under restricted boundaries of organic touchstone (Bueren and Struik, 2004).

1.2. AGROECOLOGICAL APPROACH:

In agroecological approach will have to consider safe environments that means without affecting/altering/ harassment to the environment. In the agroecological approach, all agricultural activity is directly related to nature or without harassment to nature. During this period of conversion of conventional method to organic breeding, farmers are applying sustainable agriculture to consider co-operating with nature. Considerably, to save the environment against the chemicals we should select the variety which is strongly recommended for organic conditions and simultaneously tolerance to insect, pest and disease, for required traits, ability to perform with organic substances, give high performance with low use of other product, deep rooted characteristics and produce healthy seed (Bueren and Struik 2004).

1.3 INTEGRITY APPROACH:

Organic plant breeding mainly allows developing a genotype that is eco-friendly and has higher yielder and species-specific expression potential with quality traits. Therefore, organic agriculture balances the environment without affecting the living life and by providing quality crops.

2. Emotive dimension (attitude): Emotive dimension remove all fears from farmers that kept in mind that chemicals affect to an adverse effect on human health. Thus, mostly did not use any chemicals in organic plant breeding. There is a need for a promising variety that is adaptable to the variable environment with high yield under organic conditions. Farmers should treat the seeds with organic substances before sowing which will also improve the soil. In this dimension, farmers play an important role in the maintenance and development of genetic diversity.

3. Normative dimension: Use of organic substances only in place of chemicals to control insects and pests. We are using in vitro techniques to develop plants than only use organic substances in growing media. Transgenic do not be accepted here due to excessive exploitation of micro-organism substances. The breeding techniques should be applied only in organic conditions to develop the variety for organic conditions.

AN EXAMPLE: COMPOSITE CROSS POPULATIONS IN WHEAT

One methodology that we have now started is to produce composite cross populations in wheat. Some 20 outstanding wheat varieties from the last half century in Europe are being crossed in all possible combinations. The population samples from F2 generation will be grown at a range of organic and nonorganic sites to determine the degree and rate at which the populations acclimatize to the local environment over several generations. If fruitful, the material produced could be used either directly or as a rich genetic resource for further selection and breeding. The genetic variation should permit the mechanisms of niche spread, complementarity and compensation to make the populations highly and rapidly adaptable in terms of disease, pest and weed restriction together with buffering against variation in the physical environment.

CHALLENGES:

Organic plant breeding is not a strategy but it excluded those techniques which are being hazarded for ecological perspective and attention to bring to take about the improvement of organic varieties which is suitable for all beneficiary. There are some precious challenges for organic plant breeding which are given below.

1. Main challenge to obtain new variety to organic plant breeding: it is a difficult task that any variety developed through organic plant breeding has not adapted to any environment, because many varieties do not show adaptation to all environments. Controlling insect pests in organic plant breeding is a difficult task, there are many insect pests out of which is being harmful to organic plant breeding because, in organic plant breeding, we cannot utilize any synthetic chemicals, organic chemicals, pesticides and insecticide. In organic plants, breeding can use those products which be synthesized from organic products to control insects, pests such as neem oil and pyrethrum, etc.

2. Low yield comparison to a conventional breeding method: it is demonstrated that organic plant breeding gives low yield compression to a conventional breeding method because in organic plant breeding can’t use any chemical substances with which it affected to yield (chemical is a substance such as fertilizer). But in conventional breeding continuing use of chemical fertilizer with which gives a higher yield to any variety. Organic farming drops yield due to lack of inadequate control systems, weed suppression, disease and pest resistance characters in cultivar such as late blight in potato, powdery mildew in pea, etc.

3. Organic crop ideotypes: although the organic sector is continuing to receive advantages from organic plant breeding through breeding efforts, all varieties which are going to be under trial, are not fit for all cases in organic plant breeding. The organic system approach requires that all varieties which are developed through organic plant breeding adopt the variety under a given organic environment rather than the environment to the variety. The ideotype for organic conditions should have the features e.g., wider adaptation, maintain or improve the soil fertility through the application of organic inputs, better root system, to take benefit from soil micro-organisms, suppressing ability of weeds, maintain soil and crop health, good quality product and high yield stability (Van Bueren *et al*., 2002).

4. Loss of genetic resources: many farmers continue using modern new varieties in place of landraces, transgenic and hybrids due to no systemic collection of landraces. Small or no variety/gene pool/germplasm has conserved in seed gene bank of organic plant breeding.

CONCLUSION:

Organic plant breeding is a system that develops the variety which is higher yielder under organic conditions which maintain the soil and human being health due to the non-application of chemicals. Eventually, the yield of organic variety may be low but that can be addressed through the use of plant breeding techniques under organic soil. The varieties developed through organic plant breeding or varieties cultivated under organic conditions may not have any adverse effect on human health and are even familiar to the environment also. The next decade may be the era of organic breeding activities and organic agriculture without any yield barrier and other challenges that we are facing in the present scenario.

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