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BIOTECHNOLOGY FOR SUSTAINABLE AGRICULTURE: ENHANCING AGRICULTURAL PRODUCTIVITY AND VALUE-CHAIN ADDITION IN CROPS

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Agriculture has been the backbone of food and nutrient supply not only for human but also for animals directly and indirectly. However agricultural land is continuously constricting and decreased over time due to population explosion since last few centuries. Therefore, global agriculture must have to adopt innovative agricultural practices so that it can supply sufficient and nutrient enriched food for ever growing populations (FAO, 2018). An innovative vision for development of agriculture in the backdrop of international regime, ecological crisis and socio-economical constraints worldwide could truly be derived only from the convergence of agricultural biotechnology with Nano-Science and Bioinformatics. Precision agriculture embodies such a convergence of Bio based technologies. Critically we must seek to blend traditional wisdom with modern tools of biotechnology (Estrada *et al.,* 2017). Aided by the wisdom of sustainable agriculture and the wonders of precision farming, farmers will have a fighting chance to give us daily bread and provide cleaner environment to the future generations.

Major Constraints to Sustainable Agriculture

Sustainable Agriculture can be defined as the management of agricultural resources to satisfy human needs, without compromising the quality of the environment and hampering natural resources. Sustainable agricultural production is hampered by the decline in land and soil productivity as a result of inappropriate soil and water management practices. Since green revolution, huge amount of hazardous agro-chemicals such as fertilizers, pesticides and fungicides are constantly being employed to the soil which are becoming toxic to human, animals or even to other biota (FACTSHEET, 2016). Furthermore, agricultural sustainability requires improved seeds, integrated nutrient and pest management (INPM) practices, tools

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and machinery. Although these requirements are un-assessable to most resource-poor farmers due to high cost, so scientists have to take forward to resolve these issues to achieve agricultural sustainability in precise manner.

Sustainable Agriculture: Can Biotechnology play a role?

Biotechnology can provide useful products and services for sustainable development of agriculture. The major contribution biotechnology had made in modern agricultural practices is by reducing the use of agro-chemicals, without compromising the productivity needed to feed ever growing population world over with added production and development of biotic and abiotic resistant crops (Estrada *et al.*, 2017). Biotechnology can also supply faster and even more précised diagnostic tool for animal and plant diseases, and through improvements in the supply-chain of livestock fodder and feeds.

Biotechnological Tools and Techniques for Developing Sustainable Agriculture

- **Conventional Plant Breeding**

Since the beginning of agriculture eight to ten thousand years ago, farmers have been altering the genetic makeup of the crops they grow. They manually select the best plants or seeds and saved them for the next year. Early farmers adopted features such as higher yields, faster growth, larger seeds, pest and disease resistance, better fruits set, etc for selection. In the same way, Plant breeding came into existence and found that plants could be artificially mated to improve the desirable trait of interest in the crop plants. Desirable characteristics from different parent plants could be combined in the offspring by cross-pollination. With the gradual development of science of plant breeding in late 20th century, breeders learned better how to select superior parent plants, breed them and improved them as a varieties having desirable traits (Estrada *et al.*, 2017). This has considerably increased the quality and productivity of the plant produce.

- **Tissue Culture and Micropropagation**

Plants usually follow sexual means to reproduce because they have ability to set seeds after flowering and hence create their next generation. Egg cells in the flowers are fertilized by pollen from the stamens (male part) of the flower of the same plant (self-pollination) or another plant (cross). Some plants and trees on the other hand need several years before they

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flower and set seeds, making plant improvement difficult. Plant scientists have developed the science and art of tissue culture to assist breeders in this task.

- **Molecular Breeding and Marker-Assisted Selection**

For developing new varieties, conventional breeding requires multi-step process and can take 12-15 years. However, by adopting molecular breeding approaches assisted with agricultural biotechnology tools and techniques, the breeders can shortened the time upto 7-10 years to design new crop varieties (Estrada *et al.,* 2017). The most acceptable tools, which make it easier and faster for scientists to select plant traits is called marker assisted selection (MAS). The genes or QTLs associated with the complex trait such as flower color, crop yield, starch content and other quality traits can be easily identified from the plants in early stage of growth without significant influence of genotype to environment interactions, thus minimizes the time, skill and cost taken for selection and other breeding process.

- **Genetic Engineering and GM Crops**

Over the last few decades, the agricultural biotechnology has grown rapidly due to the increasing knowledge about the DNA as the chemical messenger of the genome. Genetic engineering or often gene technology is one of the modern biotechnology tools that are frequently used in agricultural science for crop improvement. This involves the manipulation of genetic makeup of plants or even animal to design chimeric organism having altered genomic constitution (Estrada *et al.,* 2017). By manipulation of genetic makeup of plants, the desirable genes can either transferred across the species or, even silenced the effect of undesirable genes. These exertions limit the crop improvements by means of plant breeding, but because of some misconception about the biosafety issues, consumer's acceptance of GM crops is also need to be resolved.

Conclusion and Future prospects

New agricultural technologies, in general, need to cover two societal requirements-ensuring a safe, nutritious, and affordable food supply for the ever growing mouths and also minimize the biosafety concerns and other associated environmental issues. Advances in plant breeding, agrochemical research and agriculture and farm mechanization will be required to meet world food production needs. Agriculture biotechnology complements breeding efforts by escalating the germplasm conservation and diversity of genes needed for

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crop improvement within a shortened time. Thus in view, the article focuses on the biotechnological approaches for building a new tool which can significantly impact crop productivity in a sustainable and environmentally sound manner.

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