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Annals of Experimental Biology, 2021, 9 (5): 9-11
(http://www.scholarsresearchlibrary.com)

ISSN:2348-1935

Agriculture and Genetic Engineering: An Imperative bond for Agri-evolution

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INTRODUCTION

The word "Agriculture" is derived from the Latin word *ager* which means "field" and *cultura* which stands for "cultivation". In layman's language agriculture is an art of growing crops and livestock. But it isn't as easy as it seems from this definition, it took a lot to get it right to make fair profits. Many countries in Africa and Asia depend mainly on agriculture, where the majority of the population relies on farming as an exclusive source of income, and agriculture becomes an integral part of the economic growth of that country. The history of agricultural evolution depicts the tale of mankind's development along. As crop growth and livestock rearing techniques have been developed, so has human development. Agriculture is believed to have begun a long time ago, with the cultivation of some wild edible plants such as lentils, barley, peas. Animal husbandry started with the domestication of animals useful for human beings such as sheep, goats, cows, etc [1]. As human being evolved new methods, as well as equipment, got invented and used. Researchers started working in the areas of improvement of pre-existing varieties and resulted in the development of new cultivars. If we look back into our history, we can imagine where we were and where we are now. From a food gatherer to a food producer, the man has come a long way. The development of improved varieties to feed seven billion people has been made possible due to the concerted efforts of plant breeders, agricultural engineers, and farmers. Simultaneous discoveries of superior techniques like hydroponics, aeroponics, etc have added to the overall production and productivity. In addition to the techniques of the production, the production of the crop also depends primarily upon the type of cultivar being used. And hence, this variety development program is an important sector of agriculture. Developing new varieties while also looking into the improvement of the existing ones is what this sector does. This process of varietal development is time and labor-intensive and is called breeding. To date, there are so many breeding techniques that have been developed, utilized, and improved again and again for the variety development. Not every technique can be utilized for any crop improvement program. The choice of the breeding method depends upon the reproduction method of that crop viz. if the plant is self-pollinated then mass selection, introduction, pedigree methods, backcross method, single seed descent method, etc can be considered whereas if the plant is cross-pollinated then recurrent selection and mass selection are the methods to be executed. The existing breeding techniques are classic and require a great deal of time to experiment around 6 to 8 years for the production of a variety. And sometimes the results aren't as expected, resulting in futile attempts made by the breeder. Perhaps, we should look for another best technique which could ensure us expected results as well as do not consume this much of a long time. Therefore, the best existing techniques that we manipulate for the production of different genetically engineered crops, which we refer to as genetically modified (GM) crops, are for our redemption genetic engineering of the crops. This is not a novel technique, rather its discovery trails back to the experiment conducted by Herbert Boyer and Stanelycohen (1973) in which they created recombinant bacteria, and thereafter this engineering of living entities is also popular as recombinant DNA (rDNA) technology. The discovery of DNA ligases and restriction enzymes is the most imperative part of this whole process because without these enzymes it would have been almost impossible to get out the particular site on the genome to add or remove a specific length of the segment from it. After the discovery of the first transgenic plants i.e. tobacco in 1983, it opened a whole new world for the researchers to try to manipulate the cultivated crops in such a way such that they will be still consumable but with far more efficiency, by efficiency we mean not only in terms of quality but also genotypic stability and best response to unfavorable conditions. A very brilliant example, which indeed was the first food with fortified nutritional contents, golden rice, was developed in 2000. Another example is the flavrsavr which is a genetically modified tomato & was supposed to have more self-life than the normal ones. Since the inception of the incorporation of rDNA technology in agriculture, the manifestation of the benefits is known to everyone.

GENETIC ENGINEERING SCOPES AND LIMITATIONS IN AGRICULTURE

The utilization of the rDNA technology in agriculture has lifted the agriculture to next level. It has not only enabled us for intrageneric transfer but also the intergeneric transfer of the gene has been conducted successfully. This has been possible with the help of various tools and techniques which can be utilized for the production of almost all types of recombinant cultivated crop plants. By tools, we mean various gene transfer techniques, with which we can achieve our goal of incorporation of a gene(s) into another genome. These methods can be broadly classified into two types viz. direct and indirect gene transfer. Methods such as electroporation, particle gun method, micro-injection, chemical method, lipofection, fiber mediated DNA delivery and pollen transformation, etc are examples of direct gene transfer whereas Agrobacterium-mediated gene transfer comes under indirect gene transfer. But before transferring, one major question arises is that how to identify and isolate the gene of interest from the identified genome. So, the answer to this question is concealed in molecular genetics. The molecular marker comes under one of the most amazing discoveries which have enabled us to identify our gene of interest in the complexly arranged genome. These markers even help to identify the transformed organisms among the non-transformed ones. These micro-entities provide us much better knowledge of the genetic resources [2]. As a consequence of the exploitation of the above techniques, today we are having so many improved cultivars in hand which we have created with help of r-DNA technologies, and those cultivars are referred to as Genetically Modified Organisms (GMO) food crops. Maize, soybean, eggplant, tomato, sugar-beet, papaya, and potato, etc are some of the most popular transgenic crops which are now widely used for cultivation in countries like the USA, Canada, Australia, Japan, China, South Africa, Chile, Brazil, etc. Whereas, in other countries like India, the use of GM crops for human or animal consumption is yet not permissible [3]. There is an apprehension in a few countries that the transgenic crops not only affect the plant health but also the health of the other related organisms who are consuming it will also affect. To date, the information regarding their potential environmental risks is comparatively less [4]. Perhaps, the rDNA technology has a very high potential for giving substantial outcomes in the field of agriculture. It is predicted that, among the total species across the globe, 90% of the human requirements are being full filled by nearly 20 species of plants and animals which indeed is very less when compared with the total species number i.e. around 10 to 30 million [5]. So, this technology could be utilized for deriving the best benefits from these small numbers of species sustainably. And hence for good or bad, these sorts of highly efficient and good technologies must not be neglected as they should also be treated equally so that they can also be explored [6]. Apart from denying the use of such high potential technologies that hold power to change the future, we should seek other paths such as one can create the equivalent condition as those of fields in the lab where the chance of escape of genes into the environment will not prevail and one can collect relevant necessary information before going for a commercial release [7].

CONCLUSION

New technologies have always been found to gear up the generations. So, envisaging environmental problems by use of rDNA technology, even before knowing much about the technology in hand would be an understatement. There is a need for more research in this realm so that all the potential environmental harms due to this technology can be identified and strategies of mitigation should be sculptured out. The bio-safety measure should always be kept in mind by the personnel. If this technology is handled gently and used precisely, then surely this can be our further or the next level for the agricultural evolution.

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