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Genome Editing and Ethical Concerns

(*Sachin Phogat[1], Priyanka Kumari[1], Ramesh[1], Narender Pal[1], Lalit[2], Manish[1], Ajay Singh Sindhu[1] and Praveen Kumar[1])
[1]ICAR-Indian Agricultural Research Institute, New Delhi
[2]Chaudhary Charan Singh Haryana Agricultural University, Hisar
*Corresponding Author's email: sachinphogat2012@gmail.com

Since the invention and beginning of recombinant DNA (rDNA) technology by Paul Berg in 1972, genetic engineering has come a long way and achieved enormous success. A number of molecular and genetic phenomena and their mechanisms have been discovered and studied in detail and the knowledge accumulated now helps researchers to explore the new dimension and insights of the modern science to perform genetic studies and crop breeding, due to its simplicity, flexibility, consistency and high efficiency. Creation of novel biotechnological tools for breeding, an application area of genetic engineering, has received significant focus resulting in accelerated development of new varieties. However, conventional genetic engineering strategy has several issues and limitations, one of which is the complexity associated with the manipulation of large genomes of higher plants. Genome editing through programmable endonucleases is the most recent approach to genetic engineering. Genome editing is a method that allow scientists particular change in the DNA of many organisms, including plants, bacteria, and animals. Over the last few years, the exuberant development of genome editing has revolutionized research on the human genome, which has enabled investigators to better understand the contribution of a single-gene product to a disease in an organism. Targeted editing of the genomes of living organisms not only permits study and understanding of the fundamental basis of biological systems but also allows addressing a wide range of goals towards improving productivity and quality of crops. This includes the creation of plants with valuable compositional properties and with traits that confer resistance to various biotic and abiotic stresses. In the 1970s, the development of genetic engineering (manipulation of DNA or RNA) established a novel frontier in genome editing. Based on engineered or bacterial nucleases, genome editing technologies have been developed at a rapid pace over the past 10 years and have begun to show extraordinary utility in various fields, ranging from basic research to applied biotechnology and biomedical research. During the past few years, several novel genome editing systems have been developed; these include zinc finger nucleases (ZFNs), transcription activator-like effector nucleases (TALENs), and clustered regularly interspaced short palindromic repeats/Cas9 (CRISPR/Cas9). Currently, several tools that help to solve the problems of precise genome editing of plants are at scientists' disposal.

Ethical Issues | Risk of inducing mutations: When CRISPR/Cas9 repeatedly targets genes at various stages of embryonic development, as with other genome editing techniques, it is possible to cause off-target mutations in the genome and Mosaicism of the mutations. This can happen when CRISPR-Cas9 cleaves DNA sequences within the genome that are homologous to the target DNA sequences, leading to an unintended mutation.

Ecological disequilibrium: Due to their potential benefits over closely related wild species, the introduction of genetically engineered organisms may cause ecosystems to get out of

equilibrium. A "gene drive" that spreads a trait over an entire population of animals may result from altering the Cas9 endonuclease gene with a gene that encodes the appropriate guide RNA next to a changed gene. This may result in ecological disequilibrium.

Issues of regulation: There is need for effective and global regulation of genetically modified organisms, since current and international regulations provide inadequate guidance for CRISPR/Cas9 applications, Internationally, Regulatory agencies should require that researchers demonstrate sufficient control mechanisms as a condition of using the CRISPR/Cas9 editing system.

Animal welfare: The potential suffering of sensitive, intelligent animals confined for life in Laboratory conditions to be tested with gene editing experiments and the killing of these animals requires ethical justification. Here are risks to animal welfare for experimental animals due to technical difficulties in the use of gene editing. Due to off target mutations, there may be loss of function of a gene, adverse events, even fetal abnormalities. The use of animals in research must be justified in terms of the research value for ameliorating animal disease, human disease or the understanding of fundamental biological processes. Scientists must consider whether experimental alternatives exist, whether the species used is appropriate, the number of animals used diminished, and methods to ameliorate or avoid suffering are used.

Bioethical issues: The horizontal discourse between specialists and laypeople, which demands transparency in the information about the advantages and disadvantages of genome editing organisms, is favoured by bioethical thought. However, this use imposes a moral obligation to respect experimental organisms and not cause them unnecessary suffering, especially when working with sentient living things. The use of organisms for experimentation has as its goals environmental cleaning, human consumption, saving human lives, and alleviating suffering through therapy. The present trend is anthropocentric, which views humans as the only moral entities with the ability to control and utilise natural resources. The opposing trend is known as bio conservatism, and it is framed as a reaction against technological human involvement in biological things that changes their natural state and diminishes their intrinsic value.

Justice and equality: There are worries that genome editing will only be available/accessible to the wealthy and will widen the already-existing inequities in access to healthcare and other interventions, just like with the development of other breakthrough technologies. Some fear that if germline editing were to be taken too far, it would result in classes of people whose quality of genetic engineering would define them.

Ethical issue related to agriculture

- The use of bio-resources by multinational corporations and other organisations without the proper consent of the governments and people concerned and without remuneration is referred to as "biopiracy."
- Damage to the environment is another ethical concern in reference to agricultural genetic engineering because plants make up the majority of our environment. We regrettably currently know very little about how growing GM crops may affect the environment because the technology is so young. Short-term consequences of the technology are studied in long-term studies of GM crop production.
- A very significant ethical worry with GM technology is the risk to the food chain. Animals and other environmental species may be harmed by any pesticides or herbicides used on the crop. For instance, GM sugar beets that were developed to be herbicide resistant did successfully lower weeds. However, the skylark birds that eat the seeds from this specific weed would now have to find a new food source, putting their existence in peril.