"The contributed chapters in the book written by the faculties of science stream in the light of the recent thinking and developments in the field of science and education.- Science& Technology is now dominates almost every field of our activities.In summary, The faculties (Science stream) of GEMS Arts & Science college have made an excellent attempt to bring about this book Homo Scientia", covering almost all the important areas from biological sciences to artificial intelligence. Every article has its own merits in both academic and research fronts..I record my grateful appreciation and thanks to the contributors of this book for their untiring efforts."

Dr. Balagopalan Unni

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HOMO SCIENTIA

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Dr. K Gopalakrishnan,
Smitha Pramod V

GEMS

HOMO SCIENTIA

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Brief Biography

Dr. B.G.Unni, (Balagopalan Unni) Ph.D
(Allahabad central University)
FRES (London), FIANSc , FISAgBc, FICCE

Former Chief Scientist and Area Coordinator (Biotechnology & Biological Sciences) DADD and Fulbright Fellow retired from CSIR service in 2015 after 38 years of research career at CSIR North East Institute of Science & Technology Jorhat Assam. Appointed at Assam down town University as Director-Research in March 2015 and continued up to June 2019 and then re-designated as Adviser Research in August 2019). Back in Kerala, Dr.Unni is appointed as Director Academic & Research at GEMS College of Arts & Science affiliated to University of Calicut from August 2019. Both the positions are on honorary basis to strengthen the institutions in research areas. He did his BSc Biology (1972-74, Ewing Christian College, Alld University), MSc in Biochemistry(1974-76)(Second Rank) and Ph.D in Biochemistry from Allahabad University(1976-80) and PDF in Molecular Biology from Texas A&M University, USA(1988-91). Dr. Unni is specialized in Biochemistry, Molecular Biology, and Biotechnology and well established in his area of research and completed more than 40 years of research in both basic and applied fields of research. Dr.Unni got more than 130 research papers, 190 abstracts, 35 papers in proceedings, 7 patents,1 technology.18 chapters in books, edited 3 books and 29 students

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received PhD degrees under his guidance and supervision. Dr. Unni had completed more than 20 projects sponsored by Commonwealth Science Council, London, Ministry of Non conventional Energy Sources, Department of Non conventional Energy Sources Govt of India, North Eastern Council Govt of India, Department of Science &Technology, Department of Biotechnology, Central Silk Board,GB Pant Institute of Himalayan Environment and Development, CSIR and DRDO, Ministry of Defense, Govt of India during his scientific tenure at CSIR NEIST. Dr Unni received- Fulbright Travel Award/ Fellowship (USA) Dr. B.M. Das Memorial Science award, Hebrew University Award , H.R. Cama Memorial Travel Award,COSTED Travel Award,. DAAD- fellowship-Germany, Well Mark International Scholarship (USA) & Technology award in life sciences by CSIR,Govt of India . Best Fulbright Alumni Chapter Leader-South Asia Selected by the United States Education Foundation In India (USIEF), New Delhi .Nominated to represent India at the International Fulbright Scholars meet at Marrakech, Morocco- Nominated by United States Education Foundation In India, New Delhi . Dr. Unni is in the editorial board of more than eight indexed journal in the country .Dr.Unni was nominated to various state and central committees such as High power committee for development of sericulture activities Muga, Eri,Tassar and Mulberry in Assam nominated by Governor of Assam, .Expert in the area of non mulberry sericulture, Ministry of Textiles, Advisory Board, Post graduate Biotechnology programme, Academic Council, Assam Agricultural University, Research Council, Central Silk Board, Ministry of Textiles , DBT's Nominee for Biosafety Committee ,Vice President SBC (India) Indian Institute of Science Bangalore, Vice President Indian Academy of Neuro-sciences, Member Fulbright Academy of Science & Technology, USA, Board of studies- Botany Nagaland University and Biotechnology Saugar University Madhya Pradesh., Fellow, Indian Academy of Neurosciences & Indian Society of Agricultural Biochemists, Fellow Royal Entomological Society, London UK and Scientific

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Advisor International Foundation of Science, Sweden, Member, Board of Studies Raiganj University (2017----), Member Research Review committee Tea Board of India (2016-2019), Member Advisory Committee Cancer Research Advisory Board, North East Cancer Hospital & Research Institute (2017--) President, Tea Improvement Consortium, Ltd, Tocklai Assam (2018-2020) .

Dr.Unni visited USA, Germany, Israel, Jordan, France, Morocco ,UK, Thailand ,Jordan, Singapore , China and UAE under various exchange program.

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Preface

I am very happy to learn that, the GEMS Arts & Science College is bringing out a series of books written by the faculty in this academic year. The college is occupying a very important position among the colleges in Kerala, the same way the college is having unique standing in both academic and research fronts too. This is because of the excellent management, faculties and the best performances of the students.. I have full confident that in the course of time, and with the sincere commitment and dedication of the faculties , students and with management , the college will attain high level perfection and excellence and became a model college in the state of Kerala

This book entitled " Homo Scientia" had comprehensive research topics in various aspects in the topics of cyber security, biotechnology, microbiology and geology.A brief description about the cybersecurity, the protection of computer set up such as hardware, software data from several threats have been described in the chapter The best practices for deploying and managing IPS network security tools have been explored. The integration of intrusion prevention system (IPS) solutions, adherence to security policies, regular updates, monitoring and the implementation of incident response procedures are considered to be the essential components of a comprehensive network security framework. The risk management in cyber security, various cyber-attack kinds, malware, and some strategies to tackle these attacks are also explained by the authors. A comprehensive overview of the evolution of computer graphics, exploring the advancements in hardware, software, algorithms, and techniques that have propelled the field from its early pixel-based beginnings to the current state of realism etc also described. Optical character recognition has been extensively investigated in the past few years, and has been proven that high recognition rates can be achieved in specific

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application scenarios using some standard and well-studied methods such as neural network, support vector machine (SVM), etc. The possibility of learning an appropriate set of features for designing optical character recognition (OCR) has been investigated

Biotechnology is an interdisciplinary science using modern technologies to construct biological processes in research, agriculture, formulation of pharmaceutical products and other related fields. The better understanding of advances in plant genetic resources, genome modifications, omics technologies to generate new solutions for food security under changing environmental scenarios etc have been discussed in this chapter. The increasing demand for food had a great impact on the agriculture sector to address the various challenges associated with crop productivity. The tremendous advancement in plant research helps in understanding plant biology for sustainable food security, functional ecosystems, crop improvement and human health. One of the sustainable farming techniques is the use of fertilizer at nano level. Nanomaterials that enhance plant nutrition could be considered as an alternative to the conventional chemical fertilizers. one chapter covered the importance of nano fertilizer to enhance metabolic processes in plants and reviewed the concerns in developing nanotechnological methods in the future. Metabolomics has now emerged as a powerful tool for the comprehensive analysis of metabolites within biological systems. One of the chapters provides a review on metabolomics, encompassing its methodologies, applications, potential impact on personalized medicine ,and discusses further the need for advancements in analytical technologies. The antifungal activity of mangroves, particularly Rhizophora species are one of the main sources for fungicidal compounds due to the presence of high concentration of phenols. The antifungal activity of Rhizophora species has been elucidated, and could be further utilized as biocontrol agents for fungal disease in agricultural crops. One of the chapters discussed the species identification and its impact on economical and ecological level in the species like Nutmeg, one of the important medicinal plants that had a greater attention ,however, it was very difficult to differentiate the sexual identity

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in the seedling stages. But the protein content screening among the studied plantlets had differentiated the sexes in the species as explained by the author.

AI (Artificial Intelligence) or machine intelligence enables farmers to enhance the quality and ensure a quick go-to market strategy for crops, and adoption of these algorithms to improve food industries. Artificial intelligence (AI) has also the potential to revolutionize education, from personalized learning to assessment and grading. Additionally, AI-powered tools can provide greater accessibility to students with disabilities, while also enabling more engaging and interactive content. AI continues to develop and become more prevalent in education, towards responsible and equitable implementation. However the negative and positive part of the AI may also be looked into.

The chapters related to microbiological aspects have also been incorporated in this book . Carbapenem-resistant A. baumannii (CRAb), bacteria that cause multi-infections in humans and resistant to multiple drugs too. The study attempted to isolate and characterize the bacterial species from the clinical specimens using biochemical techniques. The enzyme, carbapenemase produced by the bacteria was isolated and determined by different assays. Another study identified the antibacterial, antioxidant and anticancer activities of Ganoderma lucidum by various chromatographic techniques. Anticancer activity was also assessed on HeLa cell lines using MTT assay and DPPH assay. In one of the chapters,the author discussed L-asparaginase, one of the widely exploited enzymes for the treatment of acute lymphoblastic leukemia (ALL). Also attempted to isolate and characterize the enzyme from soil samples collected from different locations at Kerala. The study indicated that soils can provide a rich source for L-asparaginase which has got ample application in pharmaceutical industries.

The studies on various geological aspects with respect to different geographical areas in Kerala soil has been included in the book. The vertical geochemical variation and elemental mobility of the lateritic terrain in the Makkaraparamba of Malappuram District, Kerala has been very well investigated. Under extremely oxidizing and leaching conditions, laterite

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soil transformed into a variety of rocks and further developed into stable secondary product in the existing humid tropical and subtropical environments. The hydrogeological conditions in Kumbala- Kaliyar river basin, Kasaragod district, Kerala was assessed by means of Vertical Electrical Sounding (VES). The digital spatial data output of the present study would be much helpful for planning and management of surface and sub-surface water resources of Kasaragod River basin in which the Kasaragod township is centrally located

The contributed chapters in the book written by the faculties of science stream in the light of the recent thinking and developments in the field of science and education.Science& Technology is now dominates almost every field of our activities. In summary , The faculties (Science stream) of GEMS Arts & Science college have made a n excellent attempt to bring about this book Homo Scientia".covering almost all the important areas from biological sciences to artificial intelligence. Every article has its own merits in both academic and research fronts..I record my grateful appreciation and thanks to the contributors of this book for their untiring efforts.

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BIOTECHNOLOGY FOR SUSTAINABLE AGRICULTURE: A FUTURE PERSPECTIVE

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ABSTRACT

Biotechnology is an interdisciplinary science using modern technologies to develop biological processes in research, agriculture, formulation of pharmaceutical products and other related fields. The better understanding of advances in plant genetic resources, genome modifications, omics technologies generate new solutions for food security under changing environmental scenario. The increasing demand for food had a great impact on agriculture sector to address the various challenges associated with crop productivity. Biotechnology has played an important role towards the sustainable management of crops using various tools resulted in an evolution for enhancing crop productivity in a way to improve food security and nutrition, employing various farming system. The conventional biotechnological research has many contributions to solve various constraints in limiting crop productivity. The limiting factors such as genome complexity, susceptibility to biotic and biotic stresses, etc. hinder crop improvement programmes. Nevertheless, invitro tissue culture system, biotechnological tools such as markers assisted selection methods, QTL mapping and advanced technology like genome editing are evolved as efficient strategies for the effective crop improvement methods. Moreover, AI (Artificial Intelligence) or machine intelligence enables farmer to enhance the quality and ensure a quick go-to-market strategy for crops and adoption of these algorithms to improve food industries.

INTRODUCTION

Biotechnology is the rapidly growing field in biological sciences possess diverse applications for the sustainable agriculture. This technology involves the manipulation of organisms through genetic engineering (GE) to produce useful products for different applications in biological sciences. At the end of 2033, the increased world's population will create greater demand for food and shelter and this pose a great challenge to agricultural system. The genetic resources of plants, animals, and microbes constitutes raw material for biotechnology-based research, development of technology, and creation of new products. The molecular biotechnological tools have accelerated precision breeding through identification, isolation, cloning and transfer of desired genes from one species to another to produce desired traits. The single-nucleotide polymorphism, identification of specific genes, assigning unknown gene functions, developing improved / desired character are the ultimate goals of biotechnology.

Nevertheless, conventional crop breeding for genetic improvement is a slow process with drawbacks caused by heterozygosity, auto incompatibility etc. New biotechnological tools such as genetic engineering techniques can promote the insertion of important and desirable genes into genome of cultivars which resulted in more efficient and reliable genetic improvement and maintaining high stability of major traits in the developed clones. The introduction of rDNA technology paved the way in plant biotechnology for generating genetically modified (GM) plants with beneficial agronomic traits in many crops. The current review addresses the important aspects of biotechnology for the sustainable management of agriculture and the future perspectives in a nutshell.

Biotechnology for a sustainable agriculture

Biotechnology offers great opportunities to increase global agricultural production and strategies to protect environment through reduced usage of agrochemicals like pesticides, fertilizers, rodenticides, etc. It has played an important role toward the achievement of environmental sustainability by

using ecofriendly herbicide tolerant, insect-resistant crops that have the ability to fix atmospheric nitrogen leading to purification of the environment. Farmers use genetically modified organisms (GMO) and agrochemicals for crop intensification without considering the issues of agricultural sustainability and cleaner production. During the initial stage of green revolution, improved crop productivity at a tremendous rate; however, indiscriminate use of synthetic chemicals has adversely affected environment and human health. Therefore, sustainable agriculture is essential to recover soil, plant, animal as well as human health to survive the human population.

Microbial biotechnology had a major contribution for the sustainable agriculture by reducing the usage of agrochemicals, particularly pesticides, through the involvement of various genes responsible for conferring tolerance or resistance to biotic and abiotic stresses. The selected genes from related or unrelated genetic resources are integrated in important / screened genotypes resulted in the production of desired trait. The contribution of biotechnology to sustainable agriculture are mainly through following ways:

- Increased resistance against abiotic stresses (drought, cold, flooding) and biotic stresses (insect, pests and diseases)
- Generation of high nutrient levels in nutrient-deficient staple crops
- Improved technologies for generating biomass-derived energy
- Increased productivity and quality
- Improved fermentation technology
- Enhanced nitrogen fixation and increased nutrient uptake
- Bioremediation and utilising bio-detectors for monitoring pollution;

Genetic engineering and traditional biotechnology

In traditional breeding, genetic crosses are made in an uncontrolled manner resulted in the incorporation of undesirable traits along with desired traits. These methods

are time-consuming, labor-intensive and hence great effort is required to distinguish the undesirable from desirable traits. But, the genetic engineering techniques allow segments of DNA that code genes for a specific character to be incorporated into a new organism and resulted in desirable traits. Through this technology, the incorporation of desirable traits isachieved more rapidly than with traditional breeding techniques. The presence of the desired gene controlling the trait can be tested for at any stage of growth, even in seedling stages before hardening. This can be achieved in tissue culture plantlets which cannot be propagated through other methods. Thus, the precision and versatility of advanced technology in biotechnology enable improvements in food quality and production to take place more rapidly than when using traditional breeding.

GM in agriculture

The potential risk of GM technology has been reported, but so far there is little evidence from scientific studies. Transgenic organisms possess a wide range of benefits that are developed through various innovations from traditional agricultural biotechnology. The various desirable quality genes are introduced in important crops for disease-resistance and increased drought tolerance. For example, researchers developed two varieties of papaya which are resistant to papaya ringspot virus by transferring one of the virus' genes to papaya to create resistance in the plants. Genes from naturally drought-resistant plants are inserted into different crops to develop varieties with increased drought tolerance. The crop-protection technologies adopted by farmers provide cost-effective solutions to pest problems to which, if left uncontrolled, would severely lower yields. However, the effective transgenic crop-protection technology can control pests in an effective manner. In some instances, farmers are not ready to accept the new technology because they afraid their traditional methods will be conquered by the new one.

Genetic engineering has introduced techniques to improve nutritional value, flavor, and texture of foods. Transgenic crops such as soybeans with higher protein content, potatoes with

nutritionally available starch and improved amino acid content, beans with more essential amino acids, and rice produce beta-carotene, a precursor of vitamin A has also developed. The production of flavour compounds can be altered by enhancing the enzymatic activity in transgenic peppers and other spices. The genetic engineering technology resulted in reduced pesticide usage in food crops, less pesticide leaching into groundwater, and minimized the exposure of farm worker to hazardous products. Bt cotton resistance to three major pests, and this transgenic variety thereby reduced total world insecticide use by 15 percent. According to U.S. Food and Drug Administration (FDA), increase in adoption of herbicide-tolerant soybeans were associated with increases in their yields and variable profits but significant decreases in herbicide use. The "Golden Rice" developed by the insertion of genes from a daffodil and a bacterium into rice plants to produce beta-carotene in higher quantity when compared to normal rice varieties. This crop has the potentiality to significantly improve vitamin uptake in poverty-stricken areas where vitamin supplements are costly.

Molecular marker technology in agriculture

Conventional and biotechnological research have played an important role to solve the major constraints which limits the crop productivity. However, limitations such as complex genome, poor fertility, narrow genetic base, susceptibility to biotic/ abiotic stresses and long duration to breed elite cultivars hinders the crop improvement programmes. Hence various biotechnological strategies are adopted to overcome the biotic and abiotic stresses to enhance the crop productivity on sustainable basis. The utilisation of isozyme and molecular based research accelerates the conventional methods of plant breeding programmes. But DNA markers are widely employed due to their abundance in the plant genome. Unlike morphological and biochemical markers, DNA markers are unlimited in number, are not affected by environmental factors or any developmental stages of the plant. Increasingly, techniques are being developed to more precise assessment of genetic variations. The different molecular markers include: hybridization-based markers

[Restriction Fragment Length Polymorphism (RFLP)], PCR based markers [Random Amplification of Polymorphic DNA (RAPD), Amplified Fragment Length Polymorphism (AFLP), microsatellite or Simple Sequence Repeat (SSR)], sequence-based markers: Single Nucleotide Polymorphism (SNP) have been applied to a large varieties of crop plants.

With the advancement of technology, these molecular markers are tightly linked with large number of disease resistance and agronomic traits and hence used to track loci in economically important crops. DNA markers associated with genes/QTLs which control several useful traits has been utilised in marker assisted selection. Molecular markers can also widely used in gene introgression through back crossing, characterization of germplasm, understanding genome organisation, transformant characterization as well as in phylogenetic analysis. In current scenario, several DNA markers become the marker of choice for the study for genetic diversity assessment to identify superior traits in agronomic crops such as maize, rice, wheat, legumes etc. for breeding programmes. Marker technology is appropriate because genes associated with important traits can be detected even in the seedling stages. This can be further utilised to increase productivity through the development of improved varieties with high yield, higher nutritional values, increased shelf life etc.

Genome editing in Agriculture

With the advancement in biotechnology and molecular biology, targeting susceptibility inducing genes using genome editing techniques has proven to bean effective way to develop stress/disease resistant crops. However abiotic stresses like drought, salinity, temperature and heavy metal toxicities also account for huge loss of crop yields. Understanding the basic physiological and metabolic pathways responsible for developing abiotic stresses in plants and by targeting several transcriptional factors leads to the production of plants with abiotic stress tolerance. Novel genome-editing technologies plays an important role in developing biotic and biotic stress resistant cultivars through important tools such as Transcription

Activator-Like Effector Nucleases (TALENs), Zinc Finger Nucleases (ZFNs), and Clustered Regularly Interspaced Short Palindrome Repeats (CRISPR)/CRISPR-associated protein 9 (Cas9) and site-directed mutagenesis. Among these tools, CRISPR/Cas9 has been reported as an effective genome editing technology for crop improvement.

Importance of Omics in agriculture

The omics approaches have emerged as an important technology for plant research for the last few years. With the advancement of Next Generation Technologies (NGS), phases of omics have been developed into different areas. Over the last few decades, various omics technologies have emerged and proved to be valuable technologies for exploring genetic and molecular basis of crop development through DNA modifications proteins level, metabolites identification, against environmental and physiological stress responses. Different omics technologies such as genomics, transcriptomics, proteomics, metabolomics, ionomics etc., have revealed each corresponding molecular biological informations integrated with plant systems. Thus, multi-omics approaches with high throughput techniques have played an important role in elucidating growth and yield, in responses to various biotic/ abiotic stress in numerous crops. The integration of functional genomics with other omics studies highlighted the relationships between genomes and phenotypes of different crops under specific physiological and environmental conditions. The influence of bioinformatics tools in integrating or analysing large data sets from omics study enhance our better understanding of molecular regulator networks for crop improvement.

Ethical issues and regulations

In developing countries, farmers who are not growing GM plants can save seeds for replanting the next year. The terminator technology developed as a result of the genetic engineering prevent them to purchase transgenic crop seeds. Since, terminator seeds are genetically engineered, to produce plants with seeds that have poor germination and are accepted

by farmers. Despite these circumstances, there is a serious issue for the inclusion of terminator genes in which farmers cannot take advantage without being brought into the economic cycle that profits the seed companies. Without profit incentive, however, these companies are unlikely to invest the seed crops to the framers.

Food derived from transgenic crops in the United States are extensively reviewed by three federal government agencies which are responsible for different process in the review: U.S. Department of Agriculture (USDA), U.S. Food and Drug Administration (FDA) and U.S. Environmental Protection Agency (EPA). USDA has the primary responsibility for determining if the new product is safe to grow, while FDA is concerned with consumer protection and the final authority to declare if a product is safe to consume. EPA reviewed on the potential impact of product to the environment.

Companies and research institutions which studies transgenic crops must register with USDA for field testing permission. According to the review from USDA, researchers must ensure that the tested plant parts particularly pollen are not released into the environment during this period. Transgenic crops must also pass scrutiny of EPA, which is concerned with potential impacts on nontarget species and endangered/ threatened species. Current law requires that food derived from GM technology crops should carry a label if they are nutritionally different from the food produced from crops through conventional methods or if they pose any health risks.

GM crops in Indian Policies

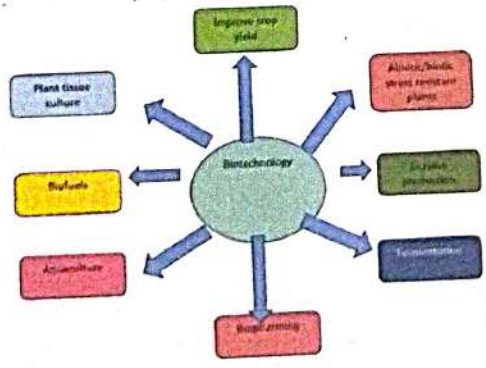
The policies on regulation of GM crops and agricultural biotechnology reflected the environmental and legal aspects existing in the country. The policies explain the complex cultural, ethical and political questions on adverse effects of GM technology arising from the public from various parts of the country. Hence the policies on agriculture sectors are framed through the constant interaction between different research institutions, scientific communities and industries all over the country.

The in-depth understanding of the existing policies allows to explore the possibilities and opportunities that the agricultural biotechnology will provide to a developing country like India. The trade-off of farmer's rights, particularly the use of Genetic Use Restriction Technology (GURT) is highly questionable and are thus rejected by India. However, real challenge exists in the way to creatively engage with the discourse of GM crops in order to take advantage of emerging technologies for the benefit of the human kind.

Future perspectives

Artificial intelligence (AI), one of the disruptive technologies that has changed processes and developments in the field of science and technology in recent years. Combined with genetic engineering and data, it can solve an important part of agriculture by maximizing the efficiency in using resources and adapting to climate change and other challenges. AI transform the agriculture sector by reducing the consumption and use of resources. Industries involved in machine learning or AI-based products for agriculture, drone and automated machine making are expected to get technological advancement in future to agriculture sector. Artificial Intelligence is advancing dramatically to transform the world both socially, and economically. Thus, the acceptance of this technology by both public and private sectors depends on policies adopted by their government.

Application of biotechnology in plant and animal sector



CONCLUSION

Globally, biotechnology provide greater opportunities for increasing productivity in agricultural sectors. They played an important role towards sustainable management of crops using various biotechnological tools. Increasing global food production within the existing land areas and with the involvement of modern plant breeding methods have enhanced production of crops, legumes in particular, to improve soil structure, fertility and organic matter content. This leads to the conservation of resources at the same prevent various environmental hazards in hilly areas. Biotechnology in agriculture which includes techniques such as, tissue culture, DNA marker- assisted breeding, gene editing and genetic modifications, has the potential to increase crop productivity and food security more effectively with the development of improved varieties with increased yields, nutritional content and storage characteristics etc. The various tools employed in biotechnology should continue to build capacity in genetic modifications technology. It should give priority to crops that are of economic importance for different traits such as drought tolerance in maize, rice, beans etc., cold tolerance, increased nutrition value and improved shelf life in rice. The establishment of germplasm are also an effective way to conserve the superior clones which will be further utilised for the management of resources. For establishing such germplasms, long development phases based on trial and error using large-scale field evaluation are required. Thus, quantitative and automated screening methods combined with decision-making algorithms like AI enables rapid screening of most promising crop lines at an early stage of development followed by the final mandatory field experiments. The combination of novel molecular markers, different screening technologies, and their applications should become the main goal of the plant biotechnological revolution in agriculture.