A STUDY ON ECO SYSTEM AND HORTICULTURE FORESTRY

Dr. Medari Ravinder
Assistant Professor of Botany, Government Degree College, Tandur, Vikarabad Dist. Telangana, India

Abstract of the Paper

Important issues in using biotechnology in agriculture and forestry are for example to enhance productivity and stress resistance of crops and trees, mainly due to restricted land area and increasing environmental pressures, and to develop carbon dioxide-neutral production systems for sustainable production of fiber/biomass and biofuel with biotechnological methods Along with the production issues, we need to conserve and protect natural diversity and species richness as a foundation of life on earth. With the recognition that increased plant diversity may also increase productivity, especially at low resource input, novel production systems combining aspects of diversity and biotechnology are emerging. Ecosystem and Forestry was an important to human beings. The techniques of plant, organ, tissue and cell culture have evolved since the beginning of this century and combined with recent advances in genetics and using conventional plant breeding, the plant biotechnology is having a significant impact on agriculture, horticulture and forestry. Some examples of the current applications in agriculture are micropropagation, somatic embryogenesis, virus and pathogen elimination, embryo rescue, germplasm storage and plant modification by somaclonal variation and genetic engineering. Another significant potential of plant biotechnology is *in vitro* production of fine chemicals using plant cell/organ cultures. This research article is to be discussed about the A study on Ecosystem and Horticulture Forestry.

Keywords: ***Sustainable Development, Ecosystem, Bioproductivity, Social Forestry, Agricultural Technology, Potential Plants, Tissue Culture***

Statement of the Problem

Important issues in using biotechnology in ecosystem, horticulture and forestry are for example to enhance productivity and stress resistance of crops and trees, mainly due to restricted land area and increasing environmental pressures, and to develop carbon dioxide-neutral production systems for sustainable production of fiber/biomass and biofuel with biotechnological methods. Along with the production issues, we need to conserve and protect natural diversity and species richness as a foundation of life on earth. With the recognition that increased plant diversity may

IJFANS INTERNATIONAL JOURNAL OF FOOD AND NUTRITIONAL SCIENCES
ISSN PRINT 2319 1775 Online 2320 7876
 Journal Volume 12,Iss 01, 2023

also increase productivity, especially at low resource input novel production systems combining aspects of diversity and biotechnology are emerging.

Biotechnological methods are currently being developed to explore and make better use of the genetic diversity in important crops, as was reported by for cassava cultivars often grown by farmers in east Africa. Pathogens are one of the biggest threats to crop production in many production systems, and modern biotechnology offers excellent possibilities for high-throughput methodologies for the rapid and efficient screening of economically important crop pathogens. The work by provides a nice example for the development of a biotechnology based methodology for the early detection and quantification of a potentially important plant pathogen, although verification of the methodology in crop plants and under field conditions still remains to be done. Crop products such as grains are often used as feed in animal production, but need to be stored for extended periods for this purpose which implies the increased use of fossil resources for instance for drying the grain. Alternatively, the moist storage of the grain has environmental and also nutritional advantages, and can be facilitated by using appropriate microorganisms with the moist stored grain. An example for this technology is reported by who exploited the microbial diversity of yeast with biotechnological methods to ultimately improve an animal production system in terms of less use of fossil fuels and enhanced nutritional quality of the feed grain.

Ecosystem, Horticulture and Forestry

The contributions of Indian agriculture in ensuring national food security, improving livelihood of rural poor and reducing poverty are well documented. Of late, there have been concerns about rising environmental costs of agricultural development, mainly because of indiscriminate use of natural resources like groundwater, erosion of soil and biodiversity. Therefore, sustainability and resilience of agricultural production systems have gained importance for future growth. The linkages between production systems, natural resources, environment and social system have now become more prominent to reduce environmental footprints of agricultural development. In particular, understanding of agriculture-ecosystem interactions and trade-offs is essential for considering agriculture and ecosystems in a holistic manner and corrections of those processes, which contribute to negative environmental footprints.

Agriculture as a manmade ecosystem provides as well as relies upon services of natural ecosystems. These ecosystem services, for well-being of people (health, livelihood, survival) and sustaining life on earth are getting increasing attention of researchers for their assessment. The Millennium Ecosystem Assessment has analysed provisioning services from agriculture such as provision of food, fibre and

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Official Publication of International Association of Food and Nutrition Scientists

IJFANS INTERNATIONAL JOURNAL OF FOOD AND NUTRITIONAL SCIENCES
ISSN PRINT 2319 1775 Online 2320 7876
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fuel. The other services from agriculture such as soil conservation, water quality, carbon sequestration, biodiversity conservation, etc. also gained importance later. At the same time, agriculture also generates ecosystem disservices (EDS) in terms of nutrient leaching, groundwater depletion, pesticide pollution, etc. It is, therefore, important to understand ecosystem services provided by different agro-ecosystems and quantify them for prioritising investment decisions and development of institutional frameworks for incentivising the people who are generating these services. Also, appropriate institutional arrangements can be designed to incorporate investment and incentives for increasing the ecosystem services in economic development framework.

Understanding of ecosystem services and their incorporation into development process is rather absent in developing countries and India is no exception to this. At the most, the concept is confined to few studies in the domain of environmental sciences. But Indian agriculture has reached a stage where further neglect of ecosystem services will impair the development process and cost significantly to the economy in terms of cost associated with the mitigation process. Air and water pollution, pesticide residue, natural resource degradation and green-house emission are some of the notable ecosystem dis-services with heavy toll on human health and environment, and their corrective measures would need significant resources. With this background, a national seminar was organized to discuss and document ecosystem services from different agro-ecosystems in India. This volume contains a summary of discussions and presentations at the seminar. The main issues discussed were nature of ecosystem services and their valuation methods, technologies and practices (biological amendments, conservation agriculture), investments and agricultural policies for increasing the flow of services. This chapter provides a synthesis of evidences, followed by a detailed review of global studies on ecosystem services and valuation methods in the next chapter. The subsequent chapters contain case studies on biodiversity, wetland ecosystems, and services from soil and water conservation programs, soil amendments, and agro-forestry systems. It is hoped that the volume would contribute to the understanding of ecosystems services from agriculture and convince for the development of an institutional mechanism to channelize investment to improve these services and quality of life.

Ecosystems and Ecosystem Services

An ecosystem can be defined as a natural unit of living things and their physical environment. Ecosystems provide a range of services for human well-being and sustaining life. They also offer goods for consumption and contribute to their attributes (system structure, diversity, etc.) for their sustenance. The concept of

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ecosystem services gained attention after a study by on ecosystems and their linkages with human welfare. The benefits people derive from the ecosystems were defined as ecosystem services (ES) and MEA identified four major types of ecosystem service, viz. provisioning services, regulating services, supporting services, and cultural services. These ecosystem services are illustrated in Similarly, mangrove ecosystems are spread across West Bengal, Gujarat, Andaman & Nicobar Islands, Andhra Pradesh, Odisha and Maharashtra. However, these ecosystems are degrading at an alarming rate, primarily because these ecosystems are common property resources with unrestricted exploitation by the users. The valuation of ecosystem services would attract attention of the government for restoration of these systems.

Current Biotechnological methods

More direct uses of biotechnology are applied to improve crop and tree management and yield by modification of plant architecture to enhance the stress resistance of economically important plants or to enhance the productivity and stress resistance of trees in the development of CO_2-neutral biomass production systems The ecological consequences of biomass production systems need to be evaluated at landscape scale, and biotechnological methods can be used with advantage to investigate the relationships between genetic diversity in tree plantations and an indicator for biodiversity (here arthropod abundance) as an ecosystem service. The latter paper is one of few examples in which serious efforts were made to link genetic diversity of a dominating tree with biodiversity at landscape scale.

The contributions to this Research Topic Ecosystem and Plant Biotechnology in Agriculture and Forestry represent an impressing breath of biotechnology applications in agriculture and forestry. However, keeping in mind that genetically modified organisms have now been used for more than two decades, surprisingly few reports were submitted with a clear focus on the ecological consequences of biotechnology in agriculture and forestry. The poor representation of investigations on ecological consequence assessments is probably indicative of the general paucity of studies linking genetically modified plant traits to ecosystem processes at longer time scales recently pointed out by and illustrates a difficulty when bridging ecological impact assessment and plant breeding: Major targets for ecological impact assessment are quantities at the ecosystem level, while the targets for plant breeding are individual plant traits. Irrespective of the technology of crop/tree improvement used, our knowledge on the mechanistic links between individual plant traits and ecosystem processes is poor and needs to be investigated more in the future. In this context, noted that biotechnology may provide a unique tool for gaining insights into the links between plant traits and ecosystem processes when integrated into basic ecological research.

IJFANS International Journal of Food And Nutritional Sciences
Official Publication of International Association of Food and Nutrition Scientists

ISSN PRINT 2319 1775 Online 2320 7876
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Although *in vitro* culture techniques were developed quite early for all the millet species transformation of millets has so far lagged behind in comparison to major cereals (wheat, rice, maize and barley). One of the main reasons is that many of the millets are not of economic importance to developed countries and therefore scarcity of research funding has always been a problem. Also major labs have concentrated their research efforts on improvement of major cereals and many of these cereals have a quite developed transformation system Genetically modified maize, wheat and rice are either under field evaluation or are being grown by farmers in large areas. The impact of genetically modified crops on society has been discussed in several publications. Millets are still not very responsive to transformation protocols. There are no model cultivars which can be transformed at an efficient rate for any of the millet species. The *Agrobacterium* transformation system is becoming the main mode of transformation for major cereals. Though initially they were thought to be out of the host range, this system is important because of its usually giving high transformation efficiency, simple integration pattern and simple handling. At present protocols are not available to infect millet explants with the *Agrobacterium*. Also the *Agrobacterium* transformation system is highly cultivar dependent and it is important to look for millet cultivars that can be transformed with the *Agrobacterium*.

Major growing regions of millets are in the under developed and developing world, where the main goal is still to increase production rather than to improve nutritional value. Increase in production is mainly possible by conventional breeding methods of selection and controlled hybrids. Many of the cultivars with natural resistance against biotic and abiotic resistance are already available. This is also one of the reasons why millets have been overlooked so far for improvement for novel traits.

All the major cereals crops including rice, wheat, maize, barley, *Avena* and *Tritordeum* have been genetically transformed using the particle gun, protoplasts or Agrobacterium mediated gene transfers But, production of transgenic plants in millets remain restricted only to pearl millet and bahia grass. Other small millets have been overlooked due to economic or regional considerations. The genetic transformation protocols for millets are important to bring the tertiary gene pool into the improved cultivated varieties.

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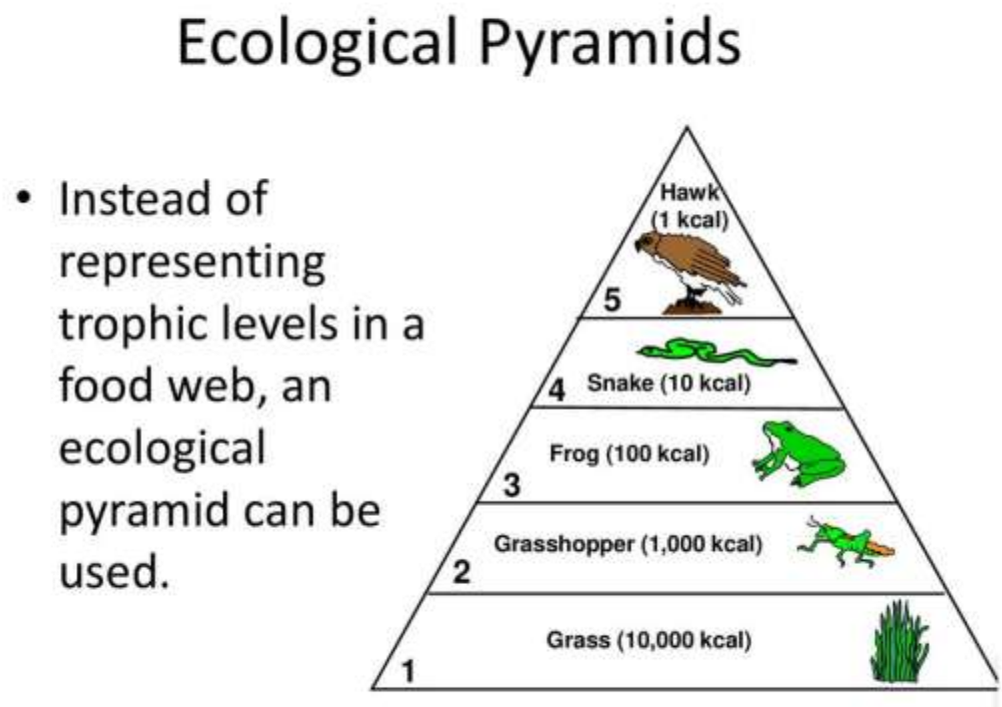
ISSN PRINT 2319 1775 Online 2320 7876
 Journal Volume 12,Iss 01, 2023

Ecological Consequences



With the increasing recognition of world population feeding and health, global climate change and biodiversity loss, and limited energy resources with fossil fuels calling for alternatives such as biomass crops, the relevance of agriculture, and forestry for human well-being in the future is more than evident. In this context, applications of biotechnological methods including genetic engineering, marker-assisted breeding, clonal propagation of elite trees, etc., are becoming very important, but are frequently debated in the public. Genetically modified organisms were first introduced into commercial agriculture more than two decades ago, and have often led to higher yields but also more flexible and efficient management strategies. Trait manipulation of target organisms and production system components also creates opportunities for improved products obtained with more effective resource utilization and reduced negative environmental impact. Nevertheless, manipulated traits may introduce unforeseen effects on ecological processes. Due to the complexity of agricultural and tree production systems and the different scales involved in the biological studies with genetically modified organisms on one hand and ecological studies targeting ecosystem processes on the other hand, trans- or inter-disciplinary approaches are often needed. The intention of this Research Topic was to highlight the need for integrated approaches in research activities and to bridge research progress within the areas of plant biology, ecology, and ecosystem science. Contributions deal

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with various aspects of crop/tree biotechnology and diversity for biomass, food and feed production and their ecological consequences.

Important issues in using biotechnology in agriculture and forestry are for example to enhance productivity and stress resistance of crops and trees, mainly due to restricted land area and increasing environmental pressures, and to develop carbon dioxide-neutral production systems for sustainable production of fiber/biomass and biofuel with biotechnological methods Along with the production issues, we need to conserve and protect natural diversity and species richness as a foundation of life on earth. With the recognition that increased plant diversity may also increase productivity, especially at low resource input, novel production systems combining aspects of diversity and biotechnology are emerging.

What need to be done?

Biotechnological methods are currently being developed to explore and make better use of the genetic diversity in important crops, as was reported by for cassava cultivars often grown by farmers in east Africa. Pathogens are one of the biggest threats to crop production in many production systems, and modern biotechnology offers excellent possibilities for high-throughput methodologies for the rapid and efficient screening of economically important crop pathogens. The work by provides a nice example for the development of a biotechnology based methodology for the early detection and quantification of a potentially important plant pathogen, although verification of the methodology in crop plants and under field conditions still remains to be done. Crop products such as grains are often used as feed in animal production, but need to be stored for extended periods for this purpose which implies the increased use of fossil resources for instance for drying the grain. Alternatively, the moist storage of the grain has environmental and also nutritional advantages, and can be facilitated by using appropriate microorganisms with the moist stored grain. An example for this technology is reported by who exploited the microbial diversity of yeast with biotechnological methods to ultimately improve an animal production system in terms of less use of fossil fuels and enhanced nutritional quality of the feed grain.

Summing up

More direct uses of biotechnology are applied to improve crop and tree management and yield by modification of plant architecture, to enhance the stress resistance of economically important plants, or to enhance the productivity and stress (drought, pests) resistance of trees in the development of CO_2-neutral biomass production systems. The ecological consequences of biomass production systems need to be evaluated at landscape scale and biotechnological methods can be used with advantage to investigate the relationships between genetic diversity in tree plantations

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and an indicator for biodiversity (here arthropod abundance) as an ecosystem service. The latter paper is one of few examples in which serious efforts were made to link genetic diversity of a dominating tree with biodiversity at landscape scale.

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