# Preservation of Biodiversity and Sustainability of Ecosystem


## Abstract

Sustainable agriculture and biodiversity have a significant impact on human well-being, ecological resilience, and food security. They are closely related aspects of the future of our planet.It promotes the stability and functioning of ecosystems, providing numerous ecosystem services vital for agriculture, including pollination, pest control, nutrient cycling, and genetic resources for crop breeding. Biodiversity provides ecosystem services strengthening agricultural productivity and resilience. For instance, pollinators like bees and butterflies facilitate the reproduction of many crops, while natural predators help control pest populations, reducing the need for chemical pesticides. Sustainable agriculture, on the other hand, seeks to meet current food needs without compromising the ability of future generations to do the same. However, modern agricultural practices have often led to the degradation of ecosystems, loss of biodiversity, and the erosion of genetic diversity in crops and livestock. These problems have been exacerbated by deforestation, overuse of agrochemicals, and monocropping.In the long term these practices harm the environment and endanger food security by reducing the system's ability to adapt to changing conditions. Sustainable agricultural practices, by enhancing farming methods such as crop rotation, agroforestry, and organic farming, can support and enhance biodiversity by preserving habitat diversity.Conservation of native species, implementation of agro-ecological practices, and support for small-scale farmers are important steps towards achieving a harmonious coexistence between agriculture and biodiversity.There is a need of collaboration across all sections of society from intergovernmental agreements down to local community action for tackling the biodiversity catastrophe. People may learn more about local ecosystems and develop a greater regard and appreciation for them by reestablishing a connection with nature and inspiring others to do the same. UNDP sustainable development goal-15 aims to protect the biodiversity by sustainable use of terrestrial ecosystem.



**Keywords** – Biodiversity, Ecosystem, Food security, Organic farming, Sustainable agriculture


## 1. Introduction

Agricultural biodiversity encompasses both the elements of biological diversity that pertain to food production and agriculture and those that constitute the broader agro-ecosystem (Altieri, 2004). The totality of all organisms, genetic diversity, and aquatic, marine, and land-based environments is known as biodiversity. It covers the diversity found in living things as well as in the ecological systems of which they are a part (FAO, 2018).Biodiversity guarantees that nature, the biosphere, and life on earth stay diversified. It is quite environmentally friendly. If life on this planet did not exist, it would perish. The cornerstone of world food and nutrition security is biodiversity (Padhy et al., 2022).

While a portion of the biodiversity is actively managed to meet human needs for goods and services, a significant portion is not directly intended for production but remains

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indispensable as a reservoir of resources. Furthermore, it plays a crucial role in supporting ecosystem services like pollination, the mitigation of greenhouse gas emissions, and the regulation of soil dynamics (Frison *et al.*, 2011). Farmers are facing more stress due to climate change and biodiversity loss (Padhy and Raju, 2020). Modern, intensive agriculture operates on a premise of diminishing agricultural biodiversity. This fundamental approach revolves around specialization, wherein farms focus on either livestock or crops, resulting in a decrease in the number of species in their operations (Jackson *et al.*, 2007) Furthermore, fields are enlarged, diminishing the presence of field margins and hedgerows that support diverse ecosystems (Proulx *et al.*, 2010). Soil amendments are employed to promote soil uniformity, and monocultures of genetically identical individuals tend to dominate the landscape. In this context, agricultural biodiversity is often primarily viewed as a resource to be conserved for its potential to provide traits that can enhance breeds and varieties, a viewpoint that holds true (Conner and Mercer, 2007) (Huang *et al.*, 2002). However, we posit that agricultural biodiversity, in and of itself, is a valuable asset that yields substantial benefits across various domains. Growing evidence suggests that diversity, in its intrinsic form, must play a central role in sustainable agricultural development. While it is true that agricultural biodiversity can provide valuable traits for breeding and variety improvement, it is equally crucial to recognize its inherent value as a driver of sustainable agricultural practices across multiple dimensions(Frison *et al.*, 2011).To accommodate the projected population of 10 billion individuals expected to inhabit Earth by 2050, it is imperative to strike a delicate equilibrium between quality and diversity in our approach to food production. This entails establishing a connection between productivity and sustainability, all while addressing the fundamental needs of our global populace. It is increasingly evident that the preservation of biodiversity and the sustainable management of natural resources must take precedence within national strategies if we aim to supply nourishing sustenance for both present and future generations and fulfill the objectives outlined in the 2030 Agenda for Sustainable Development (FAO, 2018). Due to rapid industrialization and environmental degradation, there is loss of biodiversity(Pattanayak and Padhy, 2020). Presently, a staggering 821 million people continue to grapple with chronic hunger, with nearly a quarter of children under the age of five experiencing stunted growth, while malnutrition affects a third of the world's population. The concerning surge in obesity, impacting one in every eight individuals worldwide, constitutes a troubling recent phenomenon. This surge is largely driven by rapid urbanization and the accessibility of inexpensive, energy-dense, processed foods high in fats, salts, and sugars, which are readily available to economically disadvantaged communities (FAO, 2018).Biodiverse ecosystems safeguard human beings against natural calamities like floods and storms, as well as filtering and renewing our soils. Biodiversity is really important for the environment(Padhy et. al., 2022).

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## 2. Implementing diversity in agroecosystems

Biodiversity eco-system functioning (BEF) relationships are asymptotic. Thus, the biggest benefits of additional species occur inspecies-poor communities (Cardinale *et al.*, 2012) (Isbell *et al.*, 2017). Agricultural monocultures, where human intervention tightly controls plant diversity, hold significant potential for enhancing ecosystem functioning through diversification, as suggested by Manning et al. (2019), across various spatial and temporal scales, as indicated by Brooker et al. (2015). Agroforestry, the integration of trees or shrubs into crop production, can offer benefits such as erosion control, improved soil fertility, and enhanced biodiversity of other organismal groups, as demonstrated in a meta-analysis by Torralba et al. (2016). The adoption of row cropping, whether involving different main crops or incorporating service crops, has the potential to boost yields, reduce the need for fertilizers, and support pollination or pest control, as evidenced by Albrecht et al. (2020) and Li et al. (2020) in their respective extensive meta-analyses. Intra-field mixtures of various crop varieties can deliver a range of advantages, with examples including the reduction of disease pressure through mixed varieties of wheat (Kristoffersen et al., 2020) or rice (Zhu et al., 2000). While diversifying root strategies increased wheat productivity, other trait diversities did not yield similar results, as found by Montazeaud et al. (2020). Moreover, Reiss and Drinkwater's meta-analysis revealed that studies explicitly targeting functional diversity enhancements reported greater yield increases compared to those that randomly mixed varieties (Reiss and Drinkwater, 2018). Temporal diversification practices encompass relay cropping and crop rotation, which may involve the use of cover crops between main crops. According to a global meta-analysis by Albrecht et al. (2020), relay cropping can deliver the benefits of row or mixed cropping while mitigating negative effects like crop competition, achieved by growing crops together only during specific periods of their growth cycle. Crop rotation, the sequential cultivation of different crops, is a widely used approach. Garland et al.'s recent study on European crop fields showed that the benefits of crop rotations are heightened when the rotation scheme incorporates a greater diversity of species (Garland et al., 2021).Crop rotations are thus crucial for sustainable agroecosystems with a longstanding history (McDaniel *et al.*, 2014), but developments like chemical inputs and specialized machinery together with economic market trends have shortened and simplified rotation cycles with often negative consequences for crop yields (Bennet *et al.*, 2012).

**2.1 Agricultural sectors are major users of biodiversity but also have the potential to contribute to the protection of biodiversity:**

Sustainable agriculture plays a pivotal role in counteracting the patterns that result in biodiversity depletion, ecological harm, forest depletion, and the general degradation of our environmental assets. When terrestrial, freshwater, and marine ecosystems are effectively and sustainably managed, the agricultural industry can actively contribute to the supply of ecosystem services. These services encompass the preservation of water quality, the cycling of nutrients, the creation and restoration of soil, erosion mitigation, carbon capture, resilience enhancement, the provision of habitats for wildlife, natural pest control, and the promotion of pollination (FAO, 2018).

Picture- 1 Major agro-forestry species of the different Indian farming agro-ecologies

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| Agroecology | Main Crops | Main Tree/Shrub Agroforestry Species |
|---|---|---|
| Hill and mountain | Rice, wheat, minor millets (ragi, barnyard millet, foxtail millet), black-seeded soybean, urd bean, horsegram, mustard, sesame, pseudocereals (amaranths, buckwheat), miscellaneous vegetables, temperate fruits, etc. | Main agroforestry species for high quality fiber are *Ficus semicordata*, *Grewia oppositifolia*, *G. asiatica*, etc., and for edible fruits are *Celtis australis*, *Grewia oppositifolia*, *G. asiatica*, *Ficus auriculata*, *F. palmata*, *F. semicordata*, *F. nemoralis*, *Pyrus pashia*, etc., beside several others. |
| Hot arid | Pearl millet, mung bean, sesame and cluster bean | *Prosopis cineraria*, *Ziziphus nummularia*, *Capparis decidua*, *Acacia senegal*. |
| Central tribal plateau | Rice, wheat, pigeon pea, mung bean, urd bean, soybean | Forestry species: *Acacia nilotica*, *Leucaena leucocephala*, *Gmelina arboria*, *Dalbergia sissoo*, *Millettia pinnata*, and as fruit trees: *Syzygium cumini*, *Psidium guajava*, *Moringa oleifera*, *Phyllanthus emblica*, *Annona reticulata*, *Artocarpus heterophyllus*. |
| North-eastern region | Rice, tea, vegetables, sugarcane, jute, cotton, black gram, lentil, green gram, gram, pigeon pea, linseed, castor, sesame, rapeseed and mustard, banana, papaya, orange, pineapple, areca nut, coconut, chili, turmeric, ginger, potato, sweet potato, etc. | *Aquilaria agalacha* (Agar), *Areca catechu*, *Schima wallichii*, *Cassia nodosa*, *Cassia seamea*, *Albizzia procera*, *Piper betel*, *P. longum*, bamboos, canes, timbers and other shade trees. |

(Source-Bisht *et al.*,,2020)

Table-1 Major staple food crop species and within species (genetic) diversity in different agroecologies:

| Sl.no | Agroecology | Crop Species Diversity (no.s) | Within-Species(Genetic Diversity) no.s | Area Share of common Landraces(%) | Area Share of Rare Landraces(%) | Loss of Species Diversity(%) | Loss of Genetic Diversity(%) |
|---|---|---|---|---|---|---|---|
| 1. | Hill and Mountain | 17 | 52 | 40 | 60 | 15 | 5 |
| 2. | Hot arid | 12 | 37 | 47 | 53 | 20 | 5 |
| 3. | Central tribal plateau | 14 | 41 | 52 | 48 | 20 | 8 |
| 4. | North-eastern region | 21 | 61 | 45 | 55 | 25 | 10 |

(Source-Bisht *et al.*,,2020)

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**2.2 Good governance, enabling frameworks, stewardship incentives and sound monitoring are key to mainstreaming biodiversity:**

Enacting laws to oversee and control genetic resource access, establishing protected areas to combat the deterioration of natural habitats, designing incentives to encourage the provision of ecosystem services, and systematically monitoring the biodiversity of flora and fauna to pinpoint endangered varieties and breeds are integral components of the support structure for incorporating biodiversity considerations. FAO collaborates with its partners to facilitate the integration of measures aimed at conserving, sustainably managing, and restoring biological diversity within agricultural domains on national, regional, and global scales (FAO, 2018).

Picture-2 Sustainable agriculture practices and systems in India (2021) – Key statistics


(Source – Gupta *et al.*, 2021)

## 3. Nutrition and Health

Every day, agriculture produces an average of 23.7 million tons of food, provides livelihoods for 2.5 billion people, and is the largest source of income and jobs for poor, rural households. In developing countries, agriculture accounts for 29% of GDP and 65% of jobs (https://www.cbd.int/article/biodiversityforfood-2) .Enhancing food yields, particularly in terms of essential nutrients like proteins and calories, may not be the most immediate priority for ensuring food security. Despite notable progress in tackling protein and calorie deficiencies, approximately one billion individuals worldwide still grapple with starvation, and a third of the global population faces various micronutrient deficiencies, often referred to as hidden hunger (Alnwick, 1996). Accurately quantifying the extent of hunger and malnutrition burdens is a complex task, and short-term statistics tend to fluctuate unpredictably. According to a joint report by the United Nations' Food and Agriculture Organization and the World Food Programme in 2010, 925 million people experienced chronic hunger that year. Interestingly, there are currently more individuals who are overweight or obese than those who are chronically hungry, even in developing countries (Gardner et al., 2000; Mendez et al., 2005). Previous strategies to combat micronutrient deficiencies have mainly followed a medical model, focusing on fortification (e.g., iodine in salt), supplementation (e.g., high doses of vitamin A), or increasing the micronutrient content of staple crops through bio-fortification. While each of these approaches has its merits, agricultural biodiversity could serve as a valuable complement (Johns and Eyzaguirre, 2006). This approach goes beyond addressing specific deficiencies with individual food components (Low et al., 2007). Instead, it aims to diversify dietary composition, firmly believing that this broader dietary diversity not only provides an array of micronutrients but also includes other vital elements such as fibre, ultimately leading to improved health outcomes.

## 4. Climate Change

It is becoming increasingly evident that climate change will lead to entirely new weather patterns (Williams et al., 2007), and these changes will significantly impact agriculture across all levels (Jarvis et al., 2008; Lobell et al., 2008).Due to climate change, global temperatures increase and it has effect on biodiversity(Padhy and Pattanayak, 2020). Substantial evidence already exists demonstrating shifts in the abundance and distribution of various insects (Menendez, 2007), which are expected to influence the spread of pests and diseases as well as methods to control them. In light of climate change and increased climatic variability, the importance of adaptability and resilience in agricultural production systems is growing, and there is evidence to support this trend (Frison *et al.*, 2011). To complete this cycle, plant and animal breeders will need to harness the existing biodiversity to develop new breeds and varieties capable of thriving in altered conditions. However, it might also be advantageous to provide farmers and other stakeholders with a broader genetic pool that they can use to select adapted and adaptable populations. These genetic resources could be in the form of segregating populations resulting from wide crosses, multi-lines, mixtures, or simply accessions from areas on the fringes of the typical growing range. Indications suggest that this approach could expedite the adaptation of farming systems to changing conditions more effectively than breeding methods reliant on additional external inputs (Finckh*et al.,* 2000)(Kotschi, 2007).Due to changing environment, farmers are facing increased levels of stress, worries, depression, problem in sleeping, emotional outbursts, dramatic changes in weight, substance abuse, and feelings of failure (Padhy et al., 2020).

## 5. A Platform For Action (FAO,2018)

The Biodiversity Mainstreaming Platform's primary objective is to transform diverse and extensive knowledge into actionable recommendations. During the Fortieth Session of the FAO Conference, FAO's initiative to spearhead this platform was warmly received. The FAO was subsequently tasked, in partnership with the CBD, various UN bodies, and collaborators, to facilitate the incorporation of measures aimed at conserving, sustainably utilizing, managing, and restoring biological diversity within agricultural sectors on national, regional, and global scales. The ultimate aim of this platform is to encourage the adoption of best practices across all facets of agriculture, thereby supporting biodiversity conservation. This approach will enhance the productivity, stability, and resilience of agricultural systems while simultaneously alleviating the pressure on natural habitats and species. With a particular focus on addressing Sustainable Development Goals 2, 14, and 15, the platform will also serve as a mechanism for sharing expertise to enhance the formulation and coordination of policies, ranging from local to international levels. Additionally, it will facilitate the exchange of information and data among stakeholders to foster a common understanding of the current situation, trends, and trade-offs related to the conservation and utilization of biodiversity services.

The Biodiversity Mainstreaming Platform is focusing on the following areas of work:

**5.1 FAO process**

- Enhancing FAO's organizational capability to incorporate biodiversity into its core activities.
- Crafting a comprehensive biodiversity plan within FAO for deliberation during the upcoming Conference session.
- Guaranteeing active involvement and endorsement of FAO's governing and statutory bodies in the process of integrating biodiversity considerations.
- Aiding nations in the integration of biodiversity measures to advance their progress towards achieving the Sustainable Development Goals.

**5.2 Multi-stakeholder engagement**

- Participating in pertinent global initiatives, such as the formulation of the CBD's post-2020 global biodiversity framework.
- Coordinating national or regional discussions involving multiple stakeholders to promote the integration of biodiversity concerns.

**5.3 Fundraising**

- Developing a funding strategy and proposals.

**5.4 Global Level**

- Raising awareness of the importance of biodiversity across agricultural sectors
- Promoting dialogue on key issues such as policies, metrics, practices and territorial planning
- Facilitating the engagement of stakeholders from the agricultural sectors in the development of the CBD's post-2020 global biodiversity framework

**5.5 Regional and National Levels**

- Regional and national multi-stakeholder dialogues promoting sustainable practices in agriculture, forestry and fisheries
- Supporting the integration of biodiversity in national agricultural plans, as well as sustainable agriculture in countries' commitments to multilateral environmental agreements
- Implementing global policy instruments for mainstreaming biodiversity

## Conclusion

Agriculture relies heavily on biodiversity, yet it also possesses the potential to contribute significantly to biodiversity conservation. Covering more than one-third of land in most countries worldwide, sustainable agricultural practices can enhance crucial ecosystem functions. These functions encompass preserving water quality, mitigating erosion, fostering biological pest control, and facilitating pollination. Our ability to harness these ecosystem services in the future hinges on our current understanding, valuation, and management of them, both within and beyond agricultural systems. To attain this goal, collaboration among various sectors is imperative (FAO, 2018). However, there are uncertainties, including doubts about the effectiveness of various management practices concerning belowground processes and the need to consider context-dependent factors such as abiotic, biotic, and cultural influences in the development of comprehensive strategies for sustainable agriculture

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(Seraina et al., 2022). Economic and sustainable development have positive effect on maintenance of biodiversity(Pattanayak and Padhy, 2022). Recent concerns regarding soaring food prices and dwindling food availability underscore the renewed international focus on agriculture and its production. There is now a growing recognition of the formidable challenges associated with increasing food production to meet the demands of a burgeoning global population amidst changing climates, all while adhering to sustainability principles. In this context, agricultural biodiversity assumes an increasingly pivotal role, not just as a source of traits for the ongoing enhancement of staple crops but as an indispensable component of upgraded production systems. While other facets of food systems and production, such as harvest and post-harvest storage, small-scale processing (including domestic cooking methods), and marketing, require further research and development to ensure sustainable improvements in food and nutrition security, the more efficient utilization of agricultural biodiversity should be integrated into these sectors as a fundamental consideration.Rural leadership is strongly required to address the biodiversity issues (Padhyet al. , 2022).

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