Biodiversity and Sustainable Agriculture

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Concept

Biodiversity consists of all the many species of animals, plants, microorganisms and other life forms and the variety that exists within each species. Official definition used by the convention on biological diversity is "the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems."

Agricultural Biodiversity

Agricultural biodiversity includes all components of biological diversity of relevance to food and agriculture, and all components of biological diversity that constitute the agroecosystems: the variety and variability of animals, plants and microorganisms, at the genetic, species and ecosystem levels, which are necessary to sustain key functions of the agro-ecosystem, its structure and processes.

Dimensions of Agricultural Biodiversity

The following dimensions of agricultural biodiversity can be identified:

1) Genetic resources for food and agriculture:

- *Plant genetic resources*, including crops, wild plants harvested and managed for food, trees on farms, pasture and rangeland species,
- *Animal genetic resources*, including domesticated animals, wild animals hunted for food, wild and farmed fish and other aquatic organisms,
- *Microbial* genetic resources.

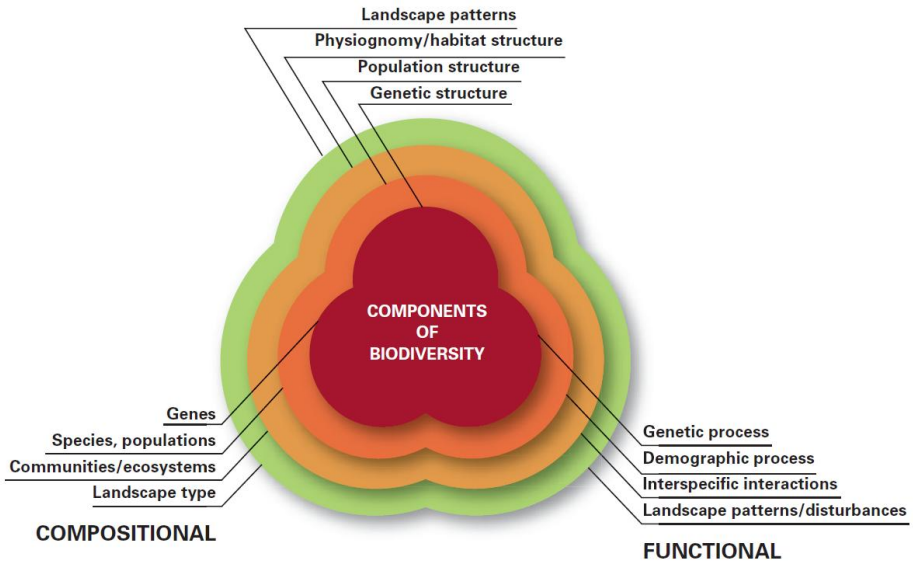

Fig. Different scales of agricultural biodiversity that support ecosystem services upon which agriculture is based (Noss, 1990)

These constitute the main units of production in agriculture, and include cultivated and domesticated species, managed wild plants and animals, as well as wild relatives of cultivated and domesticated species.

2) Components of biodiversity that support ecosystem services upon which agriculture is based. These include a diverse range of organisms that contribute, at various scales to, *inter alia*, nutrient cycling, pest and disease regulation, pollination, pollution and sediment regulation, maintenance of the hydrological cycle, erosion control, and climate regulation and carbon sequestration.

3) Abiotic factors, such as local climatic and chemical factors and the physical structure and functioning of ecosystems, which have a determining effect on agricultural biodiversity.

4) Socio-economic and cultural dimensions. Agricultural biodiversity is largely shaped and maintained by human activities and management practices, and a large number of people depend on agricultural biodiversity for sustainable livelihoods. These dimensions include traditional and local knowledge of agricultural biodiversity, cultural factors and participatory processes, as well as tourism associated with agricultural landscapes.

Importance of Biodiversity in Agriculture

It must become increasingly sustainable at the same time as meeting society's goal of providing sufficient, safe and nutritious food. Production practices based on a continuing and increasing dependence on external inputs such as chemical fertilizers, pesticides, herbicides and water for crop production and artificial feeds, supplements and antibiotics for livestock and aquaculture production need to be altered. They are not sustainable, damage the environment, undermine the nutritional and health value of foods, lead to reduced function of essential ecosystem services and result in the loss of biodiversity. At the same time, food production needs to make its contribution to reducing the number of people who are food insecure and malnourished which remains unacceptably high at nearly 1 billion.

There are already many well-established ways of improving both the sustainability of agriculture and its capacity to deliver safe, nutritious products for a healthy diet. Integrated pest management, conservation agriculture, ecoagriculture and organic agriculture are examples of approaches to agricultural production that improve sustainability in a variety of ways that are based on enhancing efficiencies of biological processes and agro-ecosystems, and that are being used over many millions of hectares around the world.

Changing agriculture and food production in ways that ensure improved sustainability and a healthier and more nutritious food supply involve the increased use of biodiversity for food and agriculture. If loss of biodiversity (including agricultural biodiversity) has been a feature of agricultural intensification, increased use of biodiversity is necessary to improve sustainability and to cope with climate change.

Biodiversity is essential for food security and nutrition. Thousands of interconnected species make up a vital web of biodiversity within the ecosystems upon which global food production depends.

With the erosion of biodiversity, humankind loses the potential to adapt ecosystems to new challenges such as population growth and climate change. Achieving food security for all is intrinsically linked to the maintenance of biodiversity.

Special nature of agricultural biodiversity

- Agricultural biodiversity is essential to satisfy basic human needs for *food and livelihood security*.

- Agricultural biodiversity has been - and is still - shaped and developed through human activities and practices over generations. Farmers' communities play a key role as custodians and managers of agricultural biodiversity. This is why *local and traditional knowledge and culture* are considered as integral parts of agricultural biodiversity management.
- Because of the degree of human management, conservation of agricultural biodiversity in production systems is inherently linked to sustainable use.
- Nonetheless, much agricultural biodiversity is now conserved *ex situ* in gene banks or breeders' materials.
- For crops and domestic animals, diversity within species is at least as important as diversity between species and has been greatly expanded through agriculture.
- Many farming systems are based on alien crop species introduced from elsewhere; this creates a high degree of interdependence between countries for the genetic resources for food and agriculture.
- The interaction between the environment, genetic resources and management practices that occurs *in situ* within agro-ecosystems often contributes to maintaining a dynamic portfolio of agricultural biodiversity.

Present facts of Biodiversity

- Since the 1900s, some 75 percent of plant genetic diversity has been lost as farmers worldwide have left their multiple local varieties and landraces for genetically uniform, high-yielding varieties.
- 30 percent of livestock breeds are at risk of extinction; six breeds are lost each month.
- Today, 75 percent of the world's food is generated from only 12 plants and five animal species.
- Of the 4 percent of the 250 000 to 300 000 known edible plant species, only 150 to 200 are used by humans. Only three - rice, maize and wheat - contribute nearly 60 percent of calories and proteins obtained by humans from plants.
- Animals provide some 30 percent of human requirements for food and agriculture and 12 percent of the world's population live almost entirely on products from ruminants.
- Of the 8,300 animal breeds known, 8% are extinct and 22% are at risk of extinction
- Of the over 80,000 tree species, less than 1% have been studied for potential use
- Fish provide 20% of animal protein to about 3 billion people. Only ten species provide about 30% of marine capture fisheries and ten species provide about 50% of aquaculture production.
- More than 90 percent of crop varieties have disappeared from farmers' fields; half of the breeds of many domestic animals have been lost.
- Over 80% of the human diet is provided by plants. Only three cereal crops provide 60% of energy intake
- Micro-organisms and invertebrates are key to ecosystem services, but their contributions are still poorly known and acknowledged

Main threats to Biodiversity

- **Habitat loss:** It occurs when natural environments are transformed or modified to serve human needs.
- **Climate change:** It alters the climate patterns and ecosystems in which species have evolved and on which they depend.
- **Overexploitation, or unsustainable use:** happens when biodiversity is removed faster than it can be replenished and, over the long term, can result in the extinction of species.
- **Invasive alien species** (IAS): These are the that have spread outside of their natural habitat and threaten biodiversity in their new area, are a major cause of biodiversity

loss. These species are harmful to native biodiversity in a number of ways, for example as predators, parasites, vectors (or carriers) of disease or direct competitors for habitat and food.

- **Pollution:** Pollution, in particular from nutrients, such as nitrogen and phosphorus, is a growing threat on both land and in aquatic ecosystems. While the large-scale use of fertilisers has allowed for the increased production of food, it has also caused severe environmental damage, such as eutrophication.

Fig. Major threats to biodiversity

Future tasks to maintain biodiversity

- assessing the status and trends of the world's agricultural biodiversity, the underlying causes of change, and knowledge of management practices;
- identifying adaptive management techniques, practices and policies;
- building capacity, increasing awareness and promoting responsible action; and
- mainstreaming national plans and strategies for the conservation and sustainable use of agricultural biodiversity into relevant agriculture sectors.

Role of farming systems on biodiversity

Biodiversity is an important regulator of agro-ecosystem functions, not only in the strictly biological sense of impact on production but also in satisfying a variety of needs of the farmer and society at large. In particular it increases resilience of agro-ecosystems and is, as such, a means for risk reduction and adaptation to climate change. Agro-ecosystem managers, including farmers, can build upon, enhance and manage the essential ecosystem services provided by biodiversity in order to work towards sustainable agricultural production. This can be achieved though good farming practices that follow ecosystem-based approaches designed to improve sustainability of production systems. These should:

- Maintain a high level of crop genetic diversity, both on farms and in seed banks, which will help to increase and sustain production levels and nutritional diversity throughout the full range of different agro-ecological conditions;
- Integrate, through ecosystem-approach strategies, the planned biodiversity (crop sequences and associations) that is maintained with the associated diversity (for example, wild pollinators);

- Adopt production system management strategies, such as not disturbing soil, maintaining mulch covers from crop residues and cover crops that increase the biological activity and diversity of the production system;
- Consider the benefits of having fragmented land (riparian areas, forest land within the agricultural landscape) on the agricultural yield, through improved biological processes such as pollination;
- Improve the adaptation of good farming practices (i.e. pest management strategies, etc.) that follow ecosystem-based approaches designed to improve the sustainability and agricultural biodiversity of production systems; and
- Aim at producing commodities that meet the consumer needs for products that are of high quality, safe and produced in an environmentally and socially responsible way.

International and national policies

- Land management policies that permit or limit production practices or, for example, permit or limit sale of large areas of land to producers likely to engage in monocropping;
- Pollution regulations that act to limit nitrogen or phosphorus use and use of agrochemicals;
- Safety regulations, especially with regard to specific agrochemicals;
- Subsidies that favour or limit use of particular production practices;
- Land and water rights, especially for small-scale farmers, rural communities and indigenous peoples;
- Research-support policies that encourage research into particular kinds of agricultural practices; and
- Legislation in respect of seed sales, product type and identity, all of which can have positive or negative effects on the ability to use diversity to achieve production objectives.

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