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Agriculture and Biodiversity: A Better Balance Benefit Both

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Sustainable agriculture is an important component of many of the 17 Sustainable Development Goals agreed upon by the UN in 2015. However, the trend in agriculture is moving in the opposite, non-sustainable direction. Agriculture is one of the major drivers of biodiversity loss. Next to biodiversity loss due to habitat destruction by conversion of natural lands into agriculture, intensification of agriculture has led to a strong decline of specific farmland biodiversity. Furthermore, many agricultural landscapes face pollution by pesticides and fertilizers, and encounter depleted soils and erosion due to unsustainable farming practices. This is threatening not only biodiversity but also complete ecosystems and the ecosystem services on which agriculture itself depends. Moreover, the pressure of feeding an increasing number of people in combination with a change in diets towards more animal protein puts a lot of additional pressure on the current available agricultural lands and nature areas. We propose a holistic approach that contributes to the development and implementation of sustainable agricultural practices that both make use and support biodiversity and ecosystem services both in agricultural and in semi-natural areas. An agricultural system based on the full potential of (functional agro) biodiversity provides opportunities to create a resilient system in which both food production and nature can thrive.

1. Introduction

Biodiversity can be described as the richness and diversity of all life on earth. Biodiversity is not just about the individual species, but also about the diversity of ecosystems, species and genes, and the relationship between them. Biodiversity is not only relevant in/for (semi-)natural areas, but also for agricultural areas, which often have specific biodiversity which contributes to ecosystem services. Agriculture in turn can contribute to the increase and conservation of biodiversity, for example by smarter management of marginal land, but also by the management of fertile areas.

Agriculture has different functions of which production of food, feed and fibres and sustaining socio-economic structures and management of ecosystem services are the most important. In doing so, agriculture often makes use of and contributes to the services provided by ecosystems such as healthy soils. About 40% of the world's terrestrial surface has been converted into agriculture, Thus, in many parts of the world, humankind has intervened tremendously into the natural succession of ecosystems. In a resilient agricultural system, farming practices provide a good balance between the exploitation and use of biodiversity, ecosystems services and the natural surroundings. In these systems, the

challenge is to optimize food production while at the same time minimising impacts on the environment and the ecosystem.

1.1 Agriculture benefits from biodiversity: Agriculture hampers ecosystem succession, as with each cropping cycle, the system is brought back to an early-successional stage. At the same time, agriculture stimulates productivity and manages biodiversity. By converting natural ecosystems into agriculture, a new environment was created that allowed for a different biodiversity. A good example is the strong increase in the black-tailed godwit (*Limosa limosa*) population in the Netherlands when forests and peatbogs were converted into meadows and agricultural grasslands. However, today's agriculture generally aims to produce large quantities of food, against the lowest economic costs, in the short term. These short-term goals often lead to conflict with the conservation and management of biodiversity and other long-term ecosystem services. Moreover, a short-term focus on maximizing productivity can endanger the ecosystem services in such a way that dependence on external inputs such as fertilizers and pesticides increases in order to maintain productivity. When out of balance, these systems inevitably collapse or need more technical interventions to remain productive, all at great economic, social and ecological costs. The importance of agricultural biodiversity (agrobiodiversity) is thus large: living organisms are involved in all natural processes used in agriculture to produce food. If only considering soil, many types of bacteria, fungi, nematodes, springtails, earthworms, etc. are active in the soil to provide ecosystem services e.g., digesting manure, crop residues and roots. This digestion process releases nutrients for crops, and at the same time contributes to the carrying capacity of soils, to disease-suppression, water retention and water-supplying capacity of the soil. But also, on the level of plant and grassland biodiversity, the diversity of farm animals, the agricultural gene pools, or the on-farm habitat diversity, agriculture basically depends on biodiversity to function well. Recently more attention has been paid to these services in agriculture.

1.2 Biodiversity can benefit from agriculture: Besides the direct function of biodiversity in agriculture, (bio)diversity also provides other values. Due to the presence of hedges, ditches, field margins, hedgerows, etc. the cultural aspects of landscape design are preserved, but these elements also form the specific habitat for insects, birds, plants and other animals. This biodiversity has a high cultural and nature value, but can also support agricultural production e.g., nutrition, animal health (as leaves of shrubs and trees contain health-promoting substances) and welfare of livestock (animal behaviour and shade), or the provisioning of insects for pollination or biological plague reduction. When aiming for a durable and robust farming system and thus for sustainable agriculture, it is essential to preserve, support, use and promote biodiversity. There are many examples where agriculture has a positive (and negative) effect of biodiversity. Here we use examples of grassland management. Recent outbreaks of common voles (*Microtus arvalis*) in the North of the Netherlands (Friesland) caused extensive damage to the grassland and therewith milk production. It was shown that land use changes, management and lowering the groundwater table was the main cause of the outbreaks. Increasing the water table led to better control of the vole population but at the same time increased grassland productivity and the meadow bird population.

2. Agriculture threat to biodiversity

Occupying 70% of the land area of the India, the agricultural landscape is the largest habitat for plants and animals. There are more than 45,000 plants, fungi, insects, animals and other organisms known in the India. A large number of these species depend on the agricultural landscape as their prime habitat. However, in recent years species for which the India is extremely important, like the black-tailed godwit (Limosa limosa), lapwing (Vanellus vanellus), partridge (Perdix perdix) and the skylark (Alauda arvensis), have been in decline. Strikingly, the most significant cause of the decline of meadow birds lies in their breeding

grounds in the India, rather than elsewhere along their migratory route. The dairy sector uses 40% of the terrestrial area of the India. As such the sector has a large impact on the biodiversity in the agricultural landscape. Moreover, the dairy sector is one of the largest contributors to nitrogen deposition in nature areas, which is considered one of the main causes of ongoing biodiversity loss in open nature areas. The average number of species of breeding birds and vascular plants (such as flowers and grasses) has increased in semi-natural areas between 1990–2005 compared to 1975–1989. For example, the critical nitrogen load is exceeded in two thirds of the semi-natural ecosystems. The quality of these areas is thus under pressure through agriculture, which is next to burning of fossil fuels the main source of nitrogen deposition. Moreover, both nature and agriculture profits from species that live in both areas, such as pollinators, butterflies, etc. Therefore, decline of these species in nature affects agriculture.

2.1 How Monocropping Destroys Biodiversity: Industrial agriculture's impacts are not limited to habitat destruction through its expanding footprint: its reliance on heavy chemicals to create giant stands of single crops has serious consequences for plant, animal and microorganism biodiversity. A number of innovations allowed for widespread intensification of agriculture throughout the twentieth century. Widespread adoption of steel plows, hybrid seeds, GMOs, chemical fertilizers and pesticides helped farmers produce more food per acre than ever before. More recently, the adoption of genetically modified seeds helped to increase yields even further. This productivity comes at a great cost, however. Wide fields of a single crop (called monocultures) provide simplicity for farmers and a steady supply of feed to factory farms, but they are biodiversity deserts. Maintaining monocultures requires intense chemical inputs that reduce the abundance of wild species both on and off the farm.

2.2 Killing soil: Industrial agriculture also wreaks havoc on biodiversity within soil. Communities of insects and other invertebrates have their habitats disturbed when farmers plow up soil, interrupting their ability to recycle dead plants into the rich, stable organic carbon that makes soils fertile. Likewise, chemical use impairs the microorganisms involved in this process: scientists have found fewer species of beneficial bacteria and fungi in soils where chemical fertilizers and pesticides are used. Ultimately, these soils become less biodiverse and less healthy for crops. Such changes also contribute to climate change: soil stores over 1.6 trillion tons of carbon dioxide worldwide, but highly disturbed soils with low biodiversity quickly lose that carbon to waterways and the atmosphere.

3. Biodiversity in Sustainable Agriculture

Given that agriculture's expanding footprint is responsible for so much habitat loss, preventing wild lands from being converted into farmland is critical to maintaining biodiversity. By embracing both traditional knowledge and new research, farmers and scientists are producing food in a way that harnesses biodiversity to make the most of what nature provides. This approach is called agroecology, and is a core component of regenerative agriculture, which builds up natural resources like healthy soil and water rather than using them up.

While embracing agroecology is a revolutionary shift away from industrial farming, it's nothing new: these practices are often adapted from the practices of Indigenous peoples worldwide, who have created complex agroecological systems that exist in balance with nature. Preserving and reviving these Indigenous traditions can make agriculture around the world more sustainable and help preserve biodiversity. The fact that 80 percent of the world's biodiversity is preserved on lands that are managed by indigenous people is a testament to agroecology's potential.

Conclusion

A paradigm shift is needed in agriculture to stop the large-scale loss of biodiversity in the agricultural landscape and soil, but even more than that to rethink the use of the role of soil life, landscape elements and biodiversity in sustainable agriculture. In India, where long-term data are available it is shown that most species are in decline. For some species as birds, butterflies and insects the speed and extend of decline is alarming. In hotspot intensive agricultural areas such as the India for some years policies have been implemented that should help improve the situation (manure policy, nitrate directive, air quality, nature protection...). While in the semi-natural areas this has led to some success stories and species decline is stopped or reversed, this is not the case in agricultural areas. Here a steady decline is still observed. The agricultural intensification which focuses on increasing productivity per hectare or per unit input (such as feed) is the main cause of the decline. Apparently, we reached a tipping point where rethinking our agricultural practices is needed in the face of sustainability and production of food. There are different successful initiatives, but a large-scale change is not observed.