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Defining Agricultural Biodiversity

Agricultural biodiversity includes all components of biological diversity of relevance to food and agriculture: the variety and variability of plants, animals and micro-organisms at genetic, species and ecosystem level which are necessary to sustain key functions in the agro-ecosystem, its structures and processes.

Agricultural biodiversity is essential to the world for the following functions:

- sustainable production of food and other agricultural products, including providing the building blocks for the evolution or deliberate breeding of useful new crop varieties;
- biological support to production via, for example, soil biota, pollinators and predators;
- wider ecological services provided by agro-ecosystems, such as landscape protection, soil protection and health, water cycle and quality, and air quality.

Agricultural biodiversity includes the following:

- higher plants - crops, wild plants harvested and managed for food, trees on farms, pasture and rangeland species;
- higher animals - domestic animals, wild animals hunted for food, etc., wild and farmed fish;
- arthropods - mostly insects including pollinators (e.g., bees, butterflies), pests (e.g., wasps, beetles), and insects involved in the soil cycle (notably termites);
- other macro-organisms (e.g., earthworms);
- micro-organisms (e.g., rhizobia, fungi, disease-producing pathogens).

Local knowledge and culture can be considered as integral parts of agricultural biodiversity, because it is the human activity of agriculture which conserves this biodiversity. Indeed, most crop plants have lost their original seed dispersal mechanisms as a result of domestication and so can no longer thrive without human input.

Domestication started 10,000 years ago and has been followed by natural selection through exposure to different climates, pests, pathogens and weeds, by human selection for specific traits and market needs, as well as for socio-economic reasons, and by wide dispersal. Crops and domestic animals are now found well beyond the limits of ecological tolerance of their immediate wild relatives, there is remarkable variability among and within crop landraces and animal breeds, and extraordinary ranges of adaptation. In the last 100 years, there has also been controlled plant and animal breeding by scientists which has allowed the recombination of diversity from widely different backgrounds, and the application of intense selection pressure.

There are several distinctive features of agricultural biodiversity compared to other components of biodiversity.

- Agricultural biodiversity is actively managed by farmers.

- Many components of agricultural biodiversity would not survive without this human interference;

indigenous knowledge and culture are integral parts of agricultural biodiversity management.

- Many economically-important farming systems are based on 'alien' crop species introduced from elsewhere (maize and cassava, two most important food crops in Africa were introduced from America); this creates a high degree of inter-dependence between countries for the genetic resources on which our food systems are based.

- As regards to crop and livestock diversity, diversity within species is at least as important as diversity between species.

- Because of the degree of human management, conservation of agricultural biodiversity in production systems is inherently linked to sustainable use - preservation through protected areas is less relevant.

- Nonetheless, in industrial-type agricultural systems, much crop diversity is now held *ex situ* in gene banks or breeders' materials rather than on-farm.

Components of Agricultural Biodiversity

Crop Diversity

Of the 27,000 species of higher plants, about 7,000 species are used in agriculture, but only three (wheat, rice and maize) provide half of the world's plant-derived calorie intake. A substantial share of energy intake is also provided by meat, which is ultimately derived from forage and rangeland plants.

Although world food production in the aggregate relies on few crop species, many more are important if production is disaggregated to regional, national or local levels. For example, in Central Africa, cassava supplies over half of the plant-derived energy intake, although at the global level, the figure is only 1.6%. Outside the communities concerned, however, there is a lack of knowledge about the diversity and distribution of less utilized food and agriculture species.

Genetic diversity (variation within species) is vital for the evolution of agricultural species and their adaptation to particular environments through a mixture of natural and human selection. In crop agriculture, for some species, this selection has led to the development of many thousands of landraces or farmers' varieties.

Wild Plant Biodiversity

In addition to domesticated plants, wild species are important nutritionally and culturally to many people. Foods from wild species form an integral part of the daily diets of many poor rural households. They are an important source of vitamins, minerals and other nutrients, and also represent ready sources of income for cash-poor households.

There are also wild relatives of crop plants which may supply useful genes through natural or artificial introgression. Neighboring wild companion plants can harbor biocontrol agents useful in agriculture. Weed plants may be left to grow in order to be harvested later for food.

Many wild plant populations are carefully nurtured by people although less intensively than those cultivated in their fields. Thus, there is no obvious or strict division between 'domesticated' and 'wild' food species.

Livestock Diversity

Of about 50,000 known mammal and bird species, only about 40 have been domesticated. These species provide people not only with food but also clothing, fertilizer and fuel (from manure) and draught power. From these species, farmers and breeders have developed about 5,000 identified breeds to fit local environmental conditions and to meet specific needs. Such diversity has enabled people to inhabit a wide range of production environments from hot humid tropics to arid deserts and cold mountainous regions.

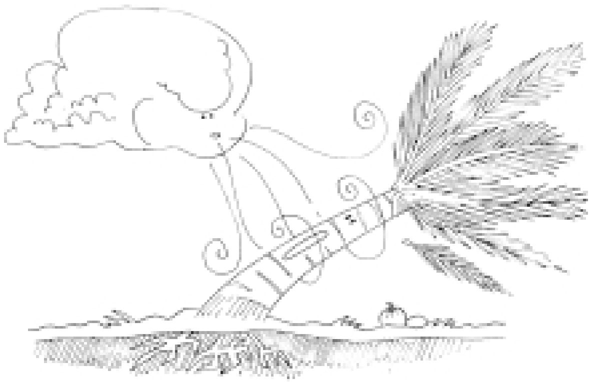
Genetic diversity also allows livestock to adapt to diseases, parasites and wide variations in the type and availability of food and water. Yet, almost a third of these breeds are estimated to be at risk of extinction.

Aquatic Diversity

Fish and other aquatic species are integral parts of several important farming systems. For example, in the tropical rice-fish systems of Asia, fish from rice paddies may provide as much as 70% of dietary protein. More generally, aquaculture is becoming increasingly important and now supplies about 20% of total fish production.

Below-ground Biodiversity

Roots are responsible for nutrient and water uptake by crops. They physically stabilize soil structure against erosion and soil movement on steep slopes and, in tropical systems, the contribution of roots to soil organic matter is proportionately larger than from above-ground inputs. The effects of roots on soil biophysical properties are particularly critical in impoverished farming systems where crop residues are at a premium for fuel and fodder. But there has been little attention to the selection of rooting traits in cultivars by crop breeders, and much less research into the production, turnover and structure of rooting systems in tropical crops than into the above-ground components they support.



Microbial Biodiversity

Microbes contribute a wealth of gene pools that could be a source of material for transfer to plants to achieve traits such as stress tolerance and pest resistance, and large-scale production of plant metabolites.

Microbes play varied roles in plant communities and agriculture. Microbial interactions with plant communities range from disease-producing pathogens to associations with plant rhizosphere, phyllosphere, and spermosphere as free-living entities or in well associated symbiotic associations for nitrogen-fixation or as mycorrhiza. Seed-borne microflora are instrumental in seed transmission of disease and thereby important in plant quarantine. Microorganisms, as food sources of 'neutral insects', support these alternative food sources of natural enemies of plant pests.

Arthropod Biodiversity

It is well known that insects, spiders and other arthropods often act as natural enemies of crop pests. But other components of arthropod diversity are also important in this respect. For example, research on Javanese rice fields has shown that arthropod communities are structured in such a way that the dynamics of seasonal succession consistently lead to high levels of pest suppression by natural enemies, with little chance of major pest outbreaks.

Control of plant pests by natural enemies is often considered inadequate due to seasonal oscillations in populations: the pest population peaks before that of the natural enemies. However, in the Javanese rice fields, "neutral' arthropods, mostly detritivores and plankton-feeders, such as midges and mosquitoes, provide an alternative source of food for the natural enemies of rice plant pests, thus stabilizing the populations of the natural enemies. In turn, the detrivores are dependent on high levels of organic matter in the paddies which provides the food source for an array of micro-organisms (bacteria and phytoplankton) and zooplankton.

Insects and arthropods are also important pollinators of many crops. Bees and other pollinating insects are essential agents for the production of many crops. Insect pollination is also required for seed production.

Agricultural Biodiversity and Ecosystem Functions

Historically, the focus in agricultural biodiversity work has been on characterizing and conserving species and genetic diversity. Now, however, there is increasing realization of the importance of agricultural biodiversity at the ecosystems level.

An ecosystem consists of a dynamic complex of plant, animal and microorganism communities and their non-living environment interacting as a functional unit. Thus, agro-ecosystems need to be considered at several levels or scales. For instance, a leaf, a plant, a field/crop/herd/pond, a farming system, a land use system or watershed. These can be aggregated to form a hierarchy of agro-ecosystems. At a higher level still, the full assemblage of ecosystems constitutes the global biosphere.

Ecological processes can also be identified at different levels and scales. Maintenance of agricultural biodiversity within the agro-ecosystem is necessary to ensure the continued supply of goods and services such as:

- evolution and crop improvement through plant breeding;
- biological support to production; and
- wider ecological functions.

This is sometimes referred to as 'functional agricultural biodiversity', i.e., that which is necessary to sustain the ecological function of the agro-ecosystem, its structures and processes in support of food production and food security. Focusing attention on functional agricultural biodiversity can be a useful way of prioritizing effort.

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