Food and Agriculture Organization of the United Nations

Interactions in AGROECOLOGY

Virtuous Cycles and Ecosystem Services that Underpin Agricultural Production

POLLINATION

Most flowering plants only produce seeds if animal pollinators move pollen from the anthers to the stigmas of their flowers. Pollination as a factor in food production and security has been little understood and appreciated, in part because it has been provided up until now as a "free service" by nature. As pollination services have faced several threats, there is a great interest in understanding key interactions and helping nature provide these pollination services, through greater diversity on farm and reduction or elimination of pesticide use.

NATURAL PEST CONTROL

Agroecological approaches to natural pest control strategies go beyond eliminating problem pests, and rather seek to reinforce the interactions of pests and natural enemies in natural ecosystems, maintaining a functional balance with low pest populations. This can be done through understanding and reinforcing the full composite of inherent plant defences, plant mixtures, healthy soils and crops to fend off attacks, natural enemies, and other components of the system, in a web of feedback loops.

CROP-LIVESTOCK INTEGRATION

Integrated crop-livestock systems involve linking crop and livestock production together to generate positive economic and environmental outcomes. Integration is done to recycle resources efficiently, whereby products or by-products of one component serve as a resource for the other – i.e. manure goes to the crops and crop residues feeds animals. The actual relationship between crops and livestock can vary in these systems. It may range from relatively intimate, within-farm integration of crops and livestock (e.g. grazing crop residues after grain harvest) to more indirect relationships (e.g. shared manure application among crop farms within a region).

SOIL BIODIVERSITY

The creatures living in the soil are vital to soil health. They influence soil structure and thus soil erosion and water availability. If healthy and numerous, they can protect crops from pests and diseases. They are central to decomposition and nutrient cycling and therefore affect plant growth and amounts of pollutants in the environment.

NITROGEN FIXATION

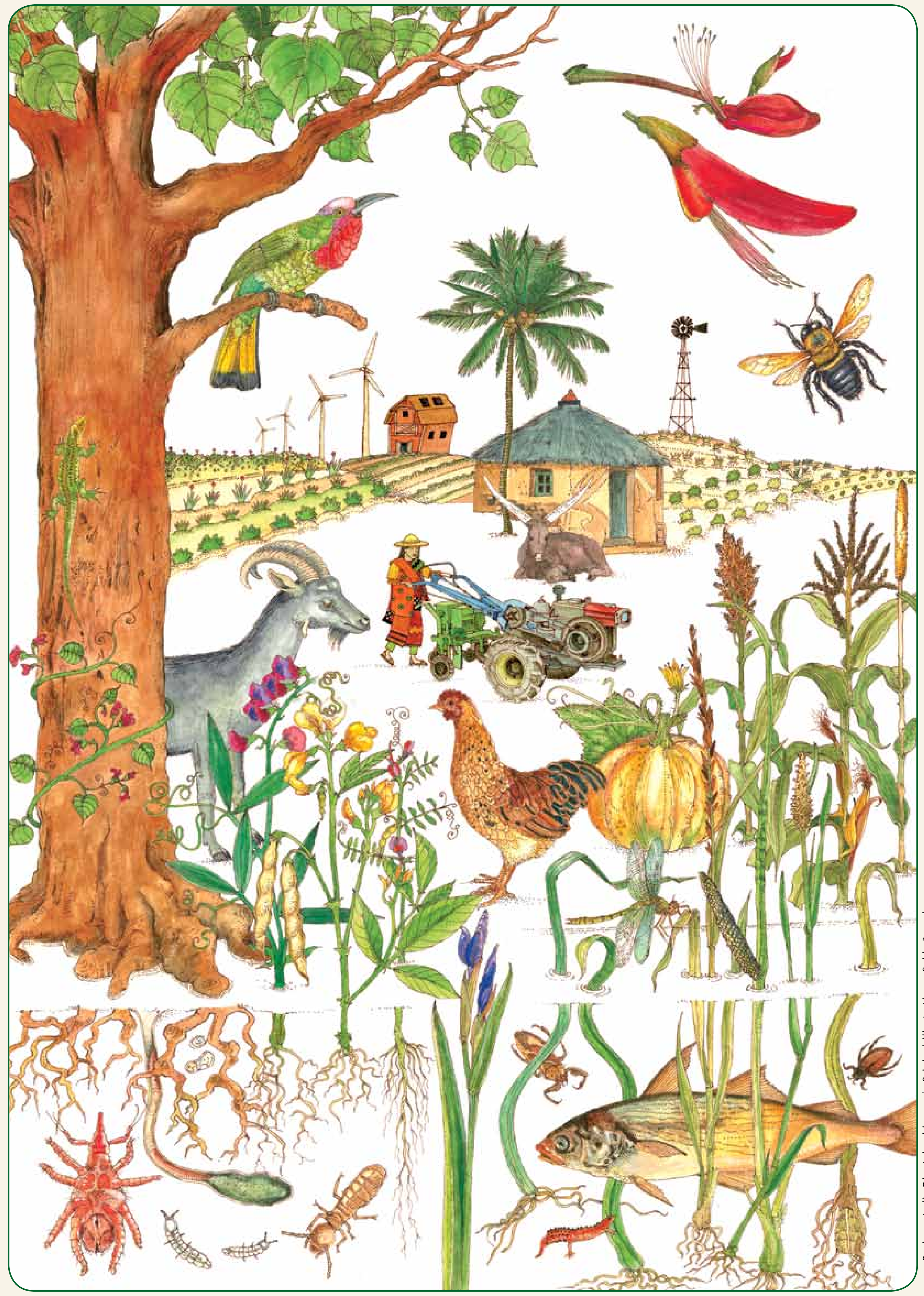
The growth of all organisms depends on the availability of mineral nutrients, and none is more important than nitrogen, which is required in large amounts as an essential component of proteins. There is an abundant supply of nitrogen in the earth's atmosphere - nearly 79 percent in the form of N_2 gas. However, atmospheric N_2 is unavailable for use by most organisms and is often the limiting factor for growth and biomass production. Microorganisms such as bacteria have a central role in almost all aspects of nitrogen availability and thus for life support on earth. They can convert N_2 into ammonia by the process termed nitrogen fixation; these bacteria are either free-living or form symbiotic associations with plants or other organisms (e.g. termites, protozoa).

DROUGHT RESISTANCE

In the face of climate change, many older crops such as pearl millet and sorghum, are gaining attention. Such crops have multiple attributes: they are inherently drought tolerant, and provide food, feed and, in the case of millet, fuel and construction materials, even in arid conditions. However, agroecological approaches to drought resilience go further, to focus on the diversification of production systems, including polycultures, agroforestry and integration of crops and livestock, along with enhancing biodiverse interactions in the soil and farm.

AGROFORESTRY

Agroforestry is a dynamic, ecologically based, natural resource management system that, through integration of trees on farms and in the agricultural landscape, diversifies and sustains production and builds social institutions. The adoption of agroforestry – a broad suite of ecologically and socially adapted practices – is helping to restore productivity and resilience of landscapes as well as contributing to improving the food, nutrition and income security of smallholders and, especially, other vulnerable groups of society. Agroforestry is based on a sound understanding of agroecology and an improving understanding of the social and economic systems of the people who inhabit these landscapes.



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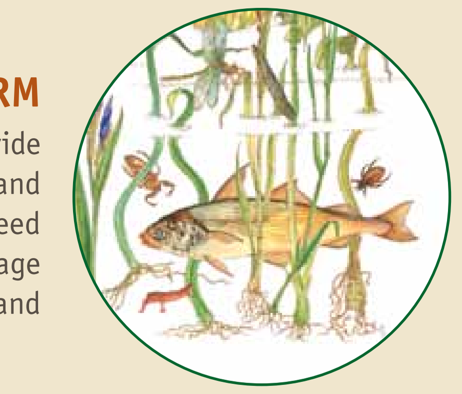
AGROECOLOGY

is the integrative study of the ecology of the entire food system, encompassing ecological, economic and social dimensions. It focuses on working with and understanding the interactions between plants, animals, humans and the environment within agricultural systems. By bringing ecological principles to bear in agroecosystems, through ecological intensification, novel management approaches can be identified, building on key interactions and strengthening virtuous cycles in agricultural production that would not otherwise be considered.

WATER MANAGEMENT

The ways and means of capturing and holding water that might otherwise runoff from agricultural lands is an integral part of agroecology. An agroecological approach calls for intensive management of water throughout the agroecosystem, through an integrated network of surface impoundments, contour ditches, small-scale berms, and basins. Redundancy in water storage systems is emphasized, with the priority placed first on soil storage, then surface water impoundments, followed by tank storage. Water catchment pools, used as reservoirs during dry spells can also be used for aquaculture and by water birds such as ducks.



AQUACULTURE, PONDS AND WETLANDS ON-FARM

Wetlands have high levels of biological productivity and resource potentiality, and can provide multiple services in agroecosystems. They can be used for agriculture, animal-husbandry, and fisheries. Wetlands have also been reclaimed into rice paddies, pastures, forest land and reed production bases. Ecologically, wetlands can not only play a role in flood control, water storage and climate regulation, but can also purify water, improve soil, and increase the species and number of wild animals.

COVER CROPS AND ROTATION

Planting cover crops in rotation between cash crops is widely agreed to be ecologically beneficial, providing multiple ecosystem services. Benefits include increased carbon and nitrogen in soils, erosion prevention, more mycorrhizal colonization – beneficial soil fungi that help plants absorb nutrients – and weed suppression. Crop rotation, cover crops and reduced tillage through simple machines such as two-wheeled tractors are three of the basic practices of conservation agriculture.

PERENNIAL CULTIVATION

Scientists are working to breed perennial versions of wheat, rice, sorghum, other grains and other annual crops. Perennials shed some portion of their biomass every year thus replicating the biomass recycling that occurs in natural systems. Root systems of perennial crops are deep and massive, compared to current cultivated grains, and a diversity of soil organisms can flourish. The goals are crops that tap the main advantage of perennials – the deep, dense root systems that fuel the plants' rebirth each spring and that make them so resilient and resource efficient – without sacrificing too much of the grain yield that millennia of selection have bred into annuals.

From http://ngm.nationalgeographic.com/2011/04/big-idea/perennial-grains-text

WILDLIFE

Wildlife that eat insects such as birds and bats may have remarkable impacts on insect populations. For example, each year in the spring, millions of Brazilian free-tailed bats migrate northward from Mexico to form enormous colonies in limestone caves and bridges throughout the southwestern United States. Their primary food source is moths including devastating agricultural pests such as the corn earworm or cotton bollworm moth and the tobacco budworm moth and they are key to effective control of these pests that also migrate from Mexico to Texas at this same time. The benefits conferred to agriculture by consumption of these moths by bats may not be limited to their local foraging areas (e.g. in Texas and New Mexico) but may extend to agricultural landscapes hundreds of kilometers away.

Kurz *et al.* 2011. Ecosystem services provided by bats. *Ann. N.Y. Acad. Sci.* 1-38.

ENERGY

Making more efficient use of energy has always been a focal point of agroecological practices, and still is for any design of sustainable food systems. In agroecology, the energy efficiency is tightly related with multiple strata silvopastoral systems and crop-livestock integrated managements which are able to host high species richness. Diverse, integrated and self-sufficient agroecological farm systems that employ low levels of external inputs, demonstrate efficiency in the use of water, nutrients and energy, while also being environmentally sound, economically and technically feasible, and socially desired.

Funes-Monzote *et al.*, (abstract for this symposium) Agroecological management of energy flows to maintain healthy agro-ecosystems: some general principles and practical examples.

BUILDING COMMUNITIES

Agroecological approaches have strong elements of community building, recognizing that it is the interactions among people that are central to agricultural sustainability and regeneration. Agroecology seeks to build the autonomy of rural communities over management of natural resources and food systems, and their resilience in the face of climate change. The success of many communities in applying agroecological approaches is linked to their social organization and farmer to farmer networks.

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