



LIBERATION



Linking farmland Biodiversity to Ecosystem seRvices for effective eco-functional intensificATIOn

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Managing semi-natural habitats and on-farm biodiversity to optimise ecological
services

Collaborative Project

Glossary of terms on ecosystem services in agriculture



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Introduction

Increasingly, the global community has recognized that while the last half-century has witnessed striking increases in global food production through intensive use of inputs, such practices may deplete natural resources and impair the ability of agro-ecosystems to sustain production into the future.

However, the Food and Agriculture Organization of the United Nations (FAO, 2011a) along with numerous recent reviews (The Royal Society 2009; Clay 2011; Foley et al. 2011, Bommarco et al. 2013) have highlighted that it is both possible and highly advantageous to address future needs by transitioning to systems of food production that are based on “ecological intensification”—using land, water, biodiversity and nutrients efficiently and in ways that are regenerative, while minimizing negative impacts. Ecological intensification may be formally defined as a knowledge-intensive process that requires optimal management of nature’s ecological functions and biodiversity to improve agricultural system performance, efficiency and farmers’ livelihoods.

Areas of the world where agricultural productivity is extremely high - such as in Europe or North America- often depend on unsustainable high levels of external inputs. Here the challenge for ecological intensification is to reduce reliance on external inputs while maintaining high productivity levels by reestablishment of soil and landscape ecosystem services). In other places where productivity is less high, the challenge is to enhance productivity by optimising ecosystem services rather than by increasing agricultural inputs. A further challenge for ecological intensification is the development of novel poly-cropping systems and landscape-scale management of matrix habitats to increase the stability of agricultural production systems and provide ‘ecological resilience’.

FAO in its role in leading a work package on Communication, Dissemination and Training of Effective Ecological Intensification in the EU FP7-funded project LIBERATION is providing tools and documents to help policy-makers and practitioners understand and utilize the concepts of ecological intensification in agricultural production.

One of the challenges of ecological intensification is to move agricultural research out of a focus on singular focal areas – e.g., improved seed, pest control, water management – to solutions that integrate all components of the farming system. As such, the canon of knowledge supporting ecological intensification is transdisciplinary, focusing on the biological components of farming systems and agroecological practices but extending as well to considerations of policy and farmer and societal benefits. As the biodiversity benefits of ecological intensification, along with the negative externalities of conventional agriculture are an important motivation for ecological intensification, we have included literature on these topic, as well as references that relate climate change to ecosystem services in agriculture.

The glossary presented here is compiled on this basis, to provide definitions of key terms relevant to ecological intensification.

The glossary has been assembled by a joint effort of Helga Gruberg and Toby Hodgkin (Platform for Agrobiodiversity Research) and FAO (Barbara Gemmill-Herren and Benjamin Gräub).

Glossary

A

Abiotic. Non-living. Abiotic resources comprise non-living things (e.g. land, water, air and minerals). (FAO 2009a p 1)

Adaptation. Adjustment in natural or human systems to a new or changing environment. Adaptation to climate change refers to adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Various types of adaptation can be distinguished, including anticipatory and reactive adaptation, private and public adaptation, and autonomous and planned adaptation. (IPCC 2001 p 365)

Agricultural biodiversity. The component of biodiversity that is relevant to food and agriculture production. The term agrobiodiversity encompasses genetic species and ecosystem diversity. (FAO 2009a p 2)

Agricultural intensification. Refers to any practice that increases productivity per unit of land area at some cost in labor or capital inputs. (FAO 2009a p 5)

Agricultural landscape quality. Different ways in which agricultural models for land use modify the surroundings and influence ecological processes. (Altieri 1999 p 66)

Agri-environmental Measures (AEM). AEM belong to the EU Rural Development Program. AEMs provide payments to farmers who subscribe, on a voluntary basis, to environmental commitments related to the preservation of the environment and maintaining the countryside. (European Commission 2012)

Agroecological restoration. Restoration of the relationship between farming and nature by following an ecosystem approach, welcoming greater biodiversity and use of free ecological services. (Jackson and Jackson 2002 p 6)

Agroecology. In general it has three meanings or forms related to the application of ecology to agricultural systems: 1) a *scientific discipline*, 2) an *agricultural practice* and 3) a *social movement*. While there are many different definitions, according to Wezel et al. (2009, p. 510) one of the broadest definitions by Francis (2003) is “the integrative study of the ecology of the entire food system, encompassing ecological, economic and social dimensions.” Alternatively agroecology refers to “the study of purely ecological phenomena within the crop field, such as predator/prey relations, or crop/weed competition. Agroecology often incorporates ideas about a more environmentally and socially sensitive approach to agriculture, one that focuses not only on production, but also on the ecological sustainability of the productive system and goes well beyond the limits of the agricultural field. (Hecht 1987)”

Agroecosystem. A semi-natural or modified natural ecosystem managed by humans for food and agricultural production purposes. (FAO 2009a p 6)

Agroforestry. Collective term for land-use systems and technologies in which woody perennials are deliberately used on the same land management unit as

agricultural crops and/or animals, in some form of either spatial arrangement or temporal sequence. (FAO 2008d p 6)

Allelopathy. Direct influence from a chemical released from one plant on the development and growth of another one. Allelopathic substances, if present in crop varieties, may reduce the need for weed management, particularly herbicide use. (FAO 2003b)

Alley farming (cropping). It is an agroforestry practice that consists in planting perennial trees or shrubs on the sides of crops. (Tropical Grassland Society of Australia 1998)

Alpha diversity. Richness in species of a particular stand or community, or a given stratum or group of organisms in a stand. (Whittaker 1960 p 320)

Alternative agriculture («Agricultura alternativa»). Agricultural approach that attempts to provide a balanced environment, sustained yields and soil fertility; and natural pest control through the design of diversified agroecosystems and the use of self-sustaining technologies, based on ecological principles. (Altieri and Nicholls 2000 p 15)

Amensalism. Interaction of two organisms where one is harmed and the other is unaffected. (FAO 2011b p 1)

Aquaculture. The farming of aquatic organisms in inland and coastal areas, involving intervention in the rearing process to enhance production and the individual or corporate ownership of the stock being cultivated.(FAO 2008d p 15)

B

Beneficial insects. Some insects have beneficial roles for nature: 1) plants reproduction (pollinators), 2) waste biodegradations (decomposers), and 3) natural resistance of agroecosystems/natural control of harmful species (natural enemies, predators, parasitoids). They also have beneficial roles for humans as edible insect species in nutrition, insect valuable products (e.g. silk and honey) and biomimicry among others. (FAO 2013a, p. 5-7)

Benefits transfer. Method used to estimate economic values for ecosystem services in one location by transferring available information from studies already completed in another location and/or context. It is often used when it is too expensive and/or there is too little time available to conduct an original valuation study, yet some measure of benefits is needed. (King & Mazzotta 2000)

Beta diversity. The extent of change of community composition, or degree of community differentiation, in relation to a complex gradient of environment, or a pattern of environments. (Whittaker 1960 p 320)

Biodiversity. The variability among living organisms from all sources including terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within and among species and diversity within and among ecosystems. (Millennium Ecosystem Assessment 2005 a p 49 & p 208)

Biodynamic agriculture. Biodynamic agriculture considers both the material and spiritual context of food production and works with terrestrial as well as cosmic influences. The influence of planetary rhythms on the growth of plants and animals, in terms of the ripening power of light and warmth, is managed by guiding cultivation times with an astronomical calendar. (FAO 2009a p 14)

Biofuel. Energy carriers that store the energy derived from biomass (e.g. food, fibre and wood process residues from the industrial sector; energy crops, short rotation crops and agricultural wastes from the agriculture sector; and residues from the forestry sector). (FAO 2008a p 10)

Biogeochemical cycle. The manner in which the atoms of an element critical to life (such as carbon, nitrogen, or phosphorus) move from the bodies of living organisms to the physical environment and back again. (Agroecology Online)

Biointensive agriculture. Intensification of agricultural productivity through biological means on a minimum area of land, while simultaneously improving the soil. (FAO 2009a p 16)

Biological pest control. Method of controlling pests, diseases and weeds in agriculture that relies on natural predation, parasitism or other natural mechanisms that restrain the development of pathogenic organisms. (FAO 2009a p 17)

Biomass. The total mass of living organisms in a given area or volume; recently dead plant material is often included as dead biomass. (IPCC 2001 p 367)

Biotic. Living organisms that make up the biotic parts of ecosystems. (Tyler and Miller 2001)

Buffer zone. In general buffer zones are defined as zones that separate two things in order to separate incompatible parties from each other (e.g. natural parks from human use, demilitarized zones, etc.). Currently the definition has shifted to a more “protective” management tool and less “separator/barrier” definition: a buffer zone is meant to ensure effective protection of the nominated property through complementary legal and/or customary restrictions placed on its use and development in order to give an added layer of protection to the property. (UNESCO 2009 p 46)

Buffer zone (organic agriculture). A clearly defined and identifiable boundary area bordering an organic production site that is established to limit the application of, or contact with, prohibited substances from an adjacent area. (FAO 2009a p 27)

C

Capital value (of an ecosystem). The present value of the stream of future benefits that an ecosystem will generate under a particular management regime. Present values are typically obtained by discounting future benefits and costs; the appropriate rates of discount are often a contested issue, particularly in the context of natural resources. (Millennium Ecosystem Assessment 2005a p 208)

Carbon cycle. The flow of carbon (in various forms such as carbon dioxide) through the atmosphere, ocean, terrestrial biosphere, and lithosphere. (IPCC 2001 p 368)

Carbon sequestration. The process of increasing the carbon content of a carbon reservoir other than through the atmosphere. (IPCC 2001 p 384)

Change in productivity approach. Economic valuation techniques that value the impact of changes in ecosystems by tracing their impact on the productivity of economic production processes. (Millennium Ecosystem Assessment 2005a p 208)

Climate-smart agriculture. Type of agriculture that builds resilience to climate change and reduces greenhouse gas emissions through, for example, increased sequestration of carbon in soil. (FAO 2011a p iv)

Climax. Mature stage in the natural succession of species. There are different interpretations of climax: monoclimax (one theoretical climax), polyclimax (in equilibrium with physical and environmental conditions), regional theoretic climax (in equilibrium with the regional climate) and edaphic climax (in equilibrium with the substrate). (Odum 1953)

Common pool resource. A valued natural or human-made resource or facility in which one person's use subtracts from another's use and where it is often necessary but difficult to exclude potential users from the resource. (Millennium Ecosystem Assessment 2005a p 209)

Common property resource. A good or service shared by a well-defined community. (Millennium Ecosystem Assessment 2005a p 209)

Community. The individuals of all species that potentially interact within a single patch or local area of habitat. (Leibold, Holyoak et al. 2004 p 603)

Community biodiversity registers. Record kept in a register by community members, of the genetic resources in a community, including information on their custodians, passport data, agro-ecology, cultural and use values. (Upadhyay, Shrestha et al. 2012 p 1)

Community seed banks. Community seed banks are collections of seeds that are maintained and administered by the communities themselves. Seeds can be stored by a community either in large quantity to ensure that planting material is available, or in small samples to ensure that genetic material is available should varieties become endangered. (The Development Fund 2011 p 4)

Compensating factor. A factor of the environment that overcomes, eliminates, or modifies the impact of another factor. (Agroecology Online)

Compensation and Rewards for Environmental Services (CRES). Contractual arrangements and negotiated agreements among ecosystem stewards, environmental service beneficiaries and / or intermediaries, for the purpose of enhancing, maintaining, re-allocating or offsetting damage to environmental services. A particular CRES contract or negotiated agreement will include a compensation or reward instrument or combination of instruments. (Swallow, Kallesoe et al. 2007 p 34-35)

Compensation for environmental services (CES). Payments or other forms of restitution made to economic service beneficiaries or ecosystem stewards to offset foregone entitlements to environmental services or ecosystem stewardship benefits. (Swallow, Kallesoe et al. 2007 p 35)

Competition. Interaction between individuals, brought about by a shared requirement for a resource, and leading to a reduction in the survivorship, growth and/or reproduction of at least some of the competing individuals concerned. (Begon, Townsend et al. 2006 p 132)

Composting. Natural process of 'rotting' or decomposition of organic matter by microorganisms under controlled conditions. (FAO 2003d p. 1)

Conservation agriculture (CA). Conservation agriculture aims to achieve sustainable and profitable agriculture and subsequently aims at improved livelihoods of farmers through the application of the three CA principles: minimal soil disturbance, permanent soil cover and crop rotations. To do so it promotes no-tillage to safeguard soil biodiversity, uses several organic fertilization practices such as rotations and mulching but allows the use of genetically modified organisms (GMOs) and chemical inputs, namely herbicides. (FAO 2009a p 27)

Conservation-tillage farming. It is a practice used reduce the effects of tillage on soil erosion, however, it still depends on tillage as the structure forming element in the soil. (FAO 2009a p 28)

Contingent valuation (CV). Economic valuation technique based on the stated preference of respondents regarding how much they would be willing to pay for specified benefits. A detailed description of the good or service involved is provided, along with details about how it will be provided. CV is designed to circumvent the absence of markets by presenting consumers with hypothetical markets in which they have the opportunity to buy the good or service in question. The methodology is controversial, but widely accepted guidelines for its application have been developed. (Millennium Ecosystem Assessment 2005a p 209)

Corridors. Landscape elements that connect similar patches through a dissimilar matrix or aggregation of patches. The patches connected by corridors are often called nodes. A given corridor (a road, for example) may function as a corridor for some organisms (humans) and a barrier for others (slugs). (Diaz and Apostol 1992 p 25)

Crop rotations. The practice of alternating the species or families of annual and/or biannual crops grown on a specific field in a planned pattern or sequence so as to break weed, pest and disease cycles and to maintain or improve soil fertility and organic matter content. (FAO 2009a p 32)

Crop wild relatives. Plant species that are more or less genetically related to crops, but unlike them, have not been domesticated. (Crop Wild Relatives Global Portal)

Cross-pollination. The transfer of pollen from the anthers of one plant to a recipient stigma on another plant that may result in fertilization and fruit set.

Also known as outcrossing or xenogamy. ((FAO 2009b) citing Buchmann & Nabhan 1996)

Cultural services. The nonmaterial benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation and aesthetic experience, including, for example, knowledge systems, social relations, and aesthetic values. (Millennium Ecosystem Assessment 2005a p 209)

D

Deficit irrigation. Irrigation scheme in which water supply is less than the crop's full requirements, and mild stress is allowed during growth stages that are less sensitive to moisture deficiency. The expectation is that any yield reduction will be limited, and additional benefits are gained by diverting the saved water to irrigate other crops. (FAO 2011a p 59)

Determinants of well-being. Inputs into the production of well-being, such as food, clothing, potable water, and access to knowledge and information. (Millennium Ecosystem Assessment 2005a p 209)

Directed selection. The process of controlling genetic change in domesticated plants through manipulation of the plants' environment and their breeding process. (Agroecology Online)

Direct use value (of ecosystems). Benefits derived from the goods and services provided by an ecosystem that are used directly by an economic agent. These include *consumptive uses* (e.g. harvesting goods) and *non-consumptive uses* (e.g. enjoyment of scenic beauty). (Millennium Ecosystem Assessment 2005a p 210)

Dispersal agent (seed). Means by which seeds are dispersed. Seeds are mainly dispersed through water currents, animals and the movement of vehicles, machinery, livestock, grain, stock feed and other produce, and to a lesser extent by the wind.(APFISN Online p 1)

Disservices. Some agricultural practices can generate negative effects over the environment leading to ecological disservices (e.g. decreases in water and air quality or a contribution to biodiversity loss) (Doré, Makowski et al. 2011 p 198). They reduce productivity or increase production costs (Zhang, Ricketts et al. 2007 p 1)

Disturbance. A cause, a physical force, agent, or process, causing a perturbation in an ecological component or system; relative to a specific reference state and system; defined by specific characteristics. (Rykiel 1985 p 364)

Diversity. The variety and relative abundance of different entities in a sample. (Millennium Ecosystem Assessment 2005b p 894)

Domestication The process of altering, through directed selection, the genetic makeup of a species so as to increase the species' usefulness to humans. (Agroecology Online)

Drip irrigation. Technique for achieving a low rate, high frequency or long duration water delivery through pipes to drip nozzles located near the plants. (FAO 1985)

Driver. Any natural or human-induced factor that directly or indirectly causes a change in an ecosystem. (Millennium Ecosystem Assessment 2005a p 210)

Driver (direct). A driver that unequivocally influences ecosystem processes and can therefore be identified and measured to differing degrees of accuracy. (Millennium Ecosystem Assessment 2005a p 210)

Driver (endogenous). A driver whose magnitude can be influenced by the decision-maker. (Millennium Ecosystem Assessment 2005a p 210)

Driver (exogenous). A driver that cannot be altered by the decision-maker. See also endogenous driver. (Millennium Ecosystem Assessment 2005a p 210)

Driver (indirect). A driver that operates by altering the level or rate of change of one or more direct drivers. (Millennium Ecosystem Assessment 2005a p 210)

Drought tolerant crops. Crops which are resilient to water shortages. (FAO 2009a p 36)

E

Eco-functional intensification. Increase in food production, a considerable reduction in the negative impacts of agriculture on the environment, ecosystem services and the use of nonrenewable resources and energy would become prerequisites for human survival. (Niggli, Slabe et al. 2008 p 35)

Ecological balance. A state of dynamic equilibrium within a community of organisms in which genetic, species and ecosystem diversity remain relatively stable, subject to gradual changes through natural succession. (FAO 2009a p 39)

Ecological diversity. The variety of forests, deserts, grasslands, oceans streams, lakes, and other biological communities interacting with one another and with their nonliving environment. (Tyler and Miller 2001)

Ecological footprint. The area of productive land and aquatic ecosystems required to produce the resources used and to assimilate the wastes produced by a defined population at a specified material standard of living, wherever on Earth that land may be located. (Millennium Ecosystem Assessment 2005a p 210)

Ecological intensification. Maximization of primary production per unit area without compromising the ability of the system to sustain its productive capacity. This entails management practices that optimize nutrient and energy flows and use local resources, including: horizontal combinations (such as multiple cropping systems or polycultures); vertical combinations (such as agroforestry); spatial integration (such as crop-livestock or crop-fish systems); and temporal combinations (rotations).(FAO 2009a p 9). A further definition is the following: An alternative approach for mainstream agriculture to meet current challenges. Ecological intensification aims to match or augment yield levels while minimizing negative impacts on the environment and ensuing negative feedbacks on agricultural productivity, by integrating the management of ecosystem services delivered by biodiversity into crop production systems (Bommarco, Kleijn et al. 2013)

Ecological security. A condition of ecological safety that ensures access to a sustainable flow of provisioning, regulating, and cultural services needed by local communities to meet their basic capabilities. (Millennium Ecosystem Assessment 2005a p 210)

Ecosystem-based practices. Management practices used to buffer the impacts of climate variability and increase overall resilience (e.g. diversification, moisture conservation, protection of pollinators and biological indicators) (Colls, Ash et al. 2009 p 12)

Ecosystem assessment. A social process through which the findings of science concerning the causes of ecosystem change, their consequences for human well-being, and management and policy options are brought to bear on the needs of decision-makers. (Millennium Ecosystem Assessment 2005a p 210)

Ecosystem boundary. The spatial delimitation of an ecosystem, typically based on discontinuities in the distribution of organisms, the biophysical environment (soil types, drainage basins, depth in a water body), and spatial interactions (home ranges, migration patterns, fluxes of matter). (Millennium Ecosystem Assessment 2005a p 210)

Ecosystem functions. Activities, roles or processes performed by structures. There are five main types of functions: *capture* (input) - resources are brought into the system; *production* - resources are “manufactured” within the system; *cycling* - resources are transported within the system; *storage* - resources are conserved within the system; *Output* - resources leave the system. Structures often are involved in more than one function, and a function often requires more than one structure. (Diaz and Apostol 1992 p 18)

Ecosystem health. A measure of the stability and sustainability of ecosystem functioning or ecosystem services that depends on an ecosystem being active and maintaining its organization, autonomy, and resilience over time. (Millennium Ecosystem Assessment 2005a p 211)

Ecosystem interactions. Exchanges of materials and energy among ecosystems. (Millennium Ecosystem Assessment 2005a p 211)

Ecosystem services. The benefits people obtain from ecosystems. These include provisioning services such as food and water; regulating services such as flood and disease control; cultural services such as spiritual, recreational, and cultural benefits; and supporting services such as nutrient cycling that maintain the conditions for life on Earth. (Millennium Ecosystem Assessment 2005a p 211)

Ecosystem stability. A description of the dynamic properties of an ecosystem. An ecosystem is considered stable if it returns to its original state shortly after a perturbation (resilience), exhibits low temporal variability (constancy), or does not change dramatically in the face of a perturbation (resistance). (Millennium Ecosystem Assessment 2005a p 211)

Ecosystem structure. Structures are the physical, tangible elements of systems, the things we can touch, see and feel. They can be living or non-living, mobile or fixed. Landscapes are commonly described as having three kinds of structures (which are referred to collectively as “landscape elements”): a matrix, corridors and patches. (Diaz and Apostol 1992 p 19)

Emergent property. A phenomenon that is not evident in the constituent parts of a system but that appears when they interact in the system as a whole. (Millennium Ecosystem Assessment 2005a p 211)

Erosion. The process of removal and transport of soil and rock by weathering, mass wasting, and the action of streams, glaciers, waves, winds, and underground water. (IPCC 2001 p 372)

Evapotranspiration. The combined process of evaporation from the Earth's surface and transpiration from vegetation. (IPCC 2001 p 372)

Ex situ conservation. Conservation of plant genetic resources in conditions different from those of their natural habitats. (Jaramillo and Baena 2007 p 10)

Existence value. The value that individuals place on knowing that a resource exists, even if they never use that resource (also sometimes known as conservation value or passive use value). (Millennium Ecosystem Assessment 2005a p 211)

Extensive agriculture. Farming system that requires small amounts of labour and capital in relation to area of land being farmed. (Encyclopedia Britannica 2013a)

Externality. A consequence of an action that affects someone other than the agent undertaking that action and for which the agent is neither compensated nor penalized. Externalities can be positive or negative. (Millennium Ecosystem Assessment 2005a p 211)

F

Fair trade. Trading partnership, based on dialogue, transparency and respect, which seeks greater equity in international trade. It contributes to sustainable development by offering better trading conditions to, and securing the rights of, marginalized producers and workers - especially in the South. (FAO 2009a p 54)

Fallow land. Land set aside for at least one season, and sometimes for periods of up to ten years or more with the aim of improving soil fertility and controlling pest and diseases. It may also refer to the period between the harvest of one crop and the planting of the next crop. (FAO 2003a)

Farm diversity. Variety of farm activities, diverse grassland ecotypes, site-specific crop rotations with high numbers of crops in sequence, and the integration of livestock into cropping systems. (Niggli, Slabe et al. 2008 p 19)

Farmer field school (FFS). Group-based learning methodology that has been used by a number of governments, NGOs and international agencies to promote Integrated Pest Management. It brings together concepts and methods from agroecology, experiential education and community development. (FAO 2005)

Fertilization. The act or process of rendering land fertile, fruitful, or productive; the application of fertilizer, either synthetic or natural. (FAO 2009a p 61)

Food chain. The sum of all the processes and activities in a food system. A food system comprises multiple food chains operating at the global, national and local levels. (FAO 2008b p 5)

Food insecurity. Situation when people lack secure access to sufficient amounts of safe and nutritious food for normal growth and development and an active and healthy life. It may be caused by the unavailability of food, insufficient purchasing power, inappropriate distribution, or inadequate use of food at the household level. (FAO 2013b)

Food security. Situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life. (FAO 2001)

Food sovereignty. The right of peoples to define their own food and agriculture; to protect and regulate domestic agricultural production and trade in order to achieve sustainable development objectives; to determine the extent to which they want to be self reliant; to restrict the dumping of products in their markets; and to provide local fisheries-based communities the priority in managing the use of and the rights to aquatic resources. Food sovereignty does not negate trade, but rather, it promotes the formulation of trade policies and practices that serve the rights of peoples to safe, healthy and ecologically sustainable production (FAO 2005 citing Via Campesina).

Food system. Encompass (i) activities related to the production, processing, distribution, preparation and consumption of food; and (ii) the outcomes of these activities contributing to food security (food availability, with elements related to production, distribution and exchange; food access, with elements related to affordability, allocation and preference; and food use, with elements related to nutritional value, social value and food safety). The outcomes also contribute to environmental and other securities (e.g. income). (GECAFS Online)

G

Gamma diversity. The species diversity of a number of community samples, for some range of environments, which have been combined, so that the diversity value is a result of both alpha and beta diversities of these samples. (Whittaker 1960 p 320)

Genetic erosion. Process that refers to a change in genetic diversity over time. To measure this change some authors argue that it is important to focus on the loss of richness or evenness of alleles, while others argue that it is more important to focus on the loss of genes or genotypes. (Brown 2008 p 13; Brush 1999)

Genetic vulnerability. The susceptibility of genetically uniform crops to damage or destruction caused by outbreaks of a disease or pest or unusually poor weather conditions or climatic change. (Agroecology Online)

Genetically Modified Organism (GMO). Organism in which the genetic material has been changed through modern biotechnology in a way that does not occur naturally by multiplication and/or natural recombination (e.g. a plant may be given fish genetic material that increases its resistance to frost). (FAO 2009a p 66)

Green manuring. To cover crop grown to help maintain soil organic matter and increase nitrogen availability. (FAO 2009a p 68)

Greenhouse Emissions. Gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of infrared radiation emitted by the Earth's surface, the atmosphere, and clouds. This property causes the greenhouse effect. (IPCC 2001 p 374)

H

Habitat. The particular environment or place where an organism or species tend to live; a more locally circumscribed portion of the total environment. (IPCC 2001 p 374)

Habitat fragmentation (process). Set of mechanisms leading to the discontinuity in the spatial distribution of resources and conditions present in an area at a given scale that affects occupancy, reproduction, and survival in a particular species. (Franklin, Noon et al. 2002 p 27)

Hardening. Subjecting a seedling or plant to cooler temperatures in order to increase its resistance to more extreme cold. (Agroecology Online)

Hedonic price methods. Economic valuation methods that use statistical techniques to break down the price paid for goods and services into the implicit prices for each of their attributes, including environmental attributes such as access to recreation or clean air. Thus the price of a home may be broken down to see how much the buyers were willing to pay for a home in a neighborhood with cleaner air. (Millennium Ecosystem Assessment 2005a p 212)

Home gardens. Farming system which combines different physical, social and economic functions on the area of land around the family home. (FAO 1995)

Humus. Decomposed, dark brown and amorphous organic matter of soils, having lost all trace of the structure and composition of the vegetable and animal matter from which it was derived. Humus hence refers to any organic matter that has reached a point of stability and which is used in agriculture to amend soil. (FAO 2009a p 72)

I

Importance value. A measure of a species' presence in an ecosystem or community—such as number of individuals, biomass, or productivity—that can be used to determine the species' contribution to the diversity of the system. (Agroecology Online)

In situ conservation. Conservation of plant genetic resources in their natural habitats. (Jaramillo and Baena 2007 p 10)

Incentives to adopt Good Agricultural Practices (GAPs). The incentives for farmers to adopt GAPs include economic incentives such as increasing and/or stabilizing revenue, reducing average costs, improved market access, increased capital valuation of farm assets, reduced vulnerability to poor agricultural practices of other farmers; regulatory or legal incentives including changes in ownership rights or tax burdens, liability rules, subsidies; and human capital incentives including access to new skills. (FAO 2003c p viii, ix)

Indirect use value. The benefits derived from the goods and services provided by an ecosystem that are used indirectly by an economic agent. For example, an agent at some distance from an ecosystem may derive benefits from drinking water that has been purified as it passed through the ecosystem. (Millennium Ecosystem Assessment 2005a p 212)

Integrated Pest Management (IPM). Careful consideration of all available pest control techniques and subsequent integration of appropriate measures that discourage the development of pest populations and keeps pesticides and other interventions to levels that are economically justified and reduce or minimize risks to human health and the environment. IPM emphasizes the growth of a healthy crop with the least possible disruption to agro-ecosystems and encourages natural pest control mechanisms. (FAO 2009a p 77)

Intensification. Intensification in conventional agriculture is understood primarily as using a higher input of nutrient elements and of pesticides per land unit. It also means more energy (direct for machinery and indirect for inputs). (Niggli, Slabe et al. 2008 p 34)

Intercropping. Growing two or more crops as a mixture in the same field at the same time. (FAO 2009a p 78)

Interventionist approach. In which most aspects of production are controlled by technological interventions such as soil tilling, protective or curative pest and weed control with agrochemicals, and the application of mineral fertilizers for plant nutrition. (FAO 2011a p 17)

Intrinsic value. The value of someone or something in and for itself, irrespective of its utility for someone else. (Millennium Ecosystem Assessment 2005a p 212)

Irreversibility. The quality of being impossible or difficult to return to, or to restore to, a former condition. (Millennium Ecosystem Assessment 2005a p 212)

K

Kantianism. A theory of ethics that ascribes intrinsic value to rational beings and is the philosophical foundations of contemporary human rights and the extended ascription of intrinsic value to a wide spectrum of non-human natural entities, including ecosystems. (Millennium Ecosystem Assessment 2005a p 212)

L

Land cover. The physical coverage of land, usually expressed in terms of vegetation cover or lack of it. Influenced by but not synonymous with land use. (Millennium Ecosystem Assessment 2005a p 212)

Land degradation. Temporary or permanent lowering of the productive capacity of land. (FAO 1994 citing UNEP 1992)

Land sharing. Involves integrating biodiversity conservation and food production on the same land. (Phalan, Onial et al. 2011 p 1289)

Land sparing. Separates land for conservation from land for crops, with high-yield farming facilitating the protection of remaining natural habitats from agricultural expansion. (Phalan, Onial et al. 2011 p 1289)

Land use. The total of arrangements, activities, and inputs undertaken in a certain land cover type (a set of human actions). The social and economic purposes for which land is managed (e.g., grazing, timber extraction, and conservation). (IPCC 2001 p 377)

Land-use change. A change in the use or management of land by humans, which may lead to a change in land cover. (IPCC 2001 p 377)

Land Utilization Type (LUT). A kind of land use described or defined in a degree of detail greater than that of a major kind of land use. In the context of irrigated agriculture, a land utilization type refers to a crop, crop combination or cropping system with specified irrigation and management methods in a defined technical and socio-economic setting. (FAO 1976)

Landrace. Landrace refers to domesticated animals or plants adapted to the natural and cultural environment in which they live (or originated) and, in some cases, work. They often develop naturally with minimal assistance or guidance from humans using traditional breeding methods. (FAO 2013a)

Landscape. An area of land that contains a mosaic of ecosystems, including human-dominated ecosystems. The term cultural landscape is often used when referring to landscapes containing significant human populations. (Millennium Ecosystem Assessment 2005a p 212)

Landscape change. Land transformation by several spatial processes: *perforation* is the process of making holes in an object such as a habitat or land type; *dissection* is the carving up or subdividing of an area using equal-width lines; *fragmentation* is the breaking of an object into pieces (that are often widely and unevenly separated); and *shrinkage* is the decrease in size of objects, and attrition is their disappearance. (Forman 1995 p 138)

Landscape composition. The physical and biological characteristics of a landscape element. (Diaz and Apostol 1992 p 22)

Landscape contrast. The degree to which adjacent landscape elements differ from each other, with respect to species composition and physical attributes. (Diaz and Apostol 1992 p 23)

Landscape diversity. Diversity has been characterized as having three components: compositional, structural and process: *compositional* diversity refers to the variation in types of landscape elements or vegetation types, their relative proportions within the landscape, their degree of rarity or commonness; *structural* diversity describes the variation in sizes and shapes of landscape elements, as well as diversity of pattern; and *process* diversity relates to the variety of landscape flows, functions and processes present. (Diaz and Apostol 1992 p 26)

Landscape edge. The interface between landscape elements of different composition and structure, for example between an open clearcut and a closed-canopy forest. Edges have environmental conditions (temperature, light,

humidity, wind) that are different from either of the adjacent landscape elements. (Diaz and Apostol 1992 p 23)

Landscape elements (structures). Physical, tangible elements of systems, the things we can touch, see and feel. They can be living or non-living, mobile or fixed. Landscapes are commonly described as having three kinds of structures (elements): a matrix, corridors and patches. (Diaz and Apostol 1992 p 18)

Landscape pattern. Arrangement of landscape elements. (Diaz and Apostol 1992 p 22)

Landscape resistance. Landscape resistance is described as the effect of spatial pattern impeding the rate of flow of objects, such as species and materials. (Forman 1995 p 137)

Landscape stability. The likelihood a landscape structural element will change significantly (in composition, physical features, etc.) over time, and the rate of that change. (Diaz and Apostol 1992 p 22)

Living mulch. A cover crop that is inter-planted with the primary crop(s) during the growing season. (Agroecology Online)

Lodging The flattening of a crop plant or crop stand by strong wind, usually involving uprooting or stem breakage. (Agroecology Online)

M

Matrix. Most connected portion of the landscape, that is, the vegetation type that is most contiguous. This becomes increasingly less true as forests become fragmented by clearcutting, where in some cases it may not be possible to discern a matrix at all. (Diaz and Apostol 1992 p 21)

Mineralization. The process by which organic residues in the soil are broken down to release mineral nutrients that can be utilized by plants. (Agroecology Online)

Mitigation (of climate change). An anthropogenic intervention to reduce the sources or enhance the sinks of greenhouse gases. (IPCC 2001 p 379)

Monoculture. This refers to a cultivation system in which a single crop species covers a plot of land. (Di Gregorio and Jansen 2000)

Mosaics. Mosaics are evident at all scales from submicroscopic to the planet and universe. All mosaics are composed of spatial elements (patches, corridors and matrix). Those at the landscape scale are commonly called landscape elements, and those at the regional scale are landscapes. (Forman and Godron 1986)

Multifunctionality. Recognizes agriculture as a multi-output activity producing not only commodities (food, feed, fibers, agrofuels, medicinal products and ornamentals), but also non-commodity outputs such as environmental services, landscape amenities and cultural heritages. It also recognizes that some of the non-commodity outputs may exhibit the characteristics of externalities or public goods, such that markets for these goods function poorly or are non-existent. (IAASTD 2009 p 4)

Multiple cropping system. Planting two or more species in the same field during the same growing season. It can take the form of double-cropping, in which a second crop is planted after the first has been harvested, or relay cropping, in which the second crop is started amidst the first crop before it has been harvested. (FAO 2009a p 91)

N

Natural selection. The process by which adaptive traits increase in frequency in a population due to the differential reproductive success of the individuals that possess the traits. (Agroecology Online)

Niche (ecological). All of the interactions of a species with the other members of its community, including competition, predation, parasitism, and mutualism. A variety of abiotic factors, such as soil type and climate, also define a species' niche. Each of the various species that constitute a community occupies its own ecological niche. (Encyclopedia Britannica 2013b)

Neglected and underutilized species. Non-commodity crops, which are part of a larger biodiversity portfolio, once more popular and today neglected by users' groups for a variety of agronomic, genetic, economic, social and cultural factors. (Padulosi and Hoeschle-Zeledon 2004 p 5)

O

On-farm conservation. Management of genetic diversity of locally developed crop varieties (landraces) by farmers within their own agricultural, horticultural or agri-silvicultural systems. (Negri, Maxted et al. 2009 p 7)

Open access resource. A good or service over which no property rights are recognized. (Millennium Ecosystem Assessment 2005a p 213)

Open pollination. The natural dispersal of pollen among all the members of a cross-pollinating crop population, resulting in the maximum degree of genetic mixing and diversity. (Agroecology Online)

Opportunity cost. The benefits forgone by undertaking one activity instead of another. (Millennium Ecosystem Assessment 2005a p 213)

Option value. The value of preserving the option to use services in the future either by oneself (option value) or by others or heirs (bequest value). Quasi-option value represents the value of avoiding irreversible decisions until new information reveals whether certain ecosystem services have values society is not currently aware of. (Millennium Ecosystem Assessment 2005a p 213)

Organic agriculture. Holistic production management system which promotes and enhances agroecosystem health, including biodiversity, biological cycles, and soil biological activity. It emphasizes the use of management practices in preference to the use of off-farm inputs, taking into account that regional conditions require locally adapted systems. (FAO 2009a p 99)

Organic fertilization. The use of natural organic fertilizer that helps to provide all the nutrients required by the plants and increase the quality of the soil with a natural microorganism environment. (FAO 2009a p 106)

Organic matter. Plant and animal residues at various stages of decomposition, cells and tissues of soil organisms, and substances synthesized by the soil population. (FAO 2009a p 110)

P

Participatory plant breeding. Farmers participate in the selection of parent materials and in on-farm evaluations. (FAO 2011a p 46)

Pastoral system. The use of domestic animals as a primary means for obtaining resources from habitats. (Millennium Ecosystem Assessment 2005a p 213)

Patches. Areas of vegetation that are relatively homogeneous internally and that differ from what surrounds them (the matrix, or other patches). In a complex landscape where a matrix is not apparent, forest stands are also patches. (Diaz and Apostol 1992 p 21)

Payments for Environmental Services (PES). Transparent system for the additional provision of environmental services through conditional payments to voluntary providers. (Tacconi 2012 p 35)

Permaculture. Conscious design and maintenance of agriculturally productive ecosystems which have the diversity, stability, and resilience of natural ecosystems. The focus is on the relationships created among elements by the way they are placed in the landscape. This synergy is further enhanced by mimicking patterns found in nature (e.g. pollination services, pesticide application, pest control, poly cropping systems, plant breeding, permanent soil cover, etc.). (FAO 2009a p 120)

Plant genetic resources. Inter and intra-specific diversity of crops, varieties and related wild species which are central to agricultural development and improvements. (FAO 2011a p 43)

Pollination. The completion of the sexual phase of reproduction in some plants by the transportation of pollen. (Millennium Ecosystem Assessment 2005a p 213)

Polyculture. Complex form of intercropping in which a large number of different plants maturing at different times are planted together. (Tyler 2001 p G14)

Polyvarietal cultivation. Planting a plot of land with several varieties of the same crop. (Tyler 2001p G14)

Precautionary principle. States that if an action or policy has a suspected risk of causing harm to the public or to the environment, in the absence of scientific consensus that the action or policy is harmful, the burden of proof that it is not harmful falls on those taking an action . According to the Rio Declaration, in order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation. (UNECE, 1992)

Private costs and benefits. Costs and benefits directly felt by individual economic agents or groups as seen from their perspective. Costs and benefits are valued at the prices actually paid or received by the group, even if these prices are highly distorted. (Millennium Ecosystem Assessment 2005a p 213)

Property rights. An institution that gives someone possession rights to use things and to prevent others from using them; includes private, collective, common, public, and state property rights. (Millennium Ecosystem Assessment 2005a p 214)

Provisioning services. The products obtained from ecosystems, including, for example, genetic resources, food and fiber, and fresh water. (Millennium Ecosystem Assessment 2005a p 214)

R

Rainfed agriculture. Agricultural practice relying exclusively on rainfall as its source of water. (FAO 2008c p 92)

Rangeland. An area where the main land use is related to the support of grazing or browsing mammals. (Millennium Ecosystem Assessment 2005a p 214)

Regulating services. The benefits obtained from the regulation of ecosystem processes, including, for example, the regulation of climate, water, and some human diseases. (Millennium Ecosystem Assessment 2005a p 214)

Relay cropping. Cropping systems in which two or more crops are grown in sequence in the same field in the same year, with little or no overlap in time. Not a true form of polyculture because very little interspecies interaction usually occurs in these systems. (Agroecology Online)

Resilience. The capacity of a system to tolerate impacts of drivers without irreversible change in its outputs or structure. (Millennium Ecosystem Assessment 2005a p 214)

Rewards of Environmental Services (RES). Inducements provided to ecosystem stewards to enhance or continue to maintain environmental services. (Swallow, Kallesoe et al. 2007 p 35)

Ripper-furrower system. A farming system using a tractor-drawn ripper-furrower to rip the hard pan to a depth of 60 cm and form furrows for in-field rainfall harvesting. The harvested water is concentrated in the root zone of crops, which are planted in the rip lines together with a mixture of fertilizer and manure. (FAO 2011a p 25)

Risk. The probability or probability distribution of an event or the product of the magnitude of an event and the probability of its occurrence. (Millennium Ecosystem Assessment 2005a p 214)

S

Security. Access to resources, safety, and the ability to live in a predictable and controllable environment. (Millennium Ecosystem Assessment 2005a p 214)

Self-pollination. The fertilization of the egg of a plant by its own pollen. (Agroecology Online)

Semi-natural agricultural habitats Characterised as areas of farmland where the use of farm chemicals is either totally absent or they are applied at considerably lower rates per unit area than in more intensively cultivated areas. Also these habitats are relatively undisturbed by farming practices, such as from ploughing, mowing, and weeding. (OECD 2001 p 334)

Shifting cultivation. Entails the clearing for crop production of forest land that is subsequently abandoned, allowing natural reforestation and the recovery of depleted plant nutrients. (FAO 2011a p 37)

Social costs and benefits. Costs and benefits as seen from the perspective of society as a whole. These differ from private costs and benefits in being more inclusive and in being valued at social opportunity cost rather than market prices, where these differ. (Millennium Ecosystem Assessment 2005a p 215)

Subsistence farm. When the farm produces enough to feed only the farmer household and there is no surplus to sell. (FAO 2009a p 139)

Supporting services. Ecosystem services that are necessary for the production of all other ecosystem services. Some examples include biomass production, production of atmospheric oxygen, soil formation and retention, nutrient cycling, water cycling, and provisioning of habitat. (Millennium Ecosystem Assessment 2005a p 215)

Sustainability. A characteristic or state whereby the needs of the present and local population can be met without compromising the ability of future generations or populations in other locations to meet their needs. (Millennium Ecosystem Assessment 2005a p 215)

Sustainable community food system. Collaborative network that integrates sustainable food production, processing, distribution, consumption and waste management in order to enhance the environmental, economic and social health of a particular place. Farmers, consumers and communities partner to create a more locally based, self-reliant food economy. (Agricultural Sustainability Institute at UC Davis 2013)

Sustainable crop production intensification (SCPI). System which produces more from the same area of land while conserving resources, reducing negative impacts on the environment and enhancing natural capital and the flow of ecosystem services. (FAO 2011a p 2, 5, 24)

Sustainable development. Development that meets the needs of the present without compromising the ability of future generations to meet their own needs. (United Nations World Commission on Environment and Development 1987 p 37)

T

Threshold. A point or level at which new properties emerge in an ecological, economic, or other system, invalidating predictions based on mathematical relationships that apply at lower levels. For example, species diversity of a

landscape may decline steadily with increasing habitat degradation to a certain point, then fall sharply after a critical threshold of degradation is reached. Human behavior, especially at group levels, sometimes exhibits threshold effects. Thresholds at which irreversible changes occur are especially of concern to decision-makers. (Millennium Ecosystem Assessment 2005a p 215)

Total economic value framework. A widely used framework to disaggregate the components of utilitarian value, including direct and indirect use value, option value, quasi-option value and existence value. (Millennium Ecosystem Assessment 2005a p 215)

Travel cost methods. Economic valuation techniques that use observed costs to travel to a destination to derive demand functions for that destination. Developed to value the recreational use of protected areas, they have limited applicability outside this context. (Millennium Ecosystem Assessment 2005a p 215)

U

Uncertainty. An expression of the degree to which a future condition is unknown. (Millennium Ecosystem Assessment 2005a p 215)

Upscaling. The process of aggregating or extrapolating information collected at a fine resolution to a coarser resolution or greater extent. (Millennium Ecosystem Assessment 2005a p 215)

Utilitarian. An approach that focuses on the satisfaction of human preferences. In some cases, this is taken further and made the basis of a moral viewpoint. (Millennium Ecosystem Assessment 2005a p 215)

Utility. In economics, the measure of the degree of satisfaction or happiness of a person. (Millennium Ecosystem Assessment 2005a p 216)

V

Valuation. The process of expressing a value for a particular good or service in a certain context (e.g., of decision-making) usually in terms of something that can be counted, often money, but also through methods and measures from other disciplines (sociology, ecology, and so on). (Millennium Ecosystem Assessment 2005a p 216)

Value. The contribution of an action or object to user-specified goals, objectives, or conditions. (Millennium Ecosystem Assessment 2005a p 216)

Value systems. Norms and precepts that guide human judgment and action. (Millennium Ecosystem Assessment 2005a p 216)

Vermicomposting. The use of earthworms for composting organic residues. (FAO 2003d)

Vulnerability. The degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity. (IPCC 2001 p 188)

W

Water-use efficiency. Carbon gain in photosynthesis per unit water lost in evapotranspiration. It can be expressed on a short-term basis as the ratio of photosynthetic carbon gain per unit transpirational water loss, or on a seasonal basis as the ratio of net primary production or agricultural yield to the amount of available water. (IPCC 2001 p 188)

Z

Zero Hunger Challenge. A United Nations challenge which has five elements: guarantee year-round access to adequate food, end stunting in children less than 2 years old, double small holder productivity and income, achieve sustainable food systems, and reduce food waste and loss to zero. (UN 2012)

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