What is an ecosystem

The Agroecosystem

The agricultural ecosystem

A typical example of artificial ecosystem is a cultivated field or agro-ecosystem. This is a natural system altered by men through agricultural activity.
It's different from a natural ecosystem for four main characteristics:

- simplification: a farmer favours a plant species removing all other animal or plant species which could damage it
- the energy intake employed by men in the form of machinery, fertilizers, pesticides, selected seeds, processings
- the biomass (harvest) which is removed when ripe. This makes the ecosystem an open system, which means it depends from external processes to reintroduce fertilizing substances suitable to nourish a new growth and development process of organic material (plants). A natural ecosystem, instead, self-fertilizes as the biomass remains in its original setting
- the introduction of pollutant substances which, in the case of intensive agriculture, are chemical fertilizers, antiparasitics and other chemical non biodegradable substances which accumulate in the ecosystem or which seep in the subsoil, in some cases getting to the point of seriously polluting groundwaters, seas and rivers.

A home is also a small artifical ecosystem. Objects, food, solar energy, water, etc. are introduced inside houses from outdoor and solid and liquid waste generated by human activities is removed outdoor. The city functions in the same way. A city, in fact, depends from external areas for water and food supplies as well as building materials and other resources necessary for its development and waste generated in a city is unloaded outside the urban area (in landfills and incinerators), which means everything which doesn't contribute to the survival of the urban ecosystem is deposited in these areas.

Land to feed us

Cultivating land and feeding on its products has always been an acitvity men carry out keeping into consideration climatic and environmental conditions typical of every territory.
Men have slowly overcome limits set by the environment thanks to progress and modern technologies and have thus been enhancing environmental stress. Men have therefore modified landscapes to increase productivity transforming land into cultivated fields, reclaiming wetlands, terracing slopes, and converting forests into pastures. Agriculture has an impact on the environment with regards to the quantity of resources employed and substances it generates – both natural and chemical – which are released in various environmental compartments, soil, water and atmosphere. For example, to grow a cornfield, besides solar energy, also requires soil minerals and nutrients, irrigation water, and chemical fertilizers to sustain plant growth; it's also crucial to protect corn from insects, fungi and parasites attacks, which in a natural environment occurs thanks to the presence of other animal or plant organisms feeding on these insects.
To prevent parasites from attacking and feeding on fields, though, men often intervene using powerful insecticides which are harmful for the whole environment and for humans. The introduction of these substances in the environment and the use of natural resources affect the natural balance of the environment which becomes vulnerable. The environment tries to compensate the effects determined by agricultural activity as well as the effects generated by human activity. If conditions of strong climatic change occurred, especially on a global scale, whether the latter were caused by excessive inputs generated by human activity or as a consequence of the natural development of the planet, agricultural systems

would become incapable of maintaining the high levels of production required as fields rely directly on the conditions of the soul, atmosphere and water.

Agriculture and climate change

Earth's climate is changing and there is scientific evidence about this. The average temperature of the planet has been rising by 0,8 °C in the past century (in Europe it has been rising by 1 °C). It's been time since some gases have been identified as causes for global warming and the so-called "greenhouse effect", especially carbon dioxide (CO2), methane (CH4) and nitrous oxide (N2O), naturally occurring in the atmosphere, but produced in high concentrations by human activity, as the use of fossil fuels for transportation and industrial activities, land-use change and deforestation.
General climatic conditions have become more variable. Rainfall has increased in northern European regions together with the frequency of hurricanes and storms, whilst in southern regions is occurring a decline in rainfall and increased drought. Statistical analyses show that the risk of catastrophic events taking place in the future is increasingly higher along with related potential economic losses.
Southern Europe and the Mediterranean Sea basin, in particular, are among the areas at greater risk of drought, whilst mountainous areas as the Alps risk undergoing deep changes in the structure of glaciers and water flows due to temperature rise. In the following decades, cultivated lands will probably undergo great variability of annual yielding times as harvesting will be anticipated to summer and starting crop rotations will be necessary in spring, introducing species requiring less water in comparison to corn and the few selected crops currently selected.
In the light of the great impact of climate change occurring on the whole planet in the medium and long term, the political background governing and shaping the policies of each country with regards to the agricultural sector is expected to face a double challenge: on one side, the necessity of reducing atmospheric emissions of "greenhouse gases" (GHG), and on the other side, the need to adapt human activity to new climatic conditions to reduce its negative impacts on humans. In particular, agriculture could contribute greatly to the mitigation of climate change, considering its strong impact on the environment: it can, in fact, reduce high methane and nitrous oxide emissions (generated from manure used to fertilize and related zootechnical activities), enhance the capacity of cultivated lands of absorbing carbon dioxide from the atmosphere, provide useful raw materials to generate renewable energy.

And how does agriculture affect climate change?

Agriculture represents the third most important sector with regards to greenhouse gases emission, in close correlation with the livestock sector, as it produces 9% of total GHG emissions in the atmosphere generated by human acitivites The greatest agricultural impact is given by nitrous oxide (N2O) emissions generated by the application of fertilizers on farming soils (5%), followed by methane (CH4) emissions generated by manure and ruminant digestive processes. The role played by agriculture with regards to atmospheric emissions depends, in fact, from the type of farm located on a territory and intensive or extensive livestock activities taking place. Moreover, it should be considered that greenhouse gas emissions generated by agricultural activites requiring energy use (for example, fuel for machinery, electricity for lighting and to carry out activities within plants, etc.) aren't estimated, according to common European policies, within the emissions produced by the agricultural sector but are assigned to the energy sector.The same goes for the evaluation of carbon which can be naturally absorbed by soil (a phenomenon termed "carbon sequestration"), helping to reduce excessive carbon dioxide in the atmosphere: this type of activity isn't considered within the agricultural sector, but estimated in relation to soil use and land-use change. For these reasons, measuring the impact of agriculture on climate change is more complex than for other sectors as the industrial sector, as estimates of greenhouse gases emissions produced by agricultural systems must also take into account biological and environmental processes involved.

Cultivating according to new climates

If we want agriculture to keep being a productive sector it's necessary to implement solutions adapting old agricultural systems to the new climatic conditions. The goal is reducing the vulnerability of cultivations and increasing the resilience of rural areas from both an environmental and economical point of view, which means enhancing the capacity of agricultural activities of regaining productivity after catastrophic events, as droughts, hurricanes and floods. To adapt to

the different availability of resources, farms can modify crop rotation to make best use of water, plan periods of sowing with regards to temperature and precipitation, use crops which are more resilient to heat waves and drought and restore hedges, rows of trees and bushy areas between cultivated areas to reduce water losses from soil and cultivations (increasing areas of shade and reducing plants evapotranspiration).
The agricultural sector can guide activities providing information on current risks regarding climate change and potential adaptive measures which farms can implement. In Europe, some of the Member States (Finland, Spain, France, United Kingdom) are already implementing measures aiming to adapt productive agricultural activities to new climatic conditions, and are also conducting studies and researches to assess the impact of climate change on agriculture. In particular, adaptive measures regard the capacity to prevent external extreme events related to climate as floods, hurricanes and drought to limit the effects generated by temperature rise and increased variability of climatic conditions. In Germany, for example, the sowing period of corn and sugar has been anticipated by 10 days, in southern France up to 20 days ahead. In some cases adaption requires forms of investment in machinery and infrastructure to improve, for example, the irrigation system.

The amount of water employed to farm land

Agriculture consumes 70% of the water drawn in the whole world from rivers, lakes and groundwater; in particular, developing countries are accountable for consumption of 95% of the water overally destined to agriculture, especially since the application of irrigated agriculture techniques implemented mostly in China, India and Pakistan. Even if per capita water consumption has lowered since 1980 from 700 to 600 annual cubic metres, water use to cultivate lands has been growing by 100% from 1961 to 2001 and is expected to register an exponential growth in the coming years, also due to constant population growth, expansion of urban areas and growing industrialization of emerging countries. The area covered by irrigated land in Europe is also increasing resulting in depletion of water resources and deterioration of water quality thus provoking desalinization and soil degradation. Currently, about 30-40% of the availability of agricultural products on a global scale originates from 16% of the irrigated agricultural area and it is estimated that in the following years the contribution of irrigated agriculture to food production will tend to grow. Italy destines for irrigation purposes about 60% of the 56 billion cubic metres of fresh water consumed and ranks first in Europe both for water consumption per inhabitant and for the greatest agricultural irrigated area, which is equivalent to 4,5 million hectares. Irrigation is practised with different procedures according to geographical areas and climate zones, with varying degrees of sophistication and technology: irrigating is useful to stabilize the productivity of cultivations and, in tropical countries, to guarantee more crops in the same year as well as higher yields. Irrigation is important also in dry or semi-arid areas, which would otherwise be unsuitable to support some crops. Today, more than 1,2 billion people live in areas where water scarcity occurs and for 2025, according to the United Nations Development Programme (UNDP), more than 3 billion people will become familiar with water stress conditions. On one side, therefore, irrigation is a tool which is becoming increasingly relevant in terms of food availability, on the other side, it constitutes the first form of consumption of water resources on a global scale.

Water waste

The gap between water supplies and water demand is increasing in many areas of the world: in those areas where water scarcity is already occurring, increasing drought will be the major constraint to agricultural growth and development. Climate changes will cause, above all, a decrease in annual water availability in many areas of the world. In Europe, especially in southern and central European areas, water availability will decrease more and more due to the constant decline of summer rainfall and high water demand for cultivations.
Consider that the amount of water sufficient to irrigate one hectare of rice crop would also cover the needs of 100 nomads with 450 head of cattle over three years, or 100 urban families over a two-year period. Moreover, in southern countries of the world, water used for irrigation represents up to 91% of general water consumption (in comparison to a 39% share in high per capita income countries), but agricultural production is equivalent to a third of production in industrialized countries as half of the water destined for irrigation evaporates due to high temperatures or gets lost due to

leaks in the water supply distribution networks. To solve the problem of water waste it's necessary to introduce more modern technologies as drip irrigation and renew distribution networks, but often serious financial and political problems limit these options. Men draw to irrigate much more water than the amount which the planet is able to provide: withdrawal for irrigation use, in fact, in many areas exceeds the water capacity of water flows, rainfalls and regeneration of nature reserves.

Due to this imbalance, whenever delays in the arrival of rainfall occur, in comparison to natural cycles, events as famines burst out, as the one hitting some regions in Sub-Saharan Africa some years ago or, even if catastrophic events don't take place, water reserves are slowly consumed until depletion: it is estimated that in Jordan within 35 years groundwater reserves will be completely depleted and that their renewal will take thousands of years. In the United States, since as early as 1960, the Colorado river doesn't reach the sea anymore, save when exceptional rainfall occurs, because large quantities of water are drawn from the river before it reaches the Pacific Ocean.

In the African Sahel region, both due to extended drought and decreased inflow of rivers whose waters have been diverted for irrigation uses, the Chad lake has been reducing by 75% in the last 30 years. But the prime example is the drying up of the Aral lake (which was the world's 4th largest lake) in the heart of Central Asian deserts. Some Asian republics of the former Soviet Union diverted the flow of two rivers that fed the lake to cultivate rice and cotton, two crops requiring large amounts of water, especially when grown in very dry lands. This choice has reduced the surface of the Aral Lake by 70%; causing further salt concentration increases in its waters – which in the past were salty but very rich in fish – worsened by the presence of pollutants and pesticides, which have been carried for years into the lake by rivers or drained from cotton fields, and are now concentrated at the highest levels. Pollution is generating, besides the destruction of the lacustrine ecosystem, also serious health problems for local populations: anemia, infant mortality, rheumatoid arthritis, allergic reactions.

Agrobiodiversity

So far scientists have identified about 1,4 million animal and plant species on Earth and almost every day a new species joins this list. This variety of life forms is crucial for human beings. We depend on it for food, healing substances, water, energy and much more. Biodiversity, though, is increasingly threatened by human pressure, as the world population is in continuous increase and by the decay of natural ecosystems caused by human activities. Wild species risk extinction if the habitats where they live are harassed by pollution, urbanization, and deforestation. This destructive process can be hurried by negative management of agriculture, forests and ichthyic supplies. Agricultural biodiversity is represented by an innumerable quantity of plants which are necessary to feed and heal human beings. Biodiversity is found among the variety of cultivations with specific nutritional characteristics, breeds of cattle that have adapted to hostile environments, insects pollinating fields, micro-organisms regenerating agricultural soils. But also agricultural biodiversity is in danger. Human beings, infact, depend on a number of agricultural products which is increasingly reducing to eat and this lowers the prospect of some cultivated plants and bred animals to have the capacity to adapt to drastic environmental changes. About ten thousand years ago, on the basis of nature's biodiversity, human beings started to collect seeds and wild plants and grow them, choosing the most productive species or the most resistant to adverse climatic conditions. More or less during the same period, humans started to tame also animals, exploiting their strength, eating their meet and drinking their milk. Even today genetic diversity is essential for the global agricultural production to keep being sustainable.

Farmers and agronomists, infact, need genetic diversity to help plants adapt to variable life conditions or to expand production in new areas which haven't yet been cultivated. Genetic diversity of plants (defined as plant genetics) is crucial to enhance yields and have cultivations producing both more food and food with higher nutritional value. Today, four plant species alone – wheat, corn, rice and potatoes – provide more than half of the vegetable calories of the human diet, whilst about dozen animal species provide 90% of global animal protein consumption. Besides the diversity of species used for nutritional purposes, it's fundamental to maintain genetic diversity within each species: many farmes have adopted uniform potato seeds and animal breeds which give greater returns. When diversity is abandoned, though, variety and races can become extinct along with their specific features.

The push for an increase in agricultural production and higher profits, infact, has oriented the choice to a limited number

of plant species and animal races which give great returns. This is another legacy of the “green revolution”: many farmers, instead of cultivating a wide selection of plants, as in the past, have concentrated on one single culture, which is called monoculture, expecting higher returns and substantially reducing global agricultural biodiversity. Monoculture plants are often hybrid varieties crossbred from original species. A better variety produces more so that farmers have no need to plant older varieties which slowly disappear. Farmers opting for traditional agriculture, instead, tended to cultivate an ample variety of plants and often also raised cattle.

Since the beginning of monoculture farming most traditional agricultural practices have been abandoned. A high number of types of plants and animal races have silently disappeared. This disappearance is known as “extinction” and is irreversible. Agriculture, therefore, is losing its capacity to adapt to environmental changes, as global warming or new harmful insects and illnesses. If current food availability isn’t able to adapt to environmental mutations, we could find ourselves in deep trouble.

It’s extremely important to protect these resources and be sure they’re used sustainably. Farmers, as guardians of the planet’s biodiversity, have the chance to cultivate and maintain local trees and plants and provide for the reproduction of native animals, ensuring their survival. The loss of biodiversity, though, doesn’t concern agriculture alone. Forests are probably the most important deposit of biological diversity, although every year we lose thousands of hectares of forest cover.

Oceans, lakes, and rivers of the planet swarm with life but over-exploitation and fishing methods which are harmful for the environment threaten aquatic biodiversity. Experts are seriously worried about this rapid reduction of genetic reserves. Drawing from a wide range of unique features allows to select plants and animals capable of responding to mutations in their condition. Moreover, this provides scientists the raw material they need to develop more productive and resistant types of cultivations and breeds. For poor farmers, biodiversity can really be the best defense against famine: infact, in the regions of the world where subnutrition levels are higher, farmers need cultivations which grow well in difficult and adverse climatic conditions rather than types giving high yields under favourable conditions or smaller-sized animals but which are more resistants to illnesses. Even consumers, both in developed and developing countries, benefit from the availability of a great range of plants and animals because this contributes substantially to a nutrient diet: rural communities often have limited access to markets and, for this reason, availability of a wider range of local food becomes essential. Preserving plants, animals and their habitat in the end means safeguarding a series of essential functions which nature supplies. International commitment to preserve plants and animals in genetic banks and botanic and zoological gardens is crucially important.

The International Treaty on Plant Genetic Resources for Food and Agriculture has been adopted to defend this precious heritage and has been enforced on June, 29 2004. The soil, thanks to the silent and constant work of insects, bacteria, mushrooms, and worms becomes fertile and farmers can cultivate food. Livestock, mushrooms and micro-organisms break down organic material transferring nutrient elements to the earth. Ants and other insects keep parasites under control. Bees, butterflies, birds and bats pollinate fruit trees. Swamps and lakes filter polluting agents. Forests prevent floods and limit erosion. Intact ocean ecosystems help keeping ichthyic resources healthy and constant over time thus ensuring the possibility of fishing for future generations.