Plants

Introduction

Botanists, who are scientists who study plants, have identified and described over 3,500 types of plants, but there are many more! Plants have different shapes and sizes, some are so small they can only be seen with a microscope, while others are so tall that it is hardly possible to identify their foliage; many have very colourful flowers others do not have any.
There is such a large variety of plants because they live in different environments of the Earth: in the water, in thick forests or wide plains, in cold climates or blazing deserts. Since millions of years they have had to and have known how to adapt to their environment. Plants provide much of the oxygen that animals and humans breathe, and a large part of the food they eat.

Plants knowledge

What is it?

Like the word “fauna”, the word flora also comes from Greek mythology and is used to indicate the world of the vegetal species that inhabit the Earth. This world is no less complex than the animal world, and to begin to learn more about it, it is useful therefore to divide it into four large groups: algae, bryophyta (i.e.moss), ferns and seed plants (or spermatophytes).

Bryophyta

Short after the emerged lands were conquered, plants were classed into: bryophyta, that include hepatics, anthocerote and mosses and vascular plants, i.e. all higher plants.
The structure of bryophyta is very simple and it is made up of individuals that are generally shorter than 20 cm.
Bryophyta do not have roots, but they have **rhizoids**, i.e. long cells or cell filaments, that stick to the substrate. Many bryophyta have a leaf-like structure, made up of few cell layers through which they carry out the photosynthesis. As they have no roots to absorb the water, they have to take the water from aerial structures, therefore they grow maily in wet and dark areas, or in marshes.

Ferns

These plants have big leaves, called fronds, they do not produce seeds and they generally need water to fertilize. For this reason they are generally found in humid and shady forests and in marshes. Some ferns can reach 20 metres of height and behave like trees.

Spermatophytes

Spermatophytes are divided into gymnosperms and angiosperms. The name **Angiosperms** comes from the Greek words: angeion, “vase”, and sperm, “seeds”. This name means that the seeds of these plants are not “naked”, but encased in a specific structure, the ovary, that protects them from the external environment. The differences between Angiosperms and Gymnosperms are generally very clear .
The most important ones are:
• the Angiosperms include many wood or shrub species as well as many herbaceous species (unlike Gymnosperms);
• the cotyledons (i.e. the apparatuses that store food to feed the plant embryo) in Gymnosperms and few in Angiosperms (normally, one in monocotyledons sand two in dicotyledons);
• finally, in Gymnosperms the leaves are generally small and thin (needle- or scale-shaped leaves), while in Angiosperm they are more or less large and generally have an expanded lamina and reticulated or parallel ribs.

Angiosperms

Angiosperms include approximately 220,000 species (over one half of the known higher plants) and their classification is very complex and detailed and not perfectly defined yet. Angiosperms can be divided into two large groups: dicotyledons and monocotyledons. The features that distinguish Dicotyledons from Monocotyledons are generally quite clear and peculiar. The most important discriminating parameter is the number of cotyledons contained in the embryo: Dicotyledons own two cotyledons only (rarely 1, 3 or 4), while Monocotyledons own only one (or sometimes none at all). Other features shared by Angiosperms are the presence of a trunk, leaves and roots and the production of flowers, fruits and seeds. They may be have either a herbaceous or wooden "habitus". Herbaceous plants can be annual, biennial and perennial. In annual plants, the vegetative and reproductive cycle is completed in one year, while biennial plants stock up food in the first year, then bloom and make fruits in the second year, then the plant dies. Perennial herbaceous plants bloom every year.
Wooden plants are all perennial, and can be divided into shrub or tree plants. The former have a limited height and their branches depart from the basal portion of the plant; trees can reach remarkable heights and have a branched trunk. In fact, the distinction between trees and shrubs is not always easy, since many plants can look differently according to where they live.

Gymnosperms

Gymnosperms include around 750 species. Among gymnosperms we find the tallest trees on Earth, like for example sequoia that can reach up to 100 metre height. Among gymnosperms we also find coniferae (this word means “cone-carrier”). Among them, we find pines, fir trees, larches, cedars of Lebanon, cypress and juniper. Most of conifers are ever-green plants, with needle-shaped or squama-shaped leaves..

Photosynthesis

All living beings are largely composed of organic molecules (sugars, fats, proteins, etc.), that are produced from other molecules (synthesis). Plants are however different from animals, since they use different molecules in the process. Actually, green plants produce the organic substances their body is made of by using a limited number of inorganic substances that can be found in the environment, such as **carbon dioxide** (contained in air) and water and some **inorganic ions** (nitrates, sulphates, and other substances contained in soil). In particular, green plants can use solar energy to trap and turn into organic molecules the carbon contained in the atmosphere in the form of carbon dioxide. This process is called photosynthesis and is typical of autotrophic organisms. All the other organisms that cannot accomplish the photosynthesis process, such as man or animals, are called heterotrophic organisms. Heterotrophic organisms can synthesise the molecules their body is made of only by using the organic molecules contained in food (vegetal or animal food). Vegetal species are therefore an essential element for natural balance and for the life of other living species.

Still but vital

If we look at the way plants feed themselves, we can understand the reason of the specific distinguishing features of this kingdom. Plants are actually motionless, often cover large areas, both in the air (with their branches and leaves) and underground (with their roots), sometimes have no specific growth limit and are very adaptable to external stimuli. Plants are motionless because their food is rather evenly contained in the atmosphere (carbon dioxide), soil and water (inorganic ions), so they do not need to move. It is just for this reason, that they cannot move, that plants have become extremely adaptable to external living conditions; in addition, since plants take in nutrients through their leaves and roots, the larger the surface of contact between the plant and the environment (and therefore the area covered), the more the nutrients it can take in to grow. And this is the reason why plants, unlike man or animals, tend to grow bigger and bigger without a specific time limit (a property called “indefinite growth”).

Adjustment of the Earth’s climate

Vegetation strongly affects the Earth’s climate and the composition of the atmosphere through the photosynthesis activity. Through this process, plants absorb carbon dioxide (CO2) from the atmosphere, trap carbon (C) to build organic molecules and release oxygen (O). Due to the extension of vegetation on Earth, the amounts of oxygen and carbon dioxide that get into this process are huge: every year, the plants’ photosynthesis releases approximately 70 billion tons of oxygen and consumes an equally huge amount of carbon dioxide.
Through the photosynthesis, plants counteract the many oxidation processes (for instance, combustion for the production of energy, as is in all the bodies of the living beings, or combustion in industrial processes and car engines), that, using the oxygen contained in the air and giving back carbon dioxide, cause the concentration of the former in the atmosphere to decrease and that of the latter to increase.
In this way, plants play an essential role for life on Earth: stabilising the gas composition of the atmosphere.
In addition, the stabilisation of the composition remarkably affects the atmospheric temperature and humidity; this subject will be dealt in more detail in the Section on “AIR”.

Plants as energy source

At present, a large part of man’s energy requirements is covered by products of vegetal origin. Fossil fuels (coal, oil, natural gas) have formed from the partial decomposition of organisms – mainly vegetal – that lived over one hundred millions years ago (see the Section on ENERGY). When petrol burns in a car engine or methane burns in the kitchen stove, some of the solar energy trapped by the plants in distant times through photosynthesis is released. Talking of fuels, let’s not forget firewood, which now is no longer used in industrialised countries, but which in developing countries is still one of the main energy sources for the home (cooking and heating).

World plants

The main factors that affect the spreading of a vegetal species are climatic conditions (especially sun exposure, temperature and availability of water) and the characteristics of the soil.
The impact of the other living organisms that inhabit the same ecosystem (herbivores, insects, other vegetal species, etc.) should not be underestimated either.
But an analysis of the factors above is not sufficient to account for all the reasons why a species inhabits a given place and not another, similar one. A species can actually spread in a given place just because of an occasional event: for instance, many Arctic species that grow in the Alps arrived there during the glaciations, when all Europe offered them favourable climatic conditions. As the glaciers withdrew, they disappeared everywhere but on the mountain tops, where they still found favourable living conditions. In other cases, the chance factor is man, who, through migrations and trade, has promoted the spreading of numerous species away from their places of origin.

Life pioneers

Palaeontology is the science that studies the ancient living beings, their origin and evolution. This study requires the examination of the animal and vegetal remains that lived in the past and that we find today as fossils inside sedimentary rocks. Primordial organisms had very simple and small shapes, so they could not turn into fossil remains. The most ancient fossils to have been found so far date back to approximately 3 billion years ago. How have the first living organisms originated? Before the appearance of life, the Earth’s landscape was dominated by active volcanoes, a grey, lifeless ocean and a very turbulent atmosphere. The ocean received organic substances from the mainland, the atmosphere and the fall of meteorites and comets. And the ocean is the place in which such substances as water, carbon dioxide, methane and ammonia chemically reacted, producing sugars, amino-acids and fats. These molecules are the raw material required for the formation of proteins and nucleic acids that are the basic compounds of any living organism.

A history lasting millions of years

The history of the Earth is divided into five ages: Archaeozoic or Precambrian, Palaeozoic or Primary, Mesozoic or Secondary, Cainozoic or Tertiary, Neozoic or Quaternary.

Archaeozoic age

The Archeaozoic age is the longest one: it began 4.6 billion years ago and ended 530 million years ago. 3 billion-year-old fossils prove that the oldest organisms known so far are very simple, heterotrophic unicellular algae. Some green-blue autotrophic algae appeared, however, approximately two billion years; they could produce the nutrients they needed by themselves, through the photosynthesis. This process caused oxygen to spread from the sea to the atmosphere, thus leading to the appearance of more complex organisms that would conquer the Earth's surface.

The Palaeozoic age

The Palaeozoic age is called the age of "manifest life" and spans across 285 million years, from 530 million years ago to 245 million years ago. A high number of events occurred over this period. Many animal and vegetal groups made their first appearance, many of which disappeared during the same age. At the dawn of the Palaeozoic age, life existed only inside or near oceans. The most common living beings were trilobites, crustaceans, corals and some primitive types of fish. Plants were the first forms of life to spread on the mainland. Huge marshy forests developed, that over the years originated the large deposits of fossil coals that are currently exploited as en energy source. The Palaeozoic age is also known as the age of the great extinctions: at some point, approximately 95% of all the living beings of the Earth disappeared. This event was probably caused by deep climatic changes and powerful volcanic eruptions.

The Mesozoic age

Mesozoic age lasts 180 million years, from 245 million years ago to 65 million years ago. Mesozoic means "mid-life". The living organisms were actually not as primitive as in the Palaeozoic age, but were not too developed either. It is the so-called "reptilian age" because of the appearance (and disappearance) of dinosaurs. The most common vegetal organisms were trees and plants with seeds and flowers. The warm climate boosted a huge spreading of the flora, that supplied dinosaurs with large amounts of food.

The Cainozoic age

The Cainozoic age ranges from 65 million years ago to 2 million years ago and corresponds to the age of Mammals. Actually, as the big reptilians disappeared, forests and plains were invaded by these animals. The flora and fauna began to look as they do today.

The Neozoic age

The Neozoic age (which means "new life"), the age in which we live. It is in this age, which is still young compared to the earlier ones, that man made his appearance. Man has soon learnt to grow and exploit plants for his needs, to obtain more and more productive species through cross-breeding, and recently also to manipulate them genetically to artificially create plants with specific characteristics.

Man and Plants

Too much food or not enough food?

Plants are essential food for all living organisms, including man, to survive. In the Ecosystems section, we saw they are the basis of the food pyramid. Farming began 7-8,000 years ago, when men stopped living a nomadic life, began to live in stable communities, and started to produce food by selecting the plants that were fittest for periodical sowing and harvesting.

During the last century, the farming techniques have developed so much as to increase crops by almost five times. The increase in the availability of food has been, however, very different in the different countries and regions of the world. In developing countries, over 800 million people still suffer from hunger or malnutrition, while in industrialised countries more and more people are overeating or overweight. In both cases, this food imbalance negatively affects both human health and productivity. In fact, natural products have maintained their market share and are expected to even increase it over the next few decades. These products have the great advantage of being renewable: unlike modern plastics and man-made fibres, which are produced from non-renewable resources (oil, coal), they are not bound to disappear. A cotton plantation grows all over again every year, as well as a forest can renew itself, though more slowly, after the trees have been cut.

Agricultural development

The flora is an essential asset for man, since it is a renewable resource and a source of basic products for the agricultural world and for several industrial and commercial sectors. As for many other resources, though, to be able to exploit them as efficiently as he could, man had to apply work and technology to plants and lands. The result was the development of farming. The basic role of farming is to produce more and more food and raw materials (wood and fibres).
Until the 1950s, farming was mainly based on the conservation of the organic matter contained in the soil, which made the plants grow and reproduce. This goal was achieved by following some simple rules that were passed on from one generation to the next: for instance, the rotation of cultivations and the periodical rest of the land or the fertilisation of the soil with manure.
Since the Fifties, the need to obtain more and better crops urged the industrialised countries to develop modern farming methods which are more and more dependent on external help (machinery, fertilisers, irrigation systems, plant chemicals, etc.) and which are based on very specialised cultures (growing of single species).

Herbs and medicine

Herb-based medicine (phytotherapy) is the oldest and most natural treatment for the body. It involves the use of plants or parts of plants fit to treat specific ailments. Even now, all over the world, most drugs are made of vegetal substances and many synthetic products are prepared by reproducing in the laboratory environment the active agents contained in plants. The last few years have seen the spreading of “flower therapy” for the treatment of stress, eating disorders, anxiety and sleeplessness. “Bach Flowers” are most commonly used. They are 38 natural essences extracted from Welsh wild flowers that have healing properties.

Natural and synthetic fibres

Plants are for man a source of important raw materials: textile fibres, cellulose (to make paper) and wood. Thirty years ago, the experts were convinced such resources would disappear, since they would not have been able to withstand competition from man-made materials. In fact, natural products have maintained their market share and are expected to even increase it over the next few decades. These products have the great advantage of being renewable: unlike modern plastics and man-made fibres, which are produced from non-renewable resources (oil, coal), they are not bound to disappear. A cotton plantation grows all over again every year, as well as a forest can renew itself, though more slowly, after the trees have been cut. .

Impacts on ecosystems

Deforestation

Farming also means exploitation of forests. There are many reasons for deforestation: timber trade, exploitation of ore deposits, urbanisation and use of land as farmland or pasture. Unfortunately, for many poor countries, high-quality wood from the forests is one of the few assets available to develop their economy. And often we see indiscriminate deforestation being carried out, which causes huge damages to the environment and to mankind. For a sustainable use of the forestry resources, all the advantages and drawbacks should at least be assessed before pulling down a forest. Then, if one decides to pull it down, one should consider replanting either the same area or other areas, so that the total amount of forests on Earth does not change with time.
The effects of the loss of whole forests are particularly harmful and involve, among other things:

- loss of biodiversity. For instance, the Tropical forest (one of the most at risk), that contains over two thirds of the animal and vegetal species of our planet, is a huge reservoir of genetic diversity, which can be used to obtain new, more productive or better-quality crops and active agents for new drugs.
- negative effects on the soil. Once the vegetal coating has been removed, the soil becomes less fertile and more vulnerable to the eroding action of winds and water.
- increased concentration of carbon dioxide in the atmosphere. Through the photosynthesis, the forest is a natural reservoir for the absorption of atmospheric carbon dioxide (see the Greenhouse Effect under Atmosphere);
- repercussions on the water cycle and risk of desertification in some areas;
- negative and often irreversible social effects for the indigenous communities that live on the products of forest ecosystems.

The destruction of forests, especially Tropical forests, has been attached “global” importance over the last few decades because of its indirect effects on the Earth’s climate. Burning or cutting down trees, leaving them to rotten on the place, has a double effect: on one side, the combustion or decomposition processes release carbon dioxide, while, on the other side, the trees are prevented from taking in carbon dioxide from the atmosphere and releasing oxygen through the photosynthesis. In addition, the soil, deprived of its vegetal coating, reflects the sunrays better, thus further increasing the greenhouse effect. At present, the emissions of carbon dioxide caused by deforestation and changes in the use of the soil have been estimated, even if very approximately, to amount to about 1.6 billion tons of carbon a year, while those caused by combustion are approximately 6 billion.

Destructive fires

Along with deforestation for the use of wood by man, fires are one of the biggest causes of the disappearance of the forestry. Every year, 10 million hectares of boreal forests, 2 of temperate forests, 0.6 of Mediterranean forests, 40 of Tropical forests and 10 billion hectares of savannah are affected by fires. The reasons of these fires are mainly arson (wilful fires), negligence (wilful fires) and natural factors (lightning and others). The rate at which a wood burns depends on many factors: the type of undergrowth, the flammability and combustion speed of the wooden biomass of the wood, the climatic conditions (for instance, in our country, as well as in all the Mediterranean countries, the summer season is the one most at risk), and others.

The death of forests

Man can damage forests either directly, through deforestation and fires, or indirectly, through some of his productive activities. Depletion is actually a crisis event of forest environments in temperate areas, whose causes are due to atmospheric pollution, especially the effect of acid rains, the removal or degradation of the woodland due to the uncontrolled development of tourist activities. A prolonged stressful situation can lead to the death of the wood, to the reduction of its specific composition (reduction of the number of its vegetal and animal species) or just to a decrease in the stability of the forest ecosystem. For many years, man has understood how important it is to have a suitable amount of healthy forests on Earth. This is why many local and international organisations have been set up to investigate the problem of deforestation and to propose techniques for the “sustainable” exploitation of forests, and have often directly undertaken to protect and treat the existing woods or to reconstruct those that have gone lost.

Preserving forests

The awareness of the importance of protecting the flora, the numerous and complex plant world, has grown over the last century. In particular, man has understood that vegetal biodiversity (i.e. the differences existing among the many vegetal species) is probably one of the greatest resources that mankind has been given by nature. So far, the scientists have classed over 250 thousand species of moss, ferns, conifers and blooming plants. But they believe there are over 50 thousand more species that have not been documented yet, especially in distant and almost unexplored Tropical forests. Over the last century, specialised hybridisers and the large seed companies have been using this rich genetic heritage to create in a natural way, by suitably "cross-breeding" different plants, new high-yield varieties that have made modern farming much more productive. Many of the wild and ornamental species existing in nature are now preserved and protected in the 1,600 botanical gardens of the world. In addition, genetic banks for plants have been established and now preserve over 6 million samples of seed.
One day, these stocks of materials could come handy to produce new plant varieties that could be useful to man or to the environment. Botanical gardens and seed banks are indispensable conservation facilities, but they preserve, however, only a small portion of plant biodiversity compared to that that exists in nature. Vegetal biodiversity can actually be preserved with absolute certainty only by protecting the indigenous environments and ecosystems where the plants have evolved.

GMOs

The genetic revolution

In the light of the current food crisis, to increase agricultural productivity on a global scale, it's possible to expand total cultivated land, but the areas which are currently available are less and less: in Asia, for example, arable land is already all employed. In any case, the extension of arable land would allow for an increase of agricultural production by only 20% and would cause a more substantial environmental impact of the use of natural resources. As an alternative, it would be possible to intensify production itself, introducing even more invasive techniques than those currently adopted but this would lead to an increase in production which wouldn't be higher than 10%. The most substantial contribution to the increase in the availability of agricultural products, instead, seems to come from the improvement of biotechnologies which would determine a 70% increase in global agricultural production.
Biotechnologies, as defined by the Convention on Biological Diversity in 1992, don't concern only Genetically Modified Organisms (GMOs) but to a range of products as vaccines, improved varieties, micrpropagated plants (virus-free). Application of technologies to agriculture must aim to resolve famine and poverty problems in developing countries, allowing to increase the production of local small farmers and must conform to strict criteria related to biosecurity, that is men's health, biodiversity preservation and ecological sustainability. Brazil, India and China, the countries with greatest population growth, are currently achieving cutting edge results in the field of agricultural biotechnologies. Among developing countries (DCs), instead, 23 countries are capable of applying biotechnologies through development projects; 14 develop and apply some biotechnologies. Thanks to the introduction of varieties of cultivations which give high returns, chemical products and new irrigation techniques, the so-called "green revolution" in the '60s and '70s has increased crops yields and has helped millions of people to fight famine and poverty. Today, though, many small farmers can't move beyond subsistence agriculture and every day more than 854 million people, according to the latest FAO estimates, don't have enough to eat. Billions of people suffer of trace elements deficiencies, a form of insidious malnutrition caused by unbalanced nutrition. And in the following thirty years there will be two billion people in the world which will need to be fed – whereas natural resources on which agriculture depends become more and more frail.

For or against GMOs

The use of biotechnologies in agriculture, the "genetic revolution", can answer these problems? There are two schools of thought addressing this issue which, in the last decades, have been holding discussions over this topic at a global level. Man-made "genetic modification" dates back to ancient times and can probably be led back to when our ancestors started using micro-organisms to make bread, wine and cheese. Modern biotechnology has been made possible thanks to the application of molecular biology techniques, which consist in "cut and paste" genes from one cell to another. Precisely this type of genetic engineering is at the heart of the ongoing controversy. Supporters state that it's a crucial element to fight food insecurity and malnutrition in developing countries. Opponents reply that it risks causing substantial damages to the environment, increase famine and poverty and pave the road for total control of big multinational companies over traditional agriculture and food production. On one hand, there are convincing arguments in favour of modification of genetic composition of food cultivations. Intensified agricultural productivity and less seasonal variation of stocks could increase the quantity and variety of available food products. Not only this but cultivations resistant to parasites and drought could also be created thus reducing the risk of yield loss due to scarce rainfalls and infections. Moreover, vegetal varietes could be produced with the addition of more nutritional elements and vitamins to fight food shortages which affect so many poor in the world. Marginal lands could be cultivated, increasing overall food production. Biotechnology could, eventually, allow to reduce the use of toxic pesticides and improve the efficiency of fertilizers and other correctors of soil composition. On the other hand, though, scientific evaluation over the potential impact that genetic engineering applied to cultivations could have on the environment and human health is still at an early stage and should be conducted on a case-by-case basis.

GMOs against famine

FAO, the United Nations organization for food and agriculture, highlights the need to ensure that potential benefits of biotechnology applied to agricultre are shared among everybody and not only some chosen people. Farmers and poor consumers in developing countries could gain great benefits; so far, though, except in a few cases, with regards to the development of the "biotech" sector problems of poor seem to be ignored in favour of multinational companies. Contrary to the "green revolution", introduced with an international programme of public agriculture research having the specific aim of creating and transferring technologies to the developing world as public benefits, the "genetic revolution" is mainly conducted by the private sector which aims to develop commercial products destined to have extended commerce.
Both public and private biotech research programmes are currently being undertaken over more than 40 cultivations but only few extended public or private programmes can deal with problems of small farmers in poor countries and, especially, can invest substantially in new genetic technologies for the so-called "orphan crops", for example, cowpea, millet, and sorghum, which are instead fundamental for the nutrition and life conditions of the world's poorest people.
Also basic food crops for poor populations are being neglected - wheat, rice, white maize, potato and cassava. Moreover, characteristics of biotech crops that could help these populations draw little attention – drought and salinity endurance, resistance to infections, greater nutritional value – and the tendency is to concentrate more on resistance to herbicides.
Biotechnologies clearly have a great potential in the fight against famine but too many issues are yet unaddressed. How could we make genetic revolution technologies available for the greatest number of farmers in the greatest number of countries? Biotechnologies could represent a direct benefit for poor following which direction of research? And who will develop new techniques for the majority of developing countries which are too small in terms of market potential to attract substantial private investments and too weak in terms of scientific capacities to develop their own innovations? How can we enhance development and international diffusion of safe transgenic organisms and promote sharing of their intellectual property for common good? Another important issue at stake: how can we make sure that countries, especially those with financial problems, can establish appropriate systems of risk evaluation for the environment and human health both before and during the use of biotechnologies? FAO estimates that investments in agricultural biotechnologies in developing countries concern only 4% of the total 3 billion dollars invested by the 10 leading multinational companies in the world. Developing countries could thus have the chance of gaining knowledge and autonomously develop instruments to employ GMOs for their own benefit (and not to the benfit of commerce in western countries). But to do this, political will is needed so that 1% agriculture's share of GNP of developing countries (and not the current 0,1%) can be invested in research programmes to develop specific GMOs for the given area under examination.

Transgenic crops in the world

Genetically modified organisms (GMOs) represent one of the most controversial biotechnologies employed so far in agriculture to encrease production. From 1997 to 2007 total world areas harvested with GMOs registered a tenfold increase, passing from 11 to 114 million hectares. Plants target of genetic modifications are especially corn, soy, canola, papaya, pumpkin and cotton. Among the main countries where GMOs are grown, United States rank first, with 50% of total harvested areas covered by GMO crops, followed by Argentina, Brazil and Canada. In Italy GMO crops aren't allowed for commercial purposes although Italy imports GMOs to satisfy domestic needs, as from the United States from where transgenic soy and corn are imported and which merge into 60% of our food. One of the aims of GM crops (Genetically Modified) is the capacity of a GM plant to become resistant to herbicides employed to eliminate infesting wild plants, in this way farmers can spread weed killers over crops being sure that crops won't be eliminated. In 2006, the most common GMOs have been especially soy (57%), corn (25%), cotton (13%) and canola (5%). In the same year, for the first time in US was grown the first GM healing herb (on an area covering about 80 thousand hectares). The intervention of genetic engineering has allowed to modify these crops to provide them especially with two characteristics: resistance to herbicides and resistance to insects. 68% of grown GMOs have been "developed" to be able to survive herbicide spraying, whereas 19% causes death to those insects which feed on the same plant ("expressing" protein Bt, which attacks the digestive apparatus of parasites causing their death), Finally, 13% of GMOs are plants which have both characteristics and are resistant to herbicides and instects. The current tendency in international research seems to be more oriented towards the creation of GMOs resistant to pathogen organisms, such as viruses, more than herbicides, and towards the identification of genes carrying quality and resistant to environemntal stress. Even before the arrival of GMOs, the main companies producing seeds were selecting with traditional methods (through successive crossbreeding), the most suitable plants to absorb fertilizers and the more resistant to pesticides.

Patenting of living organisms

In many countries the law allows to patent GM seeds thus transforming them in a product owned by a company. Companies which sell "GMO-pesticide" to farmers gain profits in three different stages: selling pesticides, selling transgenic crops resistant to pesticides and applying patent royalties, which causes an extra charge in comparison to traditional seeds. In particular, companies can require farmers to buy seeds every year or that they pay the rights over the technology of transgenic seeds when using part of the harvest from the previous years for new crops. In any case, farmers are convinced that it's right to recognize these special rights to companies selling GM seeds: it's true that the latter have developed new characteristics for their products but it's also true that raw material, original DNA of living species, is a common good which has been produced by hundreds of million years of natural evolution and interaction with mankind, especially farmers and cattle breeders for thousands of generations.
Since the US Supreme Court in a 1980 verdict concerning the oil sector sentenced that a micro-organism which could "eat oil" could be patented (the Chakrabarty company holds this patent), as if it was a technological innovation "fruit of human inventiveness" and not a living organism, all companies producing seeds and, later, agrochemical companies started to claim rights to obtain patents for plants developed in laboratories as if these were simple artifacts. Until the arrival of GMOs every farmer could stock a part of his yield and use it to sow in the following season without having to justify to anybody. Since a farmer decides to use seeds "developed" by biotechnologists working for a company he is otherwise compelled to pay a share for every seeding, even if the company doesn't make any further effort. It's a bit like buying a cow, feeding and looking after it at our own expense and having to pay a fee to the seller every time we milk it.
In Europe there isn't a common position over the ban of GMO crops and Member States can decide whether to allocate part of their agricultural output to GMOs.
The 2001/18/CE Directive thus defines assessment procedures, valid within the European Union, that must be applied to seeds classified within the Common Catalogue and later marketed in EU. Spain ranks first among European countries for GM cultivation with 75 thousand hectares of crops employing genetically modified organisms followed by France with its 22 thousand hectares. In Italy, GMO cultivations is allocated only to research purposes – and not for marketing – with special attention to corn (trial tests reproduced on 98% of cases), followed by tomatoes (48%), beetroot (39%),

aubergine (39%) and chicory (10%). Growing food demand, though, and lacking investments in Italy for the reserach and development of a more productive and more suitable corn variety for domestic needs are making Italy less and less self-sufficient for the supply of corn and soy, food which is thus imported from countries growing GMOs with a resulting mark-up pricing for consumers.

Sustainable agriculture

A return to tradition

Sustainable agriculture was established in response to environmental problems caused by the “green revolution” and other production methods having high environmental impacts (intense use of water, pesticides and chemical fertilizers). The world movement in support of sustainable agriculture has been defined “the true green revolution” precisely to highlight the contrast between these two production methods. Farming sustainably means promoting biodiversity, preserving the environment, preferring local productions, ensuring the respect of human rights of workers, safeguarding communities and guaranteeing economical sustainability of the agricultural system without leaving small farmers behind. One of the solutions adopted to control environmental impacts of modern agricultural production and thus to make agriculture more sustainable is the return to traditional methods of crop growing used in the past as, for example, biological agriculture or conservation agriculture. At the same time, the merge between traditional knowledge and new philosophies, from a sustainable perspective, has given birth to new techniques as integrated agriculture and biodynamic agriculture.

Biological agriculture

Various methods of sustainable farming can be undertaken and organic farming is one of them: it’s a production method defined and disciplined by the common CEE 2092/91 Regulation and, at an international level, by the International Federation of Organic Agriculture Movements – IFOAM.
The organic production method respects the environment as it doesn’t resort to synthetic chemical products, as pesticides and fertilizers, but on the contrary, uses products of natural origin against parasites (sulphur, copper, plant extracts) and uses natural compost to fertilize soil. Biological farming products, though, aren’t totally devoid of residues of synthetic chemical products due to the presence of polluting agents, coming from crops where these substances are employed, in soil and water. Moreover, the use of elements existing in nature, as copper and fertilizers, doesn’t exclude potential damage to the environment but at least it guarantees that inserted substances are recognized by micro-organisms and are biodegraded over time: in nature, infact, practically all substances can cause damage to living organisms but what allows to identify a substance as toxic is the quantity which causes harmful effects in a given environment. As stated by Paracelsus “It’s the right dose which creates a poison” and, until toxic substances introduced in the environment can be assimilated and metabolized by existing organisms, pollution can be contained.
Other characteristics typical of organic farming are: crop rotation, which, on one hand, blocks parasites from finding a favourable environment to proliferate and, on the other hand, employs nutrient substances found in the soil more rationally and less intensively; superficial ploughing; use of useful insects to contrast insects that are harmful for crops; creation of dividing hedges and trees which give hospitality to natural predators of parasites and work as a physical barrier to potential external pollution; the recourse to alternative energy sources; the absence of Genetically Modified Organisms (GMOs); contemporary farming of different crops. Organic farming isn’t an innovative system, infact, before the invention of pesticides and chemical fertilizers, it was the only type of cultivation employed in the world! In many countries of the world where the “green revolution” of the ‘60s didn’t arrive, farming is still totally organic! Let’s just think that 80% of farmers in developing countries wouldn’t have to change at all their production systems if they wanted to be certified as “organic”! In addition to these countries which produce biologically without certification, organic farming at a global scale is practised by over 120 nations! According to most recent surveys, more than 634 thousand agriculture companies employ organic farming over about 31 million hectares of land. The continent with the greatest extension of organic crops, equivalent to 39% of the world’s overall crops, is Oceania; Europe is positioned at the second place

(23%), followed by Latin America (19%); in Asia, North America and Africa, organic crops are very widespread. Nations with greatest areas destined to organic farming are Australia (with a bit less than 12 million hectares), Argentina (3,1 millions), China (2,3 millions), United States (1,6 millions) and Italy (1,07 millions).

Integrated agriculture

Integrated agriculture aims to guarantee the smallest environmental impact as possible, preserve biodiversity and reduce risks for the health of agricultural workers and consumers, minimizing the use of synthetic chemical substances (as pesticides and fertilizers) and favouring, as an alternative, natural products. This type of agriculture employs a system of integrated fight that envisages the use of various instruments wisely mixed to fight parasite attacks: these methods value natural resources as well as self-regulation mechanisms of ecosystems and use chemical methods that are accurately balanced. The result is a reduction (in comparison to the maximum allowed by law) of phytopharmaceutical residues on products we eat guaranteeing a greater respect for the environment and reducing current causes of agricultural pollution on the environment. This system also tries to employ water rationally preventing erosion and ensuring soil fertility practising crop rotation as well as the “green manure” practice that consists in burying specific crops in the soil to maintain and enhance its fertility.

Conservation agriculture

Conservation agriculture consists in a set of agronomic practices allowing better soil management, limiting negative effects over its composition and structure, content of its organic matter and erosion process and resulting degradation. Conservation agriculture is characterised by some techniques as, for example, direct seeding in soil that hasn’t been ploughed or has been ploughed the least possible and avoiding burning crop residues or ploughing them in the soil. The benefits of this production system are various: ranging from the reduction of energy consumption due to the modest use of farm machinery to the resulting reduction of CO_2 emissions in the atmosphere. Other benefits are also to be found in the lowering of production costs and, from an ethical point of view, in the preservation of the environment and natural resources for future generations.

Biodynamic agriculture

Biodynamic agriculture is inspired by R. Steiner’s “anthroposophy” and is based on the premise that a farming company is truly an independent living organism inserted in a bigger living cosmic organism that influences it. Cosmic rhythms influence planting calendars, growing and gathering. The more employed techniques are crop rotation, biodynamic preparations, composting, non-destructive soil ploughing and quality fertilizing through the use of “green manures” and biodynamic compost fertilizing.