Slow Food®

Slow Food Position Paper on Soil

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1. Introduction

Soil is the only environmental compartment in which all the other environmental compartments simultaneously meet, interact and interface with each other.

Nobel Laureate Paul Crutzen has defined "global soil change" an indicator of a new geological era: the Anthropocene. The arrival of this new era is marked by the gradual reduction of the ability of soils to maintain biodiversity and support agricultural production.

With over half of the Earth's soils now used by humans for agricultural and other purposes (over 13 billion hectares), soil can no longer be exploited purely for the production of goods. Its environmental functions must also be taken into account.

Soil is a fundamental and irreproducible natural resource on which all the planet's life depends. It supports the delivery of a range of ecosystem services that allow and regulate life on the planet. Soil delivers around 99% of global food supplies for human consumption, filters rainwater and returns it clean and potable, regulates the climate and is an essential reserve of both organic carbon and biodiversity.

Soil feeds on what we put into the environment, digesting and restoring it in a constant cycle that science has not yet fully explained. By threatening nature, soil fertility and soil as a living system, we jeopardize our survival and that of the planet on which we live.

Despite its immense value to humanity, soil is under threat. It can take thousands of years to generate a few centimeters of fertile soil. Soil is today subject to many processes of rapid degradation—erosion, contamination, salinization, sealing, etc.—many of which are directly or indirectly caused by human activities.

In particular, the industrialization of agriculture—which accelerated significantly following the First and Second World Wars, when the arms industry was repurposed to produce synthetic fertilizers and pesticides—has made a profound contribution to the impoverishment of soils, causing a drastic reduction in organic matter and therefore fertility.

In much of the planet, soil health is increasingly under threat from factors such as the intense agricultural mechanization, increasingly carried out using heavy machinery and deep tilling that compacts the soil and destroys natural aggregates; irrigation washing away nutrients; monocultures; and synthetic pesticides and herbicides affecting microbial biodiversity.

For too long, soil has been considered an inert material, reduced to a simple support for growing crops, with no consideration of its . It is treated aggressively, without taking into account its complexity or thinking about the risks to biodiversity at the microflora and microfauna level, not to mention environmental equilibriums.

One of the most serious consequences of the application of the industrial agricultural model is the fundamental and generally ignored contribution to climate change, which in turn becomes a generator of further deterioration and accelerates desertification.

To this day, nothing concrete has been done to address the loss of fertility caused by the huge increase in agricultural and animal production, with disastrous consequences. It is as though we have taken out a mortgage that future generations will have to repay, and we are putting the survival of their food system at risk.
The modern industrial farming system, which aims to increase yields and efficiency in order to feed the world, has instead dramatically degraded the soil, triggering processes of desertification and ecosystem destruction. Many local communities, formerly completely self-sufficient, have suffered food crises because the price of foods that are now commodities has doubled or even tripled, leading to hunger and riots for hundreds of thousands of people, particularly in Africa and the Middle East. Agriculture has, in effect, lost its raison d'être and is now the same as any other productive sector, driven solely by the market and the pursuit of profit.
Slow Food believes that soil deterioration can only be averted through a paradigm shift away from the prevailing conventional agricultural models and towards an agriculture based on agroecology, biodiversity conservation and a promotion of terroir. This approach involves the integration of technological innovations adapted to local contexts.
Most experts, and farmers who cultivate their land with respect for natural resources, agree that the planet is an integrated system of physical, chemical, biological and human interactions. These cannot be analyzed separately, and together they determine the present and future state of the Earth.

2. Soil, a Complex System

Soil is made up of solid particles separated by voids or pores , occupied by air and water. The liquid part is known as the soil solution and is made up of water, solutes and pseudo-solutes. It contains inorganic ions, dissolved organic matter with a low molecular weight and, sometimes, dispersed mineral particles. The gaseous phase is the "soil air." In well-aerated soils, the composition of the soil atmosphere is not very different from the external atmosphere. It differs primarily in the carbon dioxide content, which can be as much as ten times higher and reach a few percentage points due to microbial and root respiration, as well as its greater weight compared to oxygen.
The solid phase can be divided into a "mineral fraction" and an "organic fraction." The composition of the solid phase regulates on a global scale the soil's intrinsic physical characteristics and, naturally, its chemical-physical and chemical characteristics as well. The mineral fraction is made up of unaltered rock and newly formed minerals produced by alteration processes. It can be divided into coarse fragments or skeletonand "fine earth" (<2 mm). The active mineral phase of the soil is formed by clay.
The soil's organic fraction or organic matter is formed of all the molecules of biological origin, including those found in living organisms. The activity of the soil organisms leads to the decomposition of the majority of the biomolecules deriving from animal and plant waste. So as well as biomass, in the soil we also find recently deposited organic matter (plant and animal waste, dead roots, remains of micro- and mesofauna), organic matter partially transformed by microflora and microfauna in which the cellular organization is still recognizable and, lastly, compounds from microbial resynthesis (polysaccharides, mucilages, extracellular enzymes) as well as humic substances. The humus is the active part of the organic fraction.

Human well-being, in environmental, economic, social and cultural terms, depends on a multitude of critical ecosystem services provided by soil, thanks to the activity of these complex fractions.
Soil performs many vital functions: producing food and other biomass; giving life to the photosynthetic plants that recycle CO_2 and produce oxygen; and storing, recycling, filtering and transforming many substances including water, carbon and nitrogen and micronutrients. Soil has a role as a habitat and gene pool, serves as a platform for human activities, landscape and heritage and provides raw materials that are essential to everyday life.

Soil contains around twice the amount of carbon present in the atmosphere and is the largest pool of biodiversity: a third of all living species live beneath the surface of the earth.

Soil is alive—a handful of soil might contain more than 10 billion microorganisms. This in turn plays a crucial role in regulating a number of life sustaining biological and chemical cycles through the recycling of nutrients that takes place through the transfer from soil to plants, groundwater and the atmosphere.

Soil, as we have said, is the only terrestrial ecosystem in which the lithosphere, atmosphere, hydrosphere and biosphere (including humans) coexist. For this reason it is a complex system, bringing together within itself the complexity of all the other ecosystems. The variations that take place in any one of these are inevitably transferred to the soil. Luckily soil is a good buffer, absorbing the shock of sudden changes, but its ability to mitigate environmental fluctuations is gradually being reduced due to poor management and desertification.

Soil has a stock of newly formed minerals, the soil clays, which form from degradation of the "parent material," which, when exposed to the external environment, is no longer in equilibrium, and from the natural alteration/transformation of the minerals contained within it. The new minerals have specific properties connected to their nature as colloids. The colloids are very small, less than 2 µm, and have electrically charged surfaces or sites. They can retain and exchange ions, almost like an accumulator. Humus also has colloidal properties and exchange capacity. The exchange capacity is fundamental for the mineral nutrition, and the exchange capacity prevents the rapid leaching of the nutrients, making their supply compatible with the plant's capacity to absorb them.

Soil has physical properties such as structure, represented by the state of aggregation of the different mineral and organic components; porosity, which allows the retention of water; and texture, determined by the particle size distribution (%) of sand, silt and clay in fine earth (the fraction of soil with particles of less than 2 millimeters in diameter).

Soil also has a biological component that includes different types of organisms: roots, soil fauna and microorganisms.

Microorganisms are the producers of humus which, along with the soil's clays, form the complex able to exchange mineral nutrients with the circulating solution and thus with plant roots. The microorganisms can also fix atmospheric nitrogen and make phosphorous and other nutrients bioavailable. Mycorrhizae, a symbiotic association of the mycelium of a fungus, especially a basidiomycete, with the roots of certain plants , can also occur in the soil. Thanks to this symbiosis, fungi receive nutrients that they cannot produce autonomously, and in turn the roots are better able to explore the soil and uptake mineral nutrients. This exchange ensures the maintenance of an optimal equilibrium in the soil population and, in the case of cultivated plants, improves their efficiency.

When it comes to mineral nutrition, soil can provide the nutrients essential for the harmonious development of plants: macro-, meso- and microelements like nitrogen, phosphorous, potassium, calcium, magnesium, manganese etc. Natural chemical fertility is a distinctive characteristic of a living soil, one with a good structure, a balanced porosity, a good supply of humified organic matter, good clays and neither an excessive acidity nor basicity.

Synthetic fertilizers used in conventional agriculture usually contain only three macroelements: nitrogen, potassium and phosphorus.Normally microelements are distributed only in cases of poor bioavailability. The use of synthetic fertilizers may cause an imbalance in the relation between plants and soil microorganisms (which are no longer fed), leading to a decrease in soil microbial biodiversity and subsequently can contribute to the collapse of the structure.

Any agricultural intervention should be based on an understanding of the soil's characteristics , as though it was a living being. A field should be understood as a complex and integrated system in which the soil and the organisms that live in it must co-exist with the plants and their life cycles and biocycles.

In agricultural landscapes, but also in forest environments, soil is also an essential cultural component, representing nature tamed by human labor. It reflects the work done by humankind over time and the accumulated memory of generations; it is culture carved into the earth.

At the same time, soil is a key component of a "terroir," a French word initially used to identify areas suited to viticulture but which has been extended to agricultural production in general. The term indicates a clearly delimited geographical area where the natural, physical, chemical, pedological, topographical and climate conditions, along with the work of humans, develop a specific aptitude for the production of a specific agricultural product, clearly identifiable thanks to the unique characteristics of the territory. This means the cultural importance of soil is reflected in the food that it produces.

We should not neglect the impact on human health of an agriculture that is too conditioned by synthetic chemicals. Scientists recognize that agriculture, food, nutrition and health should be understood in relation to each other. What we grow, how we grow it, the nutritional composition of foods, taste and how we eat have an unavoidable influence on public health and the health of the planet. In an era plagued by malnutrition it is essential to remember the complex relationships that link soil, microorganisms, plants, animals and humankind.

The industrial agriculture, even producing enough food for the world's population, not only was not able to feed the world due to economical and market constraints, but contribute to several problems, also sanitary. Currently, 850 million people suffer from chronic hunger, water scarcity in developing countries and about 2 billion people suffer from micronutrient deficiencies, while over 2 billion people are overweight or obese. The major causes of death and disability in the world

are non-communicable diseases, such as heart disease and diabetes. The major risk factors are related to diet. Humankind needs healthy food, which can only be supplied if the soil is healthy.
These concepts of soil complexity and terroir are the key to a paradigm shift. We must move beyond conventional agriculture—which has clearly shown its limitations—in order to embrace a model of sustainable agriculture. This model is based on soil fertility (the first requirement of any sustainable agricultural system), allows farmers to rediscover dignity through high-quality agriculture that does not depend on subsidies and produces foods that express a terroir.

Today, European farmers who practice sustainable agriculture are still a minority. However, the fact that they are able to survive without subsidies to support their efforts towards sustainability and that increasing numbers of citizens turn to them for their own food choices show that their agricultural choices can have a future. Encouraging and supporting those who want to convert to sustainable farming should be the basis of European food and farming policies.

Area	GLASOD	FAO TerraSTAT	GLADA
Africa	321	1.222	660
Asia	453	2.501	912
Australia and Pacific	6	368	236
Europa	158	403	65
North America	140	796	469
South America	139	851	398
World (total)	1.216	6.140	2.740

Global Assessment of Soil Degradation (GLASOD)
TERRASTAT FAO DATA BASE
Global Assessment of Lands Degradation and Improvement project (GLADA-FAO)

This table (*data from FAO, NRCS, Cornell University) can give an idea of the size of the problem of soil conservation:

Earth surface area	510 million km2
Land surface area	153 million km2
Land surface area not covered by ice or bare rock	134 million km2
Vegetated land surface area	117 million km2
Productive land surface area	85 million km2
Average soil depth	30 cm
Earth's radius at the equator	6,378 km
Estimated global soil loss	75 Gt/year
Total weight of available soil	300,000 t/km2
* Loss to erosion in developing countries	3,000 t/km2/year
*Loss to erosion in Asia, Africa and Central-South America	4,000 t/km2/year
*Loss to erosion in North America and Europe	1,700 t/ km2 /year
Average population density in agricultural areas	367/km2
Potential surface area still available for sustainable agriculture	1.5 million km2
*2Annual increase of urbanized surface area	2.7% (128.000 km2)
*Indirect costs of soil loss	€500 billion/year
*Value of lost topsoil (€30/t)	€2,500 billion/year

1 For instance, community-supported agriculture groups increased in France from a few hundred in 2007 to over 1,600 in 2012. Recent marketing studies in Europe found that one of the most important factors for consumers was not cost, but the quality of the product (Nielsen Trade MIS).

3. Soil At Risk: Threats, Causes and Immediate Consequences

Soil is found on the upper most layer of the Earth , the planet's epidermis, its depth varying from a few dozen centimeters to one or two meters, used by humans for agricultural activities. It is a limited resource, not renewable on a human time scale. Indeed, it takes thousands of years to create fertile soil. In the case of grassy pastures in temperate climates, for example, soil forms at the rate of just 1 to 2 centimeters per 100 years. The natural recovery of soil lost to degradation processes (like erosion and pollution) can take hundreds, if not thousands, of years, and in some cases is impossible.
Fertile agricultural soil in Italy is disappearing at the rate of 6-7 m2 a year, 420 m2 a minute, , in other words about 2.5 hectares a hour(a little bit less than 4 soccer fields) or 60 hectares a day, being sealed by houses, parking lots, shopping centers, overpasses and airports (ISPRA 2015).
This land use, considered by economists to be the most "developed," nonetheless has the significant handicap of not draining rainwater, not producing photosynthesis and most of all, of not producing food. Moreover it loses its ecosystemic functions, such as the carbon sink capacity.

Below are the main threats to soil identified by the International Year of Soil report, and all the data are based on "The State of Soil in Europe" (JRC, 2012).

Reduction of organic matter

Organic matter plays a major role in maintaining soil functions because of its influence on soil structure, stability, water retention and biodiversity. It is also a source of plant nutrients. The main factors driving the decline in soil organic matter are the result of human activity: the conversion of grassland, forests and natural vegetation to arable land; deep plowing of arable soils; drainage and fertilizer use; tillage of peat soils; crop rotations with a reduced proportion of fodder crops (which enrich the soil, improve its structure and help overall to clear weeds); and soil erosion.

Erosion

Erosion is the wearing away of the land surface by water and wind, primarily due to bad land management, deforestation, overgrazing, forest fires and construction activities. Erosion rates are greatly affected by climate, land use, soil structure, slope steepness, vegetation cover as well as conservation practices in fields. Given the very slow rate of soil formation, any soil loss of more than 1 ton per hectare per year can be considered as irreversible within a time span of 50 to 100 years.

Erosion due to water is one of the most widespread forms of soil degradation in Europe, affecting an estimated 105 million hectares, or 16% of Europe's total land area. Estimates of the extent of wind erosion range from 10 to 42 million hectares of European soil, with around 1 million hectares being categorized as severely affected of soil, erosion reduces soil productivity, and where soils are shallow, the loss can be irreversible. Erosion can also cause landslides, not only where land has been deforested for agricultural reasons, but also where soil and vegetation have been removed to make way for buildings, roads and other infrastructure, or where the shape of slopes has been modified for production reasons.

Compaction

Topsoil compaction occurs when soil is subjected to pressure from heavy machinery or the repeated trampling of grazing animals, especially in damp areas. Under pressure, soil micro and macro aggregates are deformed or even destroyed. The mechanization of agriculture, particularly since the 1960s, and the resulting use of heavy machinery has caused high stresses in the soil, even leading to compaction deep in the subsoil, below the plow layer.

Compaction can detrimentally affect a number of soil functions by reducing the pore space between soil particles, increasing bulk density and reducing or totally destroying the soil's capacity to absorb water. Reduced infiltration increases surface run off and leads to more erosion while decreasing groundwater recharge.

Compaction greatly compromises soil biology. A direct impact of compaction and the associated decrease in soil porosity is the reduction in the available habitats for soil organisms, particularly those living in surface areas, such as earthworms. The worms die because they no longer have the tunnels that allow them to move around. These annelids play an essential role, because they break up organic matter and accelerate its degradation, increasing the soil fertility, and their underground tunnels ensure good aeration and optimal water absorption. Their presence makes the soil softer and lighter.

Among soil organisms, essential to hold sand, silt and clay together for a good soil structure that holds water and allows soil oxygenation, preventing compaction.
The alteration of soil aeration and humidity level due to compaction can also seriously impact the activity of other soil organisms. Oxygen limitation can modify microbial activity, favoring microorganisms that can withstand anaerobic conditions. This alters the types and the distribution of all the organisms that make up the soil food web.

Sealing takes place when the soil is destroyed or covered by buildings, other construction or layers of completely or partially impermeable artificial material. This irreversible process, which destroys all of the soil's ecosystem functions, is the most high-impact form of land take.

Productive soil continues to be lost to urban sprawl and transport infrastructure. Between 1990 and 2000, the sealed area in the EU 15 increased by 6% and at least 275 hectares of soil were lost per day in the EU, amounting to 1,000 square kilometers per year. These figures have now been surpassed: Italy alone, according to ISPRA's report on soil consumption in the country, consumed 55 hectares of soil a day between 2008 and 2013. Between 2000 and 2006, the average loss in the EU increased by 3%. The indirect impacts of soil sealing on ecosystem services affect areas much larger than the sealed areas themselves.

Salinization

While naturally saline soils exist in some parts of Europe, the main concern is the increase in salt content in soils resulting from human interventions such as bad irrigation practices. Elevated salt levels in the soil limit its agroecological potential and represent a considerable ecological and socio-economic threat to sustainable development. Salts can cause harm to plant life, natural vegetation, the life and function of soil biota, soil functions, the hydrological cycle and biogeochemical cycles.

Contamination

One of the main causes of contamination is the over application of agrochemicals such as pesticides, weedkillers and mineral fertilizers. Though fertilizer sales have remained stable or fallen slightly in EU 15 countries during recent years, consumption in Europe as a whole has continued to grow steadily. Soil contamination can have lasting environmental and socio economic consequences and the damage can be extremely difficult and costly to remediate. Contamination from chemical impurities in fertilizers (that plant cannot absorb) and pesticides is more concentrated in areas with industrial agricultural production and can have significant impacts on soil biological communities (and thus soil functions), and on the quality of groundwater sources and crop uptake.

Biodiversity decline

Soil is by far the most biologically diverse part of Earth. Soil biota (its microflora and fauna) play many fundamental roles in helping to deliver key ecosystem goods and services, like decomposition and the organic matter cycle, the formation and maintenance of soil structure and water penetration, retention and transfer.

Soil degradation caused by erosion, contamination, salinization and sealing all threaten soil biodiversity by compromising or destroying the habitat of the soil's microflora and fauna. Management practices that reduce the depositing or persistence of organic matter (such as industrial agriculture) or bypass the natural biological cycle of nutrients also tend to reduce the size and complexity of soil communities.

4. Soil Degradation and Agriculture

Decades of industrial agriculture based on "modern" techniques such as high-yielding seeds, synthetic fertilizers, herbicides and pesticides, monocultures and irrigation have led to sharp rises in yields. Worldwide, farm production almost tripled in the last 50 years, while the surface area covered by agricultural land has increased by only 12%. At the same time, the same set of techniques, along with shorter rotations and fewer fallow periods, has caused soil impoverishment.

By its nature, industrial agriculture needs uniformity and high productivity: monocultures, in other words. Since the 1950s agricultural production has gradually orientated itself to depend on an ever-smaller number of species and varieties, selected to respond to the needs of the global market. They have no connection to specific places, but instead can be produced in many different environments and climates. They travel well and have a uniform taste. For example, despite the thousands of varieties of pears that have been selected by farmers over the centuries, just two commercial varieties represent 96% of the global market. Conventional crops require significant amounts of fertilizers and pesticides precisely because of their lack of connection with local soil and climate conditions.

Humankind began practicing agriculture about 10,000 years ago. Only in 1847 did it begin to consume non-renewable energy, with the introduction of mineral fertilizers: phosphorous and potassium, mineral salts from mines around the Pacific and Chile. Once these organic but non-renewable materials have been extracted from the Earth, they are gone forever. The big turning point in the move towards industrial agriculture came a century later, in 1947, when a huge munitions factory in Alabama was converted to the production of synthetic fertilizers, which were to revolutionize the human relationship with the earth. Two factors led governments to promote the use of nitrogen, in all his forms, as fertilizer: the need to grant higher yields to meet the needs of a growing population, following the baby boom after the end of World War II; and the discovery that the nitrogen produced in large quantities for war purposes could be used to double agricultural yields. Shortly, synthetic fertilizers were available on the market, easily accessible for all farmers.

Today, fertilizers are used more than ever. World consumption has risen more than fivefold in the last 50 years, though it is unevenly distributed around the globe. Worldwide, nitrogen accounts for 74% of mineral fertilizer use; in some countries this figure is as high as 90%, with potential effects on the environment.

Excess nitrogen causes severe soil deterioration as it hinders the release of nutrients from plant roots to microorganisms. Moreover, it also speeds up the decomposition of humus. Maximum nitrogen values are reached in areas where factory farming is practiced, fruit and vegetables are cultivated industrially or grain is produced with excessive fertilization.

The largest use of nitrogen compounds in Europe is to make fertilizers used in areas dedicated to grow fodder crops for animals. The roots of the crops do not take up all of the nitrogen from the fertilizers applied to the field. Then, when the fodder is fed to livestock, the animals do not absorb all the nitrogen it contains and expel it in their urine and dung. The excess nitrogen (often in the form of nitrate) may be washed into rivers and leached from the soil into underground water, contaminating sources of drinking water and damaging aquatic and marine ecosystems. Furthermore, excess nitrogen in the soil leads to an increase in the mineralization of organic matter, which in turn leads to an increased loss of carbon from soils.

Herders and Soil

Over the past 60 years, industrialization and urbanization have gradually depopulated the mountains and the remote hilly areas of Europe. The result of this abandonment has been widespread environmental degradation: landslides, wildfires, avalanches, rivers bursting their banks and carrying trunks from neglected forests down the valley. The abandonment of the mountains has serious environmental, social and economic consequences. Mountain pastures should not be thought of as wild, self-regulating areas; instead, they require careful management. They cannot be used excessively or for too long, but neither can be they be left alone. Without herders, the pastures would grow wild and disappear. If the pastures were no longer grazed, they would be overrun by shrubs. If the undergrowth was no longer tended, summer wildfires would become more frequent and intense. The hooves of the animals churn up the earth, so that it better absorbs rainwater, and their excrement serves as fertilizer, ensuring abundant grass production. Their grazing also prevents the formation of layers of dry stalks, which could otherwise cause fires in the summer and sliding snow and dangerous avalanches in the winter. Small animals like sheep and goats also help to keep the forest undergrowth cleared.

Herders have an important role as custodians of the environment and are crucial to the ecological equilibrium of large swathes of land. However, the abandonment of herding as a career, low earnings and land access difficulties mean that their activity is often under threat. Herders must also take care to use the pastures wisely, avoiding the excessive grazing that can aggravate the situation. Herding, often entrusted to people with no training and knowledge, who are underpaid and forced to live in terrible conditions, can turn from being a resource into being a problem.

5. Soil Degradation and Climate Change

The impact of industrial agriculture on soils exacerbates climate change. Climate and soil are closely connected: the climate affects soil formation and soil in turn affects the composition of the atmosphere, in particular the amount of carbon dioxide and other greenhouses gases. Soil contains more carbon than the atmosphere and all terrestrial vegetation combined.

Relatively small changes to the amount of organic matter in the soil can have significant effects on the atmosphere and global warming.

Climate change is a serious threat to global food security. Changes in temperature and rainfall patterns can have a huge impact on organic matter and the processes that take place within soils, as well as on the plants and crops that grow in them. Agriculture is also directly responsible for greenhouse gas emissions. Greenhouse gas emissions from agriculture, forestry and fisheries have nearly doubled over the past 50 years, and could increase by an additional 30% by 2050 if greater efforts are not made to reduce them. Deep plowing arable land, for instance, accelerates the release of carbon dioxide in the atmosphere. Applying nitrogen fertilizers can generate emissions of nitrous oxide, a gas with which has been calculated to have 300 times the global warming potential of CO2 over a 100 year period. According to the FAO, emissions generated during the application of synthetic fertilizers accounted for 14% of agricultural emissions in 2012. This is the fastest growing emissions source in agriculture, having increased by 45% since 2001. It has been estimated that over the last 150 years, 476 billion metric tons of carbon have been emitted from farmland soils due to bad farming and grazing practices, compared with 270 billion tons emitted from burning fossil fuels.

The FAO (2007) agrees that in order to meet the related challenges of global food security and climate change, agriculture and land management practices must undergo fundamental transformations. Improved agriculture and soil management practices that increase organic carbon, such as agroecology, conservation agriculture and agroforestry, bring multiple benefits. They produce fertile soils rich in organic matter (carbon), keep soil surfaces covered in vegetation, require fewer chemical inputs and preserve biodiversity. These soils are also less susceptible to erosion and desertification and maintain vital ecosystem services.

6. Ethical Consequences of Soil Degradation

The exploitation of new areas to replace already-exploited land has been taking place over many centuries and continues today. Between 1961 and 2007, the world's arable surface area grew by around 12%, or 150 million hectares. The cultivated surface area has however increased at the expense of forests (the cultivation of oil palms is the best-known example) and does not make up for the loss of soil for other reasons. If demand for agricultural products continues to grow at the current rate, by 2050 we will need an extra 320 to 850 million hectares (the size of India and Brazil respectively). According to the United Nations Development Programme, this would mean that the world will reach the limit of ecologically sustainable land use by 2020.

According to The Soil Atlas (2015), cities and towns currently occupy only 1 to 2% of the world's surface area. By 2050, it is estimated they will cover 4 to 5%, an increase from 250 to 420 million hectares. Forests are being felled and grasslands plowed up to compensate for the loss of fertile soils to urban sprawl.

Growing demand for land heightens political and social tensions. Worldwide, land is the source of livelihood for more than 500 million smallholders, pastoralists and indigenous peoples. Access to land is fundamental to their survival. People identify with the land, which embodies cultural and spiritual values. For some, though, land is an attractive investment, an increasingly scarce commodity that yields good returns. The recent increase in large-scale land acquisitions in the most fertile parts of the global south has benefited investors rather than local communities. Small-scale farmers are forced to abandon their land, local resources are exploited to grow commercial crops and fodder for far-off farms and the food security of local communities is put at serious risk.

Europe is largely responsible for this trend and its negative impacts. Europe is the continent most dependent on land located outside its borders. It is estimated that the EU land footprint (the amount of land needed to support European lifestyles) amounts to 640 million hectares per year, in other words an area one-and-a-half times the size of the 28 member states. If key imported materials like cotton, minerals and metals were to be factored in, this figure would be even higher.

Each citizen in the EU consumes on average 1.3 hectares of land per year, six times more than the average hectares of lands consumed in Bangladesh, for example. If everybody in the world were to consume as much meat as the average European, we would need an extra 80% of arable land compared to the current available surface area worldwide.

Soil and Food Waste

Current food production patterns, and hence current soil and land use, go hand in hand with significant levels of food wastage. About 1.3 billion metric tons of food are wasted every year worldwide. In other words, about a third of all the food produced does not end up where it is supposed to—on our plates.

- Produced but uneaten food uses up almost 1.4 billion hectares of land, which represents close to 30% of the world's agricultural land area.
- While it is difficult to estimate impacts on biodiversity at a global level, food waste unduly compounds the negative externalities that monocultures and agriculture expansion into wild areas create on biodiversity loss. Globally food waste may represent more than 20% of biodiversity pressure.
- According to the dominant agricultural model, high yields and a constant increase in production are essential to feed humanity. In reality, famine and malnutrition continue while a third of food is wasted.Considering the food system as a whole shows that the solution to global food security lies in quality—of agricultural systems, food, supply chains—and in transparency of information for consumers.

7. Solutions

How can we guarantee the fertility of soils without degrading or permanently destroying them?

Only diversified, conservation agriculture, which takes care not to jeopardize the life of the soil and combines different agronomic practices, can provide an answer: by limiting monocultures and the indiscriminate use of synthetic chemicals, by reducing or eliminating unnecessary plowing, by protecting soil with mulch, by rotating crops to maintain fertility and control parasites and weeds, and by utilizing cover crops. These are legumes like lupin, field beans and alfalfa. which productivist agriculture has often eliminated. They are important, especially in periods in which land is left fallow, because they fix nitrogen, which is integrated in the soil through green manure and helps reconstitute the soil's organic matter.

To reduce the instability of the agricultural system and its need for external inputs, which bring high costs and pollution risks, agricultural systems should be managed from an agroecological perspective: considering crops as part of the ecosystem and choosing a cultivation method that maintains the complexity of the environment and positive and balanced interactions between different agricultural species, natural species and the environment.

This would reduce the need for external inputs and create an equilibrium that is closer to a closed-cycle system, with less dependence on the external world and more stability. In a productive agroecological system, inputs are replaced by resources within the system:

- compost made from plant waste, organic fertilizers made from animal excrement, techniques that preserve soil fertility (crop rotation and intercropping with nitrogen-fixing species, mulching, green manure, etc.) rather than synthetic chemical fertilizers.
- organic pest and disease management instead of protection based on the use of synthetic chemicals.
- adoption of local varieties and cultivars with self-production of seeds and propagation materials, thus avoiding the purchase of non-native material and preserving biodiversity.
- innovation can be part of agroecology, but only when it is translated into solutions that do not take more organic matter away from the land. Renewable energy, such as solar and wind power, and the use of animal excrement to make biogas within a farm, for example, are valid alternatives to fossil fuels.

Agroecology

Agroecology integrates agronomy (crop science) and ecology (the study of interactions between organisms and their environment). Fields managed according to agroecological practices are balanced systems in which human intelligence modifies nature in order to be able to utilize its products without harming and impoverishing it, while sustaining the physical, chemical and biological mechanisms that regulate nature's cycles.

The use of agroecology as a scientific term dates back to the 1970s, but many of its solutions have been applied at different times by rural communities around the world. Over the centuries, they have often come up with farming and production systems that are in harmony with the environment.

This ancient knowledge has been systematically set aside or forgotten with the arrival of the so-called Green Revolution, which introduced a model of farming based on external inputs requiring high amounts of energy (large-scale use of synthetic agro-pharmaceuticals and powerful machines running on fossil fuels).

Over the years, it has become more and more evident that farming with high external inputs is unsustainable in the long term, both in regards to the environment and productivity. Today, agronomic science and practices are reorienting towards more sustainable approaches and reconsidering the value of traditional peasant farming.

The main goal of agroecological cultivation is not to achieve maximum performance, but to stabilize good, long-term productivity by developing economically self-sufficient agro-ecosystems, managed with technologies adapted to the local context. This method is based on the conservation and management of local agricultural resources through participation, traditional knowledge and adaptation to local conditions.

In this sense, agroecology relies on agrobiodiversity. Local varieties represent an immense potential for the future of our agricultural systems. Varieties defined as native or local are the result of selection (natural or man-made) in specific areas. All of these varieties are characterized by being well adapted to the environmental conditions in their area, and for this reason normally need fewer external inputs, like water, fertilizers or pesticides. They are hardier and more resistant to environmental stresses. Their potential is best expressed in their places of origin, where they represent an important agricultural resource or even essential tools for food sovereignty (for example in mountain or desert areas).

It is not a coincidence that these varieties are often closely connected to the culture of a local community (through customs, recipes and dialects) which the agroecological approach values along with the traditional farming knowledge that over the centuries has developed ingenious practices for cultivating steep slopes or restoring degraded land.

We need a global rethink of the agricultural system so that priority is given to crops grown to feed communities, not a food industry expanding at breakneck speed. The production of biofuels, biogas and large quantities of animal feed is in competition with food production for humans. In some parts of the planet, this competition is heavily biased towards the interests of speculators and agribusiness. The need to produce huge quantities of fodder to support factory farming has led to the intensification of its cultivation. If demand for fodder crops was reduced, arable land could be farmed less intensively, with fewer monocultures, chemical fertilizers and pesticides. This would allow soil quality to be restored.

Sustainable Intensification

Demand for food and other agricultural products (especially biofuels) is growing rapidly. By 2050, the world's population is expected to reach over 9 billion. Today, about 2 billion people globally belong to the middle class, and this number is expected to rise by 3 billion by 2030. As income increases, diets change, with the consumption of products of animal origin particularly rising. Crops for animal feed (particularly corn and soy) currently account for 53% of global plant protein production. The current yields per hectare are insufficient to meet the growing consumption of meat. It will be necessary to cultivate more land, increasing competition for natural resources and aggravating climate change.

To solve this dilemma, leading scientists have called for "sustainable intensification," defined as the process of enhancing agricultural yields with minimal environmental impact and without expanding the existing agricultural

land base. Other scientists argue that this definition does not merit the term "sustainable," because it ignores principles that are central to sustainability. They argue that sustainable intensification is likely to fail in improving food security if it continues to focus narrowly on increasing harvests, ignoring other equally or more important variables that influence food security.
The International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD) makes no reference to sustainable intensification as an answer to the question: "How can we reduce hunger and poverty, improve rural livelihoods, and facilitate equitable, environmentally, socially and economically sustainable development through the generation, access to, and use of agricultural knowledge, science and technology?" The report was created by 400 of the world's leading agronomists and agricultural experts from all fields. These experts were selected by governments, academics, NGOs and industry representatives, including Monsanto and Syngenta. Just before the report came out, Syngenta disowned it, criticizing its conclusions. In a nutshell, the report states that: the Green Revolution had severe consequences, though unintended; small-scale farmers and diverse ecosystems should be supported; we must study and learn from traditional farming. It also underlines the importance of rewarding farmers who prevent climate change and the relevance of our agricultural capital. Finally, the report stresses that it is fundamental to put human health first.

What the EU Has Done So Far

At the moment, only a few EU member states have specific legislation on soil protection, and soil is not subject to any common EU regulations. Existing EU policies in areas such as agriculture, water, waste, chemicals and prevention of industrial pollution do indirectly contribute to the protection—or the deterioration—of soils. But as these policies have other objectives, they are not sufficient to ensure an adequate level of protection for soils.

In 2006, the European Commission adopted a "Soil Thematic Strategy," with the aim of protecting soils across the EU. The strategy included a communication from the Commission to the other European institutions, a proposal for a directive on soil and an impact evaluation. After eight years of disagreements between the member states on the proposal for a directive, on April 30, 2014, the Commission withdrew the text, stating that it "remains committed to the objective of the protection of soil and will examine options on how to best achieve this. Any further initiative in this respect will however have to be considered by the next college."

The Seventh Environment Action Programme, which came into force on January 17, 2014, recognizes that soil degradation is a serious challenge. Its objectives for 2020 are that land is managed sustainably in the EU, soil is adequately protected and the remediation of contaminated sites is well underway. It commits the EU and its member states to increasing efforts to reduce soil erosion and increase soil organic matter and to remediate contaminated sites.
In 2015, the Commission set up a group of experts, made up of representatives from member states, in order to bring into force the measures provided for by the Seventh Action Programme. It also launched a call in order to put together a detailed picture and an evaluation of the policies and measures at a European Union, member state and, if necessary, regional level that contribute (directly or indirectly) to soil protection.
In regards to land, the Roadmap to a Resource Efficient Europe from 2011, part of the Europe 2020 Strategy, has the following objective: "By 2020, EU policies take into account their direct and indirect impact on land use in the EU and globally, and the rate of land take is on track with an aim to achieve no net land take by 2050; soil erosion is reduced and the soil organic matter increased, with remedial work on contaminated sites well underway."
Unlike climate or biodiversity protection, soil conservation has not been an explicit goal of international agreements. All the existing international treaties, agreements and protocols ignore soil conservation and fail to define specific targets. Only the Rio+20 Conference and the new objectives of the United Nations for sustainable development make reference to soil-related targets. But the world community has set itself three major goals that cannot be reached without soil conservation: to stop the loss of biodiversity by 2020, to limit global warming to 2°C and to ensure everyone has access to enough food.

The central function of soil in the ecosystem and in society has been undervalued, and soils and land have received far too little protection. This is despite the enormous overlaps with other areas, like agriculture, food, energy, climate, biodiversity and the right to food. Soil and land must be seen as cross-cutting themes in policymaking; only then will they receive adequate protection.

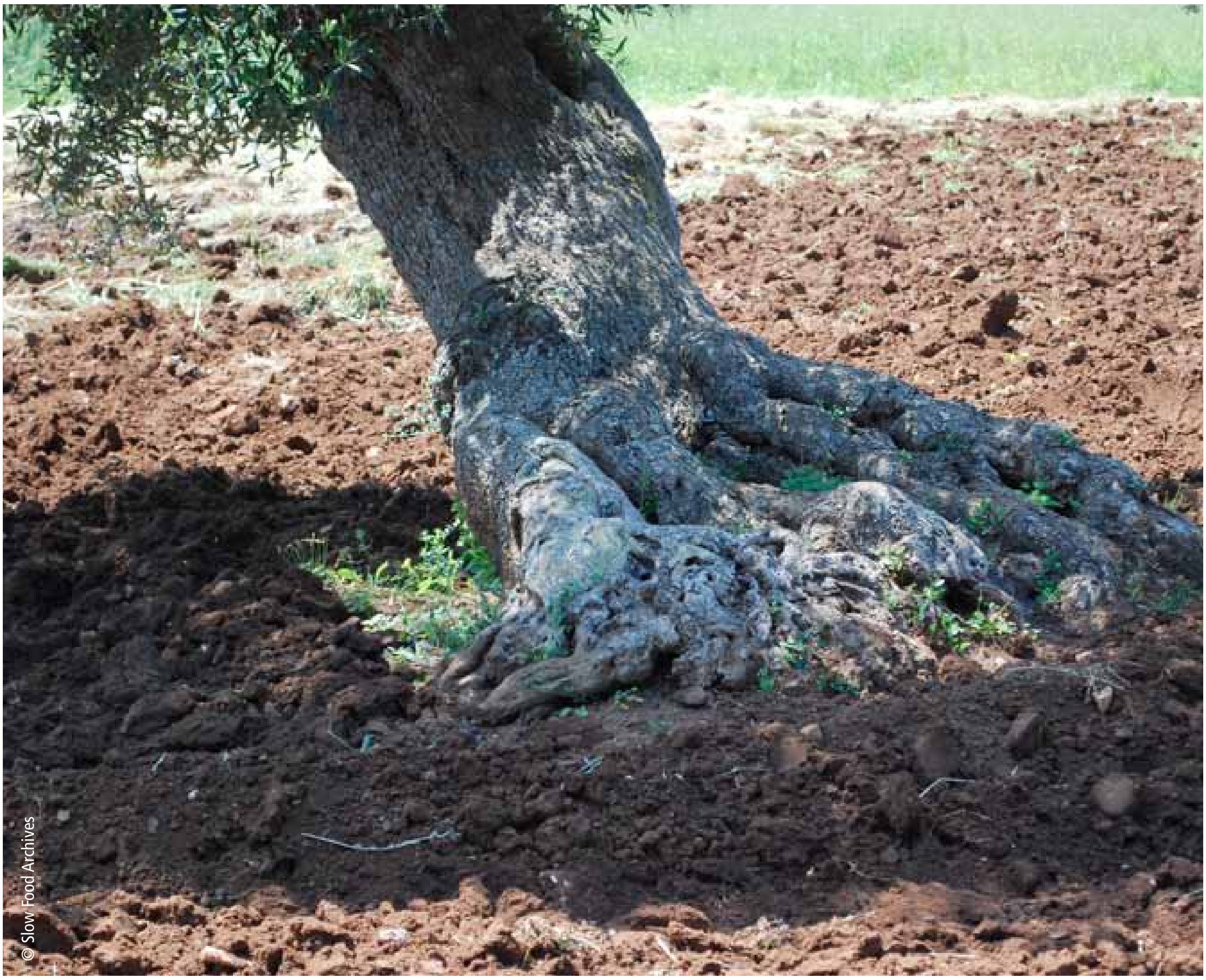
2015 was proclaimed as the International Year of Soils (IYS) at the 68th UN General Assembly. The goal of the IYS is to raise awareness about the importance of "healthy soils for a healthy life" and increase understanding of the significance of soil to human well-being, food security and essential ecosystem functions.

Among the initiatives promoted by the FAO as part of the IYS is a specific document on mountain soils, coordinated by the FAO-Mountain Partnership, and published with the aim of providing as comprehensive an overview as possible of the characteristics and management forms of soil in mountain areas, with a particular focus on agricultural practices.

The Rio+20 conference recognized that land and soil degradation are a global problem, and proposed to strive for a land-degradation-neutral world in the context of sustainable development.

The new objectives of the United Nations for sustainable development state that by 2030 governments are committed to combatting desertification and remediating degraded soils, including those affected by desertification, drought and floods, with the aim of reaching the objective of a world free from soil degradation.

In Italy, on May 13, 2014, the AISSA (the Italian association of agricultural scientific societies) presented a framework law on soil for the protection and enhancement of the Italian landscape at the Chamber of Parliamentary Groups in Rome. This legislative initiative (Senate DDL 1181) was aimed at giving Italy a framework law for the sustainable protection and management of soil. This law aims to define a coherent strategy of knowledge and support for the management of Italian soil within which the different actors who decide on the use of this fundamental resource can dialog with each other, with the aim of increasing the multifunctional productivity of soils and, more generally, the Italian landscape.



8. What Needs To Be Done

Industrial agriculture and agro-industry have created plant varieties that can thrive only through the elevated consumption of synthetic chemical fertilizers and pesticides and agricultural techniques that call for a high use of heavy machinery. In order to pay for all of this, farmers demand subsidies, but this system produces food of poor quality, which furthermore is non-competitive.

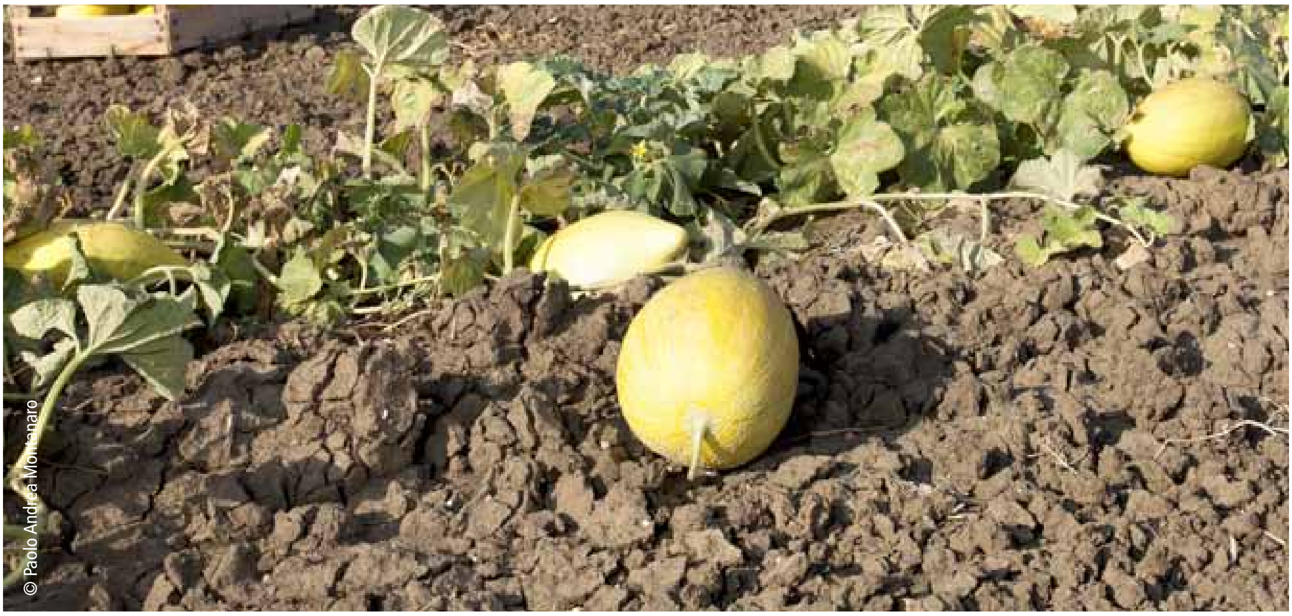
It is now essential to change direction. The laws of soil biology and the physiology of plants and animals must be respected. We must stop subsidizing an intensive agricultural model practiced on large scale, which has failed, polluted and compromised the life of soils.

Instead, we must focus on a system that starts from the health and fertility of the soil, valuing agricultural production that respects identity and reflects a link with terroir, an expression of the wealth of biodiversity of soils and places. It must be a system based on the construction of a different model of relationships and communication between farmers and citizens, one not geared solely towards the enrichment of agribusiness, but which ensures the welfare of farmers, the health and satisfaction of citizens and the protection of natural resources for future generations. In this model, farmers must be attentive to the needs of citizens and communicate with them through direct channels (producers' markets, community-supported agriculture, transparent labels etc.).

Progress towards this type of agriculture can be driven by farmers, by citizens who want to discover the pleasure of wholesome, quality food.

The institutions of the European Union must:

- recognize soil as a common good essential for our lives and assume its sustainable management as a primary commitment.
- adopt binding regulations to protect the soil, within a dedicated EU legal instrument.
- promote soil protection and agroecological farming practices in all relevant policies, such as the Common Agricultural Policy, the Rural Development and Structural Policy and the Water Framework Directive.
- support the research and development of decision-support tools with the aim of optimizing land use; this includes better knowledge about the link between small-scale farming practices (at field level) and outcomes (e.g. water quality, biodiversity), as well as a better understanding of the potential conflicts between different land uses and their impact on ecosystem services.
- support research to identify the criteria on which to base compensation for the ecosystem services provided by small-scale farming systems, especially those in marginal areas.
- develop a solid understanding of the local realities in order to ensure soil protection through EU policies like the Common Agricultural Policy, the Rural Development and Structural Policy and the Water Framework Directive.



- support continuing academic education about soil, aimed particularly at professionals, administrators, operators and farmers.
- recognize the role of small-scale farmers, herders and community systems in the management of common lands (for example for grazing). These systems are still alive and widespread in Europe but remain mostly unknown and invisible to both the general public and the authorities.
- recognize that traditional management and governance practices for common goods have contributed greatly to the preservation of European habitats and species; currently EU policies do not actively support them and, in most cases, they do not specifically recognize their benefits and potential.
- recognize European community systems, many of which are based on common grazing lands, as "Indigenous peoples' and community conserved territories and areas" (ICCAs), as a way to legitimize them as conservation methods, and obtain the support of governments, civil society and environmental organizations.
- include the Land as a Resource Communication in the European Commission's 2016 Work Programme, to bring the issue onto the political agenda and increase awareness among EU institutions, member states and citizens.
- measure and set reduction targets for land consumption in the EU.

9. Slow Food in Action

Slow Food's commitment towards living soils is based on a coordinated and complementary set of actions that involve advocacy, awareness raising and projects run at a grassroots level by local members. Our approach intends to encourage:

- consumers to change the market with their choices, becoming active about policy issues and aware of the impact of their food choices on the agricultural system and therefore the soil.
- producers to adopt sustainable production models.
- institutions to bring decision-makers closer to good practices and the needs of consumers and food producers.

Reaching out to only one of these groups cannot be effective, as their actions are closely interrelated. Slow Food organizes local, regional and international events, launches campaigns, develops networks around the theme of sustainable agriculture and creates space for dialog to engage stakeholders and decision-makers.

Slow Food Activities on Soil

Presidia: After creating the Ark of Taste project in 1996, which so far has catalogued over 2,700 foods at risk of extinction, Slow Food took the next step, engaging with the world of production, in order to get to know local areas, meet producers, understand their situations and the difficulties they face and promote their products, work and knowledge. Over the years the Presidia project has become one of the most effective tools for putting Slow Food's policies on agriculture and biodiversity into practice.
The Presidia support small-scale, traditional food products at risk of extinction, protect unique regions and ecosystems, revive ancient crafts and processing techniques and save native livestock breeds and local fruit and vegetable varieties from extinction. The producers of each Presidium work together to draft a production protocol, which includes the agroecological techniques practiced by the farmers for sustainable soil management. In the case of production based on conventional agronomy, the project will guide the producers towards the adoption of agroecological practices.
Today, over 450 Slow Food Presidia involve more than 13,000 producers in 62 countries. Of these, 326 Presidia are in Europe.

Food gardens: Slow Food's local network cultivates food gardens in schools, communities, urban and rural areas, in Europe and worldwide. Slow Food gardens are based an understanding and valuing of local resources, starting with soil, seeds and plant biodiversity. They follow agroecological principles. There are over 470 Slow Food gardens in Europe and over 2,000 in the rest of the world.

Narrative label: A narrative label does not replace the legally required food label, but supplements it by providing additional information about varieties and breeds, farming and production methods, areas of origin and animal welfare, thus allowing consumers to make informed choices.

Slow Food

Slow Food is a worldwide association involving millions of people dedicated to and passionate about good, clean and fair food, including chefs, young people, activists, farmers, fishers, consumers, educators, experts and academics in over 150 countries. Slow Food wants to link the pleasure of good food with a commitment to local communities and the environment.

According to Slow Food, food must be:

- **Good.** The flavor and aroma of a food, recognizable to educated, well-trained senses, are the result of the producer's skills and the choice of ingredients and production methods, which should in no way alter its naturalness.
- **Clean.** The environment must be respected and sustainable practices of farming, animal husbandry, processing and marketing must be applied throughout the whole production and distribution chain. Every stage in the agrifood production chain, including consumption, should protect ecosystems and biodiversity, safeguarding the health of the consumer and the producer.
- **Fair.** Social justice should be pursued through the creation of working conditions respectful of humans and their rights and capable of generating adequate compensation, through the pursuit of balanced global economies, the practice of sympathy and solidarity and respect for cultural diversities and traditions.

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