



## Food and environment: an impossible compatibility?<sup>1</sup>

Farmers are demonstrating against environmental norms they consider unbearable, consumers complain of pesticides found in food, and scientists worry about the sustainability of agriculture...

What is the issue? **Is food (and agriculture) incompatible with the protection of the environment?**

To answer this question, it is necessary to take a long-term perspective and revisit the history of relations between food and the environment, so as to understand what the main trends are.

### A little bit of history: the quest for control

Figure 1 looks at the history of interactions between food and the environment and considers **5 main stages**, from the time humans, as we know them, appeared, around 300,000 years ago, to the 20th century.

#### Hunting and gathering

This is a very long stage (from around -300,000 years and -10,000 years) during which humans simply **harvest what their nearby environment offers**. The technology is reduced to primitive predatory and storage tools (weapons, simple containers) and to hunting and gathering tactics. The success of these hunting and gathering activities requires **in-depth knowledge of the environment** (edible plants<sup>2</sup> and animals, the habitats in which they live, their habits, etc.).

The impact of these activities on the environment is limited both in intensity and space, and felt only in the neighbourhood of rare human groups.<sup>3</sup> As they have virtually no control over the availability of food, they experience a succession of

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<sup>1</sup> Based on a conference organised by the Médiathèque François-Mitterrand of Digne-les-Bains, France, in partnership with Artisans du Monde and the AMAP of Digne-les-Bains, on April 7, 2026.

<sup>2</sup> It is estimated that there are around 250,000 to 300,000 edible plants on Earth, of which around 10,000 have been consumed at one time or another during history [[read](#)].

<sup>3</sup> Estimates fix at 1-10 million the number humans around the year -10,000 [[read](#)].

seasons and periods of abundance and shortage, depending on meteorological and climatic conditions.<sup>4</sup>

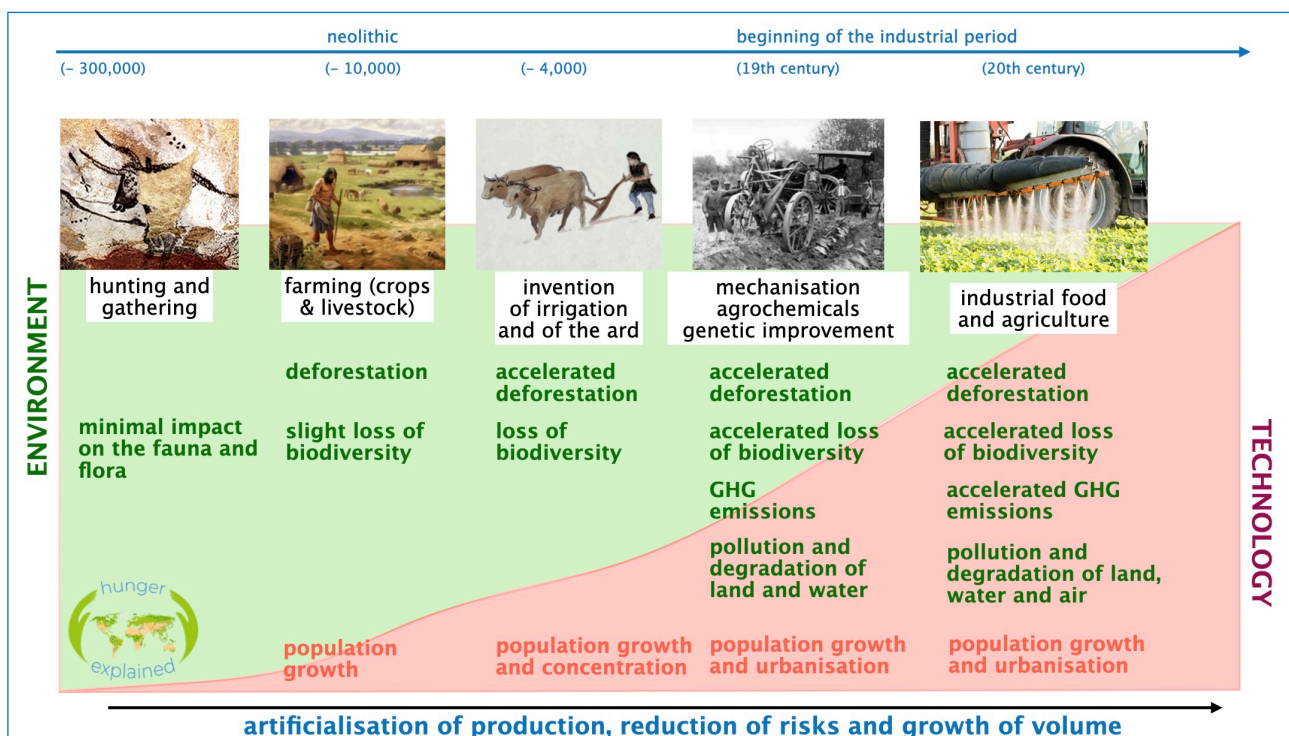
### Invention of farming (crops and livestock)

Depending on the area concerned, around year -10,000, humans begin to progressively domesticate plants and animals, and start farming (crops and animals). A growing number of human groups settle and create villages around which farming activities are organised.

Agricultural land is being developed by clearing the forest, which impacts biodiversity locally.

Through the control of production and a relative stability of the availability of food resulting from the adoption of farming, the human population increases. The diversity of food is, however, reduced, compared to the previous period.

**Figure 1 – A brief history of the interactions between food and the environment**



### Invention of irrigation and of the ard

At around -6,000 years, the invention of irrigation in the Near East and in East- and South Asia contributes to better control the production process and helps to more effectively secure the availability and stability of food.

<sup>4</sup> During this period, the climate was made of a series of cycles of around 100,000 years made each of a glacial interval of 90,000 years, followed by an interglacial interval of around 15,000 years, caused by changes in the elliptic shape of the Earth's orbit [[read](#)].

The invention of the ard at approximately –4,000 years brings about the increase of cultivated land and production. This expansion takes place through more deforestation, thus amplifying the loss of biodiversity. Little by little, humanity selects plants and animals that are more adapted to its needs. These plants and animals progressively make up a larger share of food, further reducing its past diversity.

Human population continues to grow<sup>5</sup> and starts to concentrate in the first urban centres, benefitting from supplies made possible by a greater productivity of agricultural labour.

### Beginning of the industrial period: the 19th century

The food–environment relationships sees some fundamental changes during the 19th century. The development of industry deeply modifies agriculture and food. Agriculture becomes simultaneously the customer (machines, energy, agrochemicals) and the supplier (raw material, labour force and capital) of industry [[read pp. 5–7](#)].

Mechanisation of agriculture helps to further expand cultivated land and contributes to the acceleration of deforestation and loss of biodiversity.

With the progressive replacement of draught animals by steam engines and later by combustion engines, greenhouse gas (GHG) emissions increase, causing the anthropogenic climate change.

The use of products of the nascent agrochemical industry leads to the invention of new science–based production technologies, the objective of which is to increasingly control the production process by creating conditions that are “optimal” for the growth of plants. Plant selection (including varietal selection) begins to adopt a scientific approach and is now in the hands of specialised seed companies, rather than in those of farmers.

Productivity and production increase, contributing to the provision of cheap food to a fast–growing urban population.<sup>6</sup> The downside of all this is the beginning of a still modest but increasing pollution of soils and of water.

Food security, which, until then, was mostly an issue of availability of food, turns into a problem of access to food by the most disadvantaged population groups, while a larger share of the production, which, earlier, was home consumed by farmers, is now channelled through an expanding market.

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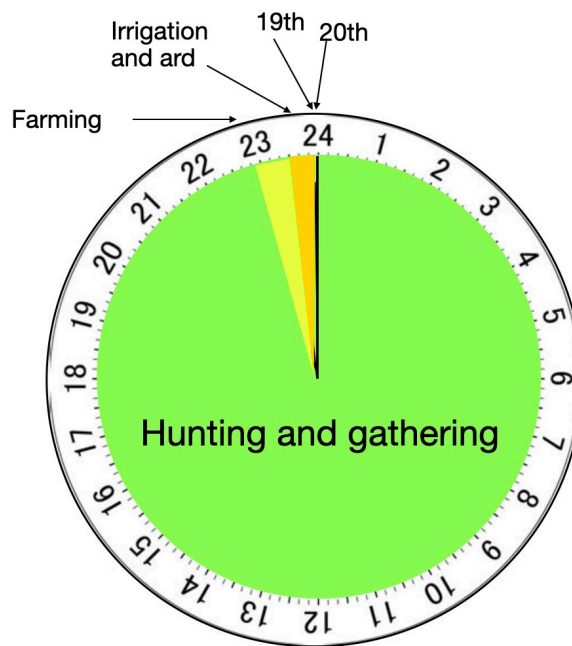
<sup>5</sup> Global population in year –6,000 is estimated between 11 and 14 million people [[read](#)].

<sup>6</sup> Global population in year 1850 is estimated at around 1.2 billion people [[read](#)], of which around 15% is urban [[read](#)].

## The advent of industrial food and agriculture: 20th century

If one wanted to illustrate by a day the time on which the history of food and agriculture unfolds, the 20th century would correspond to the events taking place during the last 29 seconds of the day... and farming would be invented shortly before 11 p.m.! (see figure 2).

**Figure 2 – The history of food brought back to one day**



During the 20th century, the changes that occurred in the preceding century further accelerate, leading to the emergence of an industrial food system that becomes global.

The use of agrochemicals (fertilisers and pesticides, veterinary products) surges, particularly after World War II [[read pp. 3-5](#)].

Glasshouse cropping develops rapidly, as do world trade [[read](#)] and agro-industries. Consumers who live more and more in cities can have access to an unprecedented diversity of off-season and exotic food products in super- and hypermarkets that spread progressively throughout the world. Large-scale retail companies acquire a prominent economic power in global food value chains, and they become the intermediaries between producers and consumers who lose direct contact with the producers, as well as the knowledge of the way in which food is being produced and the role played by the environment.<sup>7</sup>

Livestock production turns industrial and gigantic production units appear for producing poultry as well as pigs and cattle. In them, production is hyper-

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<sup>7</sup> It is quite frequent, when asking young secondary school students about where the food they eat comes from, to get the reply: "from the supermarket...", and it takes some questioning before they mention agricultural production.

controlled to achieve very high productivity levels. Simultaneously, animal products become more important in the diet [[read pp. 4–6](#)].

This evolution **amplifies the control and the artificialisation of production**, with the view to **reduce risks** and **increase volumes**. The approach adopted relies on **industrialisation by the methods used and the means mobilised**.

The consequences are

- more deforestation, particularly in intertropical areas,
- a loss of biodiversity due to deforestation, destruction of habitats and pollution by pesticides,
- increasing GHG emissions (deforestation, livestock, energy consumed during processing, storage and transport of food),
- soil, water and air pollution,
- a relative decrease in undernourishment and the development of unhealthy diets leading to the surge of the number of overweight and obese people and of those suffering from food-related diseases (diabetes, cancers, cardiovascular diseases, etc.).

**In this first part of the 21st century, the food system is “eating” the basis on which it rests**

A more in-depth analysis of some of the main impacts of the industrialised food system shows that they **undermine the basis of production and threaten its perennality**. This basis is made essentially of natural resources used by agriculture (biodiversity, soil, water and climatic conditions) and the physical and biological processes on which it relies.

### Impact on biodiversity

For the general public, when speaking of biodiversity, what comes to mind is mainly **protected animals because they are endangered**, a category most frequently associated with exotic animals such as tigers, orang-utans or elephants found in protected areas. Some may also think of certain plants, in particular those living in forests and which are part of the traditional pharmacopoeia.

Often forgotten are less famous or attractive animals, which, however, have **an essential role in agriculture** but are **threatened by the way food is being produced**. Here are three examples:

- **Pollinators**, to whom people immediately associate bees and to which should be added a great number of insects and invertebrates, and a few birds. It should be reminded here that 90% of flowering plants in the world and 84% of cultivated plants in Europe depend on pollinators. According to FAO, **35% of food production requires their involvement**. Yet, they are rapidly decreasing, threatened by poisoning by **pesticides** (in particular neonicotinoids [[read here](#) and see [graph on page 11](#)]) and by the **destruction of their habitat** by the

expansion and homogenisation of agricultural land. Unfortunately, rather than protecting them, some want to replace them by machines [\[read\]](#). Climate change, in which food has a substantial responsibility (read below), can also hamper their contribution, as it may sometimes de-synchronise the period of flowering of cultivated plants and the life cycle of pollinators.

- **Birds** are also important allies for agriculture, as they **feed in great part on insects and other invertebrates**, some of which may be pests for crops (and animals). Like insects, they are in rapid decline and for the same reasons (loss of habitat, pesticides – of which a share is ingested when eating their preys), as well as because their preys themselves tend to be fewer.
- **Earthworms** too have an important function for food. They help to maintain a good soil structure (aerating and loosening the soil) and are involved in the **degradation of organic matter** in soils to make it absorbable by plants. They play a key role in the **level of biological activity** of soils, if which their presence is a reliable indicator.<sup>8</sup> Unfortunately, they are declining in many soils, particularly when they are submitted to **unfavourable agricultural practices**: deep ploughing, spreading of mineral fertiliser, treatment with pesticides, fungicides and insecticides [\[read pp. 10-11\]](#).



To these three examples should be added the **general loss of agricultural biodiversity**, i.e. the reduction of the number of plant and animal species involved in food production, and of the varieties used in each species [\[read\]](#). The **way in which these varieties are being selected** (increasingly produced with the help of biotechnology) – i.e. on the basis of their productivity under optimal conditions defined in terms of the presence of nutrients, light and water – contributes to **homogenising technologies** and **promoting those adapted to industrial conditions** that are quite different from those found in fields or pastures. This evolution carries the danger of **locking food production in the industrial model**.

The negative side effect of this selection is a **genetic impoverishment and homogenisation** of plants and animals used for producing food, making production **more vulnerable to diseases** and obliging to further **artificialise and**

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<sup>8</sup> Plant roots are surrounded by a sheath of microorganisms (as is human skin or the inside of the intestines where it is called the microbiota) which eases exchanges between plants and their environment, thus contributing to their productivity [\[read\]](#).

**industrialise the production process**, thus reinforcing the locking in that has just been mentioned.

### Impact on soils

Farming (crops and livestock) and the technologies it uses contribute to **degrading a large share of land** by erosion, depletion, pollution and salinisation of the soils that are the basis of farming. This degradation is the result of the massive use of synthetic chemicals, irrigation<sup>9</sup> development and insufficient measures to combat erosion. It has resulted in the loss, at world level, of almost 33% of high- or middle-level productive land, as the degradation process takes place at a much greater rate than the slow natural regeneration of soils [[read pp. 6-7](#)].

The figures show that the increase of the quantity of fertiliser applied has been spectacular between 1961 and 2023:

- for nitrogen, the quantity was multiplied by 10,
- for phosphate, it was multiplied by 4,
- for potash, it was multiplied by 4 [[according to FAOSTAT](#)].

For pesticides, the volume doubled between 1990 and 2023 [[according to FAOSTAT](#)].

The large quantity of agricultural inputs applied on crops, while useful in the short-term to increase production in the context of an agriculture based on industrial monocropping, has a negative impact on the soils in the medium- and long-term.

### Impact on water

Part of the agricultural inputs, as well as a share of manure produced by industrial livestock production, are found because of leaching in water, leading to eutrophication of lakes, rivers and coastal areas. This has negative consequences for aquatic life, fisheries and aquaculture, and human health [[read pp. 5-7](#)].

### Impact on the climate

Food is a significant source of the GHGs emitted par humans that cause climate change [[read pp. 4-7](#)]. It is also a victim, as climate change brings about considerable modifications in the environment that affect a smooth functioning of agricultural production.

Traditionally grown plants do not succeed in adapting to the major modifications in meteorological conditions (temperature, rainfall, different timing of seasons). Yields decrease and agricultural practices must evolve. So must the varieties and even the species in a given location. New diseases and pests appear, pollination is

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<sup>9</sup> Two of the main ingredients, along with genetic improvement through hybridation, of the Green Revolution implemented on a large scale since the middle of the 20th century.

disrupted, the quality of products itself changes as well as that of the feed provided to animals by pastures. Fisheries suffer (fish migrate to find conditions to which they are accustomed), and trees in forests are no more adapted to the environment in which they live. Transport and conservation of food become more difficult when temperature and humidity increase [read pp. 7-9].

The complex food systems are disrupted, with potentially tragic implications for living conditions of farmers, sustainability of agriculture and food security.

In other words, it is clear that **food production, as it developed, created a series of consequences that undermine its very basis.**

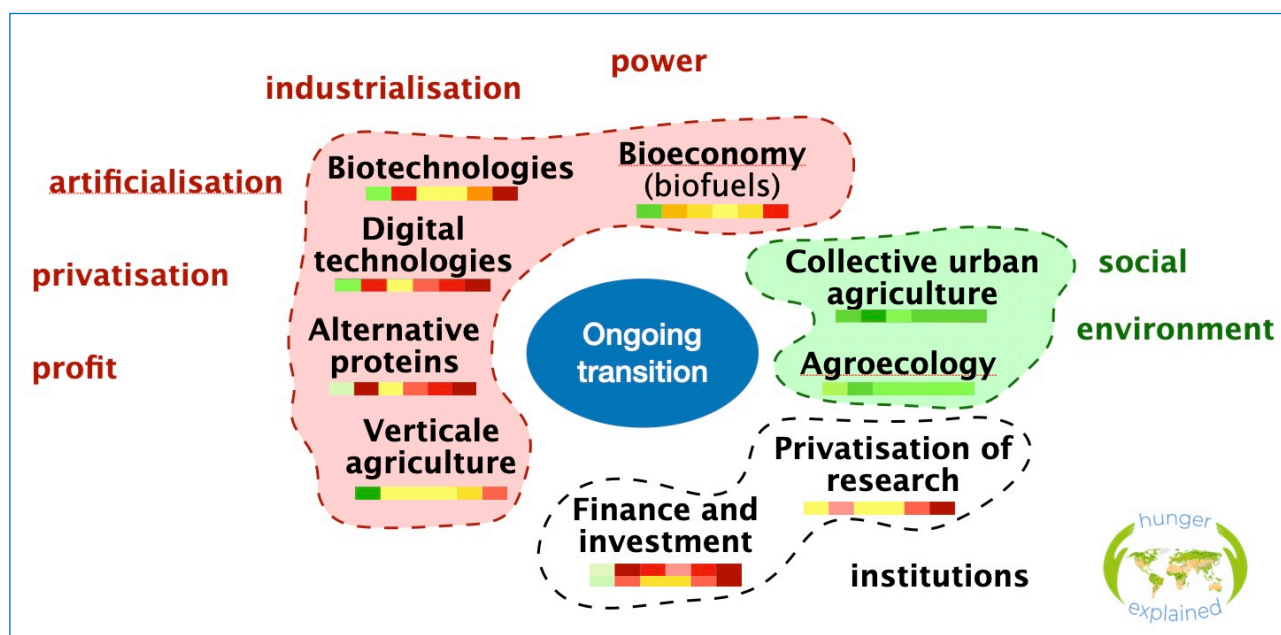
However, this does not mean that agriculture (and food) are inherently incompatible with the environment. It is the agriculture that we know, result of a long evolution process, that has become incompatible. **This implies that it has to be changed.**

When analysing ongoing changes in this beginning of the 21st century, two alternative approaches can be observed that are already being implemented.

### The ongoing transition<sup>10</sup>

Figure 3 sums up the dimensions of the ongoing transition.

Figure 2 – The dimensions of the ongoing transition



<sup>10</sup> For more details on this topic, see our article [“The ‘food and agricultural transition’ is ongoing”](#) and the references it presents.

## The techno-solutionist dimension of transition (in pink on **figure 2**)

It is made up of a series of technological innovations implemented by the private sector with the support of most governments. It is characterised by a greater industrialisation of food, leading to an acceleration of the artificialisation of activities within food systems. The more or less clearly claimed objective is to achieve their total control by decoupling them as much as possible from the environment and its hazards. This hyper-technical approach is only accessible by a small number of actors who can mobilise qualified personnel and considerable financial resources. It tends to be extremely concentrated in the hands of a limited number of large corporations for which the primary objective is making profit.

The main innovations already being implemented include:

- **Biotechnologies.** They encompass technologies such as genetic improvement based on genetic engineering, gene editing, and digital genome sequencing that make fermentation, manufacturing of biofertilisers and of biofuels possible. The immediate objectives are to develop more productive crops and animals for producing cheap food, possibly enriched, by creating plants resistant to pests and diseases, drought, excess water or salt, and nutrient deficiencies, and with good organoleptic qualities and long storage life. With time, for some, the objective is to stop relying on animals and plants, and adopt an industrial approach based on the use of microorganisms, thus establishing a food system without farmers.
- **Digital technologies.** The idea is to implement an analytical capability for real-time analysis of a staggering amount of very diverse data (soil conditions, weather, plant and animal health, agricultural technology used, agricultural inputs availability, market conditions, consumer needs and preferences, etc.). The declared objective is to improve the efficiency of food systems and reduce their impact on the environment.
- **Alternative proteins.** They are the result of the use of synthetic biology that combines biotechnology and digital technology to programme microorganisms for the production of complex organic molecules such as proteins, enzymes, aromas, vitamins, and pigments, as well as growth factors needed for cellular agriculture. These molecules then serve to produce animal products from cell cultures rather than from livestock. The declared objective is to produce food “without devouring the planet”, cut GHG emissions and diminish the degradation of the environment.
- **Vertical agriculture** is today’s state-of-the art agricultural technology [\[read\]](#). The idea is to produce in a fully controlled setting established within multiple-storey buildings in which light, temperature, water, nutrients, humidity and air concentration of oxygen (O<sub>2</sub>) and carbon dioxide (CO<sub>2</sub>) are controlled automatically with the help of a multitude of sensors, artificial intelligence and robots, and hardly any human involvement. The objective is to produce in a totally artificial manner, throughout the year, independently from the climate, seasons and soil conditions, and by reducing the life cycle of plants, saving 95% of the water and solving the land availability constraint.

- **Bioeconomy**, one of the most important aspects of which is the use by the industry of biological resources drawn from agriculture, the sea and forests in the best possible way. It includes, among others, food, chemical, pharmaceutical, wood, paper and garment industries, as well as construction and the production of energy (biofuels).

### The social and environmental dimension of transition (in green on **figure 2**)

It is led by producers and civil society associations, whose objective is to organise sustainable food systems from the economic, social and environmental point of view.

The main innovations include:

- **Agroecology**, which is simultaneously a science, a set of practices and a social movement. It applies ecological concepts and principles to farming systems, focusing on the interactions between plants, animals, humans and the environment. It takes into account transdisciplinary knowledge, farmers' practices and social movements. It encompasses organic agriculture, agroforestry, permaculture, etc. Its objective is a more efficient use of resources, resilience to shocks and more equity and social responsibility. It gives particular importance to regenerative production, biodiversity, economic diversification, adaptation to climate change, production and sharing of knowledge and technologies, equity, social and human values, social links, rights, democracy and participation.
- **Collective urban agriculture**. This includes traditional forms of urban and peri-urban agriculture such as workers' gardens and peri-urban farming. Its objective is a greater autonomy of urban and peri-urban communities, and it seeks to develop and strengthen social relations in an urban and peri-urban context.

### Changes in the institutional set-up

The two dimensions described above operate in a significantly changing institutional set-up:

- **Finance and investment** have an increasingly important role in food and agriculture since the food crisis of the mid-2000. New operators appeared that are almost exclusively concerned by profits: pension funds, impact investors and digital corporations. In parallel, the government has been withdrawing. This contributes to spreading typical financial values and attitudes (e.g. priority to immediate profits, volatility of capital).
- **Privatisation of research**, often funded by large multinationals, increases their power. As a result, research is directed towards production technologies that develop commercial activities made of sales of machines, equipment and other products and services that generate profits for firms, to which the mass of poor producers have limited access, because they do not have sufficient financial

resources. This is one of the main causes of the reinforcement of the industrial model in food systems.

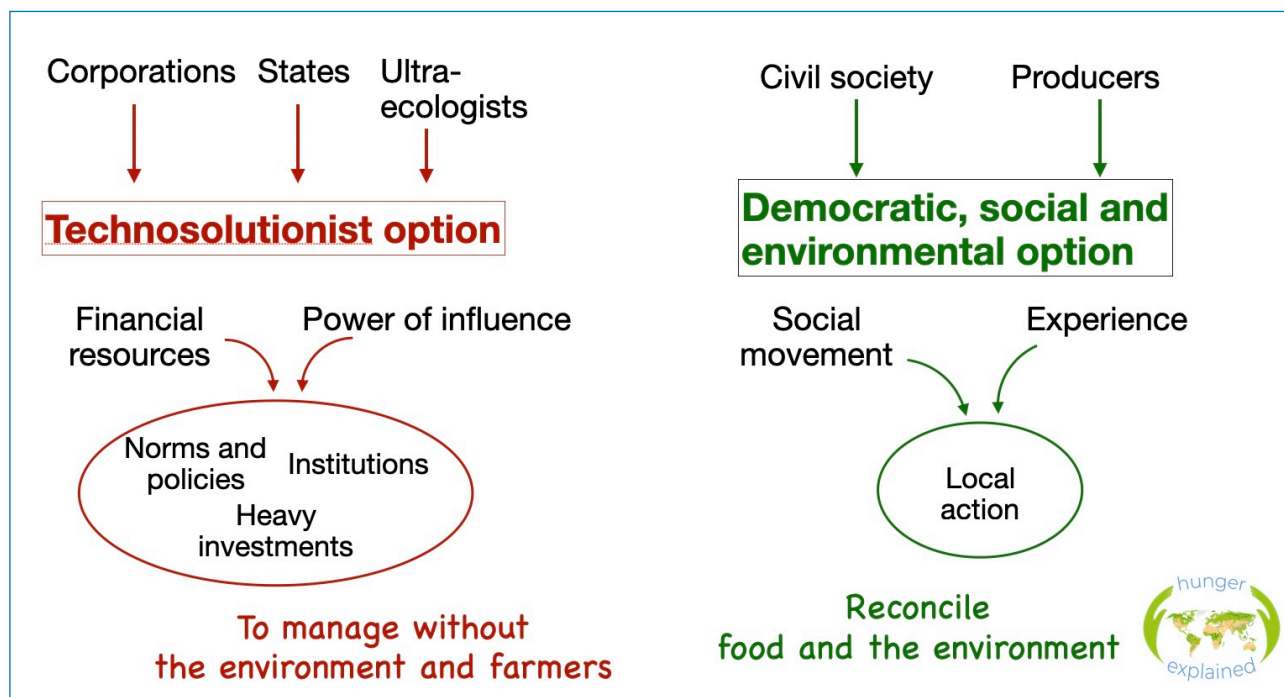
It is clear that this institutional context is **more favourable to a technosolutionist transition than to a social and environmental transition** (see figure 3).

The former benefits from the mobilisation of financial resources and political influence that generate a capability to orient food systems by creating institutions and policies that favour its development.

The latter rests on a dynamic but still minority social movement that, at this point in time, can only be implemented in a comfort zone at the local level, while its influence – its power – remains quite limited in the conflict zone where policies, norms and the economic organisation of food systems are being defined [[read pp. 8-11](#)].

To put it differently, the first envisages to separate gradually food from the environment, and the second wishes to reconcile them. The consequences of each of them on food, the environment and society will differ fundamentally.

**Figure 3 – Two options**



### What conclusion for the future?

The long-term analysis of the relationship between food and the environment shows:

- a human will to **stabilise and secure food**.

- For this, efforts were made to **ensure availability of food** with the help of **technological innovations**, the rhythm of which has accelerated with time.
- These technologies seek to **master the conditions in which the food production process takes place** but **have negative impacts of increasing importance on the environment**, which, with time, **endanger production and threaten human health**.

When considered in this way, food does indeed, paradoxically, appear incompatible with the environment that is its very basis, but to the destruction of which it contributes.

An analysis of trends in food production in this beginning of the 21st century shows that for now, confronted with this contradiction, **the balance of power is very largely in favour of adopting techno-solutions** proposed by large private industrial and financial corporations.

Driven by profit and, sometimes, by some ultra-ecologists, these corporations develop a growing number of advanced industrial food production technologies that combine digital technologies, biotechnologies and robotics in conditions that are increasingly separated from the environment. Their intention is to **establish a food system that requires neither “nature” nor farmers, but passive consumers**, which relies on processes consuming large volumes of energy and are controlled by a **small group of industrialists and financial actors**. In short, a perspective that has a strong undemocratic aftertaste of inequality.

The alternative to this approach is democratic, social and environmental. It is led by a **minority alliance of producers and consumers that seeks to reconcile food and the environment**. However, being a minority, it has much less resources and power, and is seriously handicapped.

The future will tell us if this situation will persist or if the relative weight of these two options will evolve. Whatever the future evolution will be, it will for sure determine the world in which generations to come will live.

[Materne Maetz](#)  
(April 2026)

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Selection of earlier articles published on [hungerexplained](#) related to this topic:

- [Vertical agriculture – a sustainable option for the future?](#) 2025.
- Opinion: [Farmers’ situation and industrialisation](#), 2025.
- [The major trends in the production and consumption of animal products](#), 2025.
- [Pesticides: for or against acetamiprid? An analysis of pros and cons](#), 2025.
- [Food and agriculture stakeholders – Third part: Civil society](#), 2025.
- [Understanding our world: end or new phase of capitalism?](#) 2025.

- [The “food and agricultural transition” is ongoing – Nine changes tell us to what kind of world it is leading us, 2023.](#)
- [Pollinators are declining rapidly – Rather than protecting them, some are getting mobilized \(and invest\) for replacing them! 2022.](#)
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- [The global food crunch: myth or reality? 2018.](#)
- [Food, Environment and Health, 2017.](#)
- [To produce more: build an alliance with nature rather than combat it, 2016.](#)
- [International trade in agricultural commodities, 2014.](#)
- [Genetic resources: acceleration of privatisation of living organisms is a threat to food security and biodiversity, 2013.](#)