Conclusions: The Way Forward in Achieving the SDGS—The Urgency of Transforming Our Agri-Food Systems

Stefano Zamagni

1 Introduction

What we are now experiencing is the second great transformation in the Polanyian sense. The first was the one masterfully analyzed by Karl Polanyi in his famous book *The Great Transformation*, published in 1944, a study of the impacts on Western society of the first industrial revolution (England, second half of the eighteenth century) and of the second industrial revolution (Germany, late nineteenth century). The second great transformation makes reference to the third industrial revolution (in the 1970s) and to the fourth (typically starting with the new century). We do not yet know how and to what extent the new digital and artificial intelligence technologies will modify the central core of capitalism and its underlying cultural model. However, we do know that the convergent technologies of the NBIC group (nanotechnology, biotechnology, information technology, cognitive science) are having a significant impact on many fronts, in particular on the entire sector of our current agri-food systems, which have become unsustainable for both humans and nature.

The UN Sustainable Development Goal 2 states: "End hunger, achieve food security and improved nutrition and promote sustainable agriculture." (As a reminder: the SDGs are comprised of 17 goals with 169 associated targets). It is well known that the food security SDG includes four components that must be met simultaneously, without any possibility of trade-offs between one and another. The first component is the physical availability of food, supplied through local production

S. Zamagni (✉)
Bologna Academy of Sciences, Bologna, Italy

University of Bologna, Bologna, Italy

Johns Hopkins University, SAIS Europe, Bologna, Italy
e-mail: stefano.zamagni@unibo.it

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or imports (it goes without saying that these two supply sources are not equivalent, as indicated by the heated debate on "food sovereignty" (Patel 2009)). Secondly, the mere availability of food does not in itself guarantee access to it in sufficient quantities. This depends on people's purchasing power, and therefore on disposable income and on food prices, which have risen significantly over the last two decades, with a high degree of volatility. The third component is food utilization, that is, the availability of nutrients in sufficient quantities to ensure a healthy life. Individual food utilization depends certainly on one's state of health, but also on social and familial factors associated with the prevailing cultural matrix in the community of reference. Finally, these three conditions must be met with stability (See Chap. 1). Food insecurity, in fact, can depend on the cyclical trends of crop yields, which are in turn associated with climatic variability, political unrest, unpredictable trends in food prices, and so on. Stability of access is of crucial importance, since even temporary malnutrition can lead to serious health problems, a reduction in labor productivity, and so on (See Chap. 5).

That being said, in the following pages I intend to focus attention on one specific aspect: of all the contemporary economic sectors, agri-food is the production area characterized by the greatest intensity of dilemmas, both ethical and political-institutional. After referring to the empirical evidence in support of this salient aspect, I will indicate the directions in which it is now urgent to move in order to dissolve these dilemmas. From the outset, I would like to indicate the spirit in which these notes have been written. One of the most penetrating dangers of our times is described by the famous twentieth century English writer C. S. Lewis in terms of "chronological snobbery," that is, the uncritical acceptance of what is happening simply because it belongs to the intellectual trends of our times. In my view, we must resist such a danger in every way possible, and this requires not only novelties (*res novae*, in Latin)of our times but also, and perhaps above all, a moral commitment.

2 The Dilemmas That Afflict Our Current Agri-Food Systems

2.1 The First Dilemma

One dilemma of an ethical nature, certainly not a lesser one, can be described in the following terms. Agriculture today is facing a tragic choice (in the sense of Calabresi and Bobbitt 1978): it must respond to the challenge of nourishing—not just feeding—a growing world population without jeopardizing environmental sustainability. Just a few data are sufficient to provide the measure of what is at stake. Around seven billion two hundred million human beings currently live on the planet. The most accurate estimates indicate that the world population will rise to almost ten billion by 2050. To confront such growth—the World Bank tells us—agricultural

production will have to increase by 70%, which, in the absence of transformational interventions, will require a 30% increase of the land used for agriculture. Deforestation and depletion of fresh water reserves would be the immediate and tragic consequences.

But there is more. As the average income increases progressively, meat consumption grows more than proportionally, because—as is widely confirmed—the elasticity of the demand for this good with respect to income is greater than one. Currently, the average meat consumption in North America is 83 kg/year per person, in the European Union 62 kg/year, in Asia 28 kg/year, and in Africa 11 kg/year. The conclusion to be drawn is all too obvious: the FAO predicts that meat consumption will increase by 76% globally by 2050, and this following the predictable income increases in Asia and Africa. To give a rough idea of the impact on water consumption, consider that 1 m^3 of water is needed to produce 1 kg of grain; for 1 kg of meat, it takes 15 m^3! As Joseph Poore of Oxford University has documented, if humanity gave up breeding livestock for slaughter, agricultural land use would be reduced by more than 75% (Poore and Nemecek 2018). Meat and dairy products, while supplying 18% of the calories and 37% of the protein consumed globally, require 83% of the agricultural land, since most of the crops grown are used for livestock forage, generating approximately 60% of total greenhouse gas emissions. It should be noted that even raising livestock with more environmentally friendly methods does not solve the problem, though it does mitigate its scope. This is for the simple reason that the advantages of these methods, in themselves praiseworthy, are more than neutralized by the spreading in the advanced Western countries of CAFOs (Concentrated Animal Feeding Operations), a type of intensive farming that generates greenhouse gas emissions twelve times higher than those of other types of farming (Valentini and Miglietta 2014).

The heart of the dilemma in question lies in the trade-off, unknown in past eras, between food and nature conservation. How did we get to this point? For centuries, agriculture evolved by improving crop production and livestock breeding techniques, adapting them to the current land conditions and climatic changes. The first Green Revolution, initiated in the 1960s by Nobel laureate Norman Bourlag, doubled the global production of wheat, rice, soya, and corn—products that alone supply 43% of food calories and 40% of global protein—, though using increasing amounts of pesticides, herbicides, and fertilizers. Today this kind of agriculture is colliding against its own limits, and this fuels the conviction among the populations that agriculture and livestock farming are the major causes of environmental degradation. For more than 50 years, agricultural productivity has increased to an extraordinary degree, so much so that the amount of food currently produced would be more than sufficient to relieve the hunger of the more than eight hundred million human beings who suffer from it, if only there were the wisdom and political courage to change the institutional framework that governs the entire food supply chain. However, this acceleration has led to excessive exploitation of the land, a drastic reduction in the biodiversity of the crops cultivated, and a worsening of environmental pollution. The current management of agricultural systems certainly does not favor the enrichment of organic matter in the soil. In Europe, soil erosion affects

some 12 million hectares (Panagos and Borelli 2017). Moreover, climate change manifests itself not only in the form of global warming but also in extreme weather events that are both devastating and unpredictable. It should be noted that there is not only a problem of production loss; there is also a loss of nutritional value in cereals, which, as is well known, are the staples of the planet's diet. For example, as the CO_2 level in the air increases, the protein content of rice is reduced, and there are also substantial losses of vitamins B_1, B_2, B_5 and B_9, iron, and zinc, with considerable harm to the populations whose main food source is rice (Zhu et al. 2018).

Given these data, there are some who believe that the dilemma we are facing could be dissolved if we decided to vigorously address the problem of food waste and loss. About a third of world food production is lost or wasted annually throughout the food supply chain (FAO, Rome 2013). This proportion corresponds to waste of approximately 1.6 billion tons of food; 1.3 billion if we consider just the edible fraction. The distribution of the loss and waste throughout the various segments of the global food supply chain is approximately the following: 32% during agricultural production; 22% in the post-harvesting phase; 11% during industrial processing; 13% during distribution; and 22% in the consumption phase. Clearly, this phenomenon assumes different proportions in the different regions of the world. Overall, around 56% of food waste and loss takes place in the advanced countries and the remaining 44% in the emerging and developing countries. It is easy to imagine the environmental impact, as well as the economic impact, of such an outrageous phenomenon. A recent study by the FAO (2014) gives an estimate of the hidden costs of food production, including costs attributable to conflicts over the control of natural resources; treatment of diseases linked to the use of pesticides; water purification; loss of natural habitat; the effects of reduced water availability, and so on.

It is certainly true that food loss and waste must be eliminated or at least greatly reduced, for ethical reasons first and foremost. The *Global Hunger Index* on 119 countries—based on the combination of three components: the percentage of undernourished persons out of the entire population; the percentage of underweight children under the age of 5; the mortality rate of children under the age of 5—fell from 18.7 (a value above 20 indicates that the problem is alarming) in 1990 to 15.2 in 2013, thanks also to the implementation of waste reduction programs. But the absolute number of undernourished people in the developing countries has actually risen (Von Braun 2014). This suggests that the argument that the problem of food shortages would be nothing more than a problem of distribution—that is to say, that there would be sufficient food in the world to feed everyone if only it were distributed fairly—is an over-simplification that does not help to tackle the root causes of this sad phenomenon. In fact, as we know, in capitalistic market economies, the demand for goods and services that is relevant is the effective demand (in J.M.Keynes' sense), not the potential one; therefore, those who have no income can continue to suffer from hunger, even if the grocery shelves are filled with food! This is why the "zero hunger" goal of the 2030 Agenda still seems very far from reach.

2.2 The Second Dilemma

A second dilemma, this time of an economic-institutional nature, calls into question the difficult relationships between agriculture and other sectors of the economy, above all that of finance. As mentioned above, the right of access to food depends certainly on the level of per capita income, but also and in large part on the cyclical trends of the agricultural commodities markets. I refer to the peculiar and growing price volatility of these goods, which that does not allow farmers to rationally make medium- and long-term investment plans for their farms. Added to this is the variability of the quantities produced as a consequence of climate change and natural adversities. The problem is further complicated for the most vulnerable economies, where the degree of dependence on imported food is high and the characteristics of the production systems are weaker. In the season of globalization, it no longer makes sense to talk about achieving food self-sufficiency on the part of individual countries. At the same time, however, strong dependence on international trade increases the vulnerability of countries with respect to economic trends in the markets that are detrimental to the poor segments of the population. This dependence is on the rise particularly in the developing countries, in which the FAO estimates a food trade deficit of some 50 billion dollars for 2030 (Von Braun 2011).

Underlying the phenomenon of food price volatility, we find one specific cause that should be highlighted, especially because it is almost never brought to the attention of citizens. We know that one of the main factors responsible for the malfunctioning of the market mechanism is that of technical externalities. A typical example is the company that, in order to carry out its production plan, pollutes the surrounding environment. Technical externalities always arise when, given a certain distribution of property rights, the company that, let us say, emits fumes is not obligated to compensate those who are harmed. In the presence of technical externalities, the results of the market process are inefficient, because the choices made by the actors are based on prices that do not reflect the full cost of the resources used, and therefore the market is not capable of correctly informing the actors. But what about when we are faced with the other category of externalities, the pecuniary ones? These are externalities that spread through the price system and whose effect is to inflict unwanted negative consequences on "innocent" subjects who have not taken part in the market transactions from which those externalities originated. A typical case is the worker who loses his job because his company, for one reason or another, has decided—obviously without consulting him—to relocate its facilities. Why—we might ask—do economic science and even public opinion, while dedicating (rightly) so much attention to the technical externalities, neglect, save for rare exceptions, to consider the impact of pecuniary externalities on people? It is easy to take them into account. While the former, representing a case of market failure, do not allow the market to achieve its primary purpose, that is, the efficient allocation of resources, the latter are of the same substance as the market mechanism itself, which makes use of price variations to function and carry out its task.

We must keep in mind that the price system in a market economy not only fulfills the allocative function but also the distributive one. In fact, whenever the relative price system changes significantly, there is a change in income distribution. If—to give an example that actually happened—following speculative maneuvers, the price of cereals and rice at the Chicago Mercantile Exchange increases suddenly (because, as occurred in 2009, the authorities had allowed the issuance of derivatives whose underlying was the prices of those staple goods), the poor populations, whose diet is based on those goods, will see a diminishing of their already meager purchasing power and consequently of their standard of living, without having done anything to cause that result and therefore without any fault other than that of being poor. But the financial operators in the case mentioned did not consider themselves morally responsible for the event—there were many deaths due to undernutrition—because they claimed that it was not their intention to cause that hardship and suffering.

One can understand, then, why there is a profound asymmetry between the ways in which the two categories of externalities are treated. Yet, if we want to take seriously the question of the transformation of agri-food systems, we must first pay attention to the pecuniary externalities, which are often invisible. Firstly, because price changes, as mentioned above, always lead to a redistribution of advantages and disadvantages among economic actors. And so, even if the advantages associated with certain lines of action outweigh the disadvantages in the aggregate, it may happen—as indeed happens—that certain categories of people, unrelated to those decisions, find their own condition of life worsened, leading to a restriction of their autonomy of action. These people are thus induced to make choices under the weight of an "economic constraint" that reduces their space of freedom. Secondly, because very often the pecuniary externalities inflict costs or burdens precisely on those who are least capable of withstanding them, and this raises a problem of corrective justice. To avoid misunderstandings, it should be noted that while the market does not tolerate coercion, it is perfectly compatible with constraints of an economic nature.

The question thus arises spontaneously: given that pecuniary externalities are inevitable as part of the inner workings of the market mechanism, is it reasonable to conclude that no one should be held responsible for the negative consequences that fall on those who are third parties? Is it morally (and politically) acceptable to the reasoning of those who think, since "that's how the market works" and since the market economy has no longer any valid or credible alternatives, that no attribution of responsibility can be placed on those who work in it? No, this would be a typical example of a *post hoc ergo propter hoc* fallacy. The fact is that participation in market transactions is by no means voluntary in societies where there is a division of labor, since in such circumstances exchange becomes a necessity and not a free option. So correcting the negative consequences of pecuniary externalities is a question of corrective justice, because those who bear the damage have done nothing to "deserve" the punishment. In other words, in the presence of pecuniary externalities, it is the category of agency responsibility that must be called into question.

(Agency responsibility indicates that a subject is responsible for something if he caused that something to happen, regardless of his intentions or his predictions).

A famous historical case illustrating the practical relevance of pecuniary externalities is that analyzed by the French anthropologist Germaine Tillon, who lived in the Aures region of Algeria in the 1930s. She returned to the region after the war, only to discover that the society she had described as "balanced and happy in its ancestral tranquility" had become impoverished. What happened? Believing it would help the Aures community, the French government had dispersed DDT in ponds to combat malaria and built a road to Algiers to overcome the region's isolation. These two policies, certainly legitimate and useful *per se*, produced a chain reaction. The eradication of malaria stimulated a demographic explosion and this caused shepherds' livestock to rapidly destroy the soil. At the same time, thanks to the road, a small number of people were able to bring surplus livestock to the markets of the capital city. The final result was that a small percentage of people became richer and richer, while the rest of the local population suffered. The determinant responsible for these kinds of processes was the absence of any corrective mechanism, at least after the point of no return has been reached. The accumulation of changes in power and property, as a result of the negative feedback cycle, slowly pushes the system to a tipping point (the so-called catastrophic bifurcation in natural sciences) despite the fact that each of these changes in themselves is fairly small. From that point onwards, the system loses its self-correcting ability and a return to the previous situation is no longer possible.

2.3 The Third Dilemma

I would like to mention a further bio-political dilemma, which concerns the as yet unsettled question of biodiversity, a term coined in 1985 by Walter Rosen to indicate the set of natural environments and living species that populate the biosphere. The dilemma is this: to protect plant species or compromise the development process? Quite appropriately, Pasca Palmer (2018) clarified how biological diversity is the premise of all forms of life, including human life. Indeed, natural capital is a global common good, officially recognized as such in December 1993 during the UN Convention on Biological Diversity. But despite the commitments undertaken there, the loss of biodiversity has gradually increased: about fifty living species disappear every day. It is true that extinction is a natural fact (a single species lives, in fact, a million years, on average), but the current acceleration is one thousand times higher than the natural rate (Schmeller and Bridgewater 2016).

The degradation of ecosystems is a strong violation of the principles of inclusion, justice and equity on which the 2030 Agenda on sustainable development is founded, and this for the simple reason that biodiversity is the way in which life is expressed. The World Economic Forum's Global Risk Report (2018) includes ecological collapse and loss of biodiversity among the ten main risks in terms of impact.

Biodiversity and agriculture are strongly interdependent. Agro-biodiversity contains the biological diversity that supports the key functions and processes of agricultural ecosystems. But it is a fact, as indicated by United Nations's Global Biodiversity Outlook (2014), that the determinants linked to agriculture contribute 70% to the loss of global biodiversity. Stemming from this is the urgency to modify the trends in agri-food systems. The prevailing logic over the last decades in agriculture—large farm size and monocultures, seeds patented by multinational corporations, excessive use of fertilizers—is certainly the enemy of biodiversity. (For a precise analysis of the phenomenon, see Pingali, "The Green Revolution and Crop Biodiversity", in Hunter et al. (2017), Handbook of Agricultural Biodiversity).

On the many causes of biodiversity destruction in the Anthropocene, one of which is industrialized agriculture, see the recent study by Dasgupta and Ehrlich (2017), which explains why today we cannot rule out the beginning of the sixth mass extinction, if we do not immediately intervene forcefully.

3 Food Policies in the Twenty-First Century

What can we do to try and dissolve the dilemmas mentioned above? The position I defend is that we must intervene, as a priority, even if not exclusively, on three main fronts to begin solving the problem of how to ensure that our agri-food systems are capable of producing food in sufficient quantity and quality for a growing population, while at the same time reducing the overall environmental impact. The food system encompasses everything from production to consumption—processing, storage, transportation, distribution, marketing, preparation—and is shaped by policies at both the domestic and international levels. It is critical for effective food policies to be envisaged in order to create a productive, equitable and sustainable agri-food system. Depending on policies, agri-food systems determine the availability, affordability and nutritional quality of the food supply and influence the amount of foods that people are willing and able to consume. Conflicts over land, technology, natural resources, subsidies and trade are all playing out in the food policy arena, involving many different players: international organizations, multinational corporations, medium-scale entrepreneurs, NGOs, governments, and civil society organizations.

3.1 A First Front of Intervention

A first front of intervention is to increase crop yields in regions such as Africa, Central America and Eastern Europe in a sustainable manner. In concrete terms, this means embracing "Agriculture 4.0", that is, taking seriously the reality of food tech. This is what is referred to when we speak of precision farming: satellites, drones, robots with artificial intelligence, and digital tools, are the main ingredients

used to carry out both conservative and regenerative agriculture and organic farming. (The latter should not be confused with biodynamic agriculture, around which the opinions among scientists vary widely).

As regards organic farming, the skeptics believe that yields would be lower than those associated with traditional farming systems, and this would imply the use of more land and increased deforestation. But the results of very recent studies would allay such fears. In fact, the spread of agroecology—a term introduced by A. Wezel et al. (2009) to denote the application of biological principles to food production—appears to be fully compatible with small and medium-sized agricultural enterprises, which are the source of most of the food destined for human consumption. (See also Wezel and David (2012)). On the other hand, the paradigm of industrial agriculture does not allow the traditional knowledge of farmers to be combined with new scientific knowledge into participatory processes that take into account the social, geographical and environmental aspects. This is because agroecology does not separate economic sustainability from social and environmental sustainability, as is the case with the industrial model. It is true that the main applications of the high-tech revolution in agriculture are currently limited to the cultivation of grapes, olives, and cereals, but the path of food tech now undertaken is rapidly expanding. The report *The State of European Food Tech* 2018—produced by Dealroom and the French-Bolognese VC firm Five Seasons Venture—gives a snapshot of the change in progress: investments in genetic breeding for improving livestock, precision agriculture, and robo-farming during the 2-year period 2017–2018 far exceed those of the previous years.

An effective exposition on the impact of the use of big data, artificial intelligence, and blockchain on the agro-industry supply chain is given by A. Renda (See Chap. 10). One point deserves special attention: the agriculture of the twenty-first century can do without genetically modified agriculture (GMO) as it has been known to date. This is because sustainable agriculture will be able to combine the increase in productivity with improvement of the quality of the agricultural product, to create a reality in which agriculture earns more and consumers eat better. It goes without saying that we are still far from this goal, since companies still too dazzled by the prospect of "short-termism" are favoring GMO processes. Just consider that the intellectual property rights on transgenic products impede the use of second generation seeds for the subsequent planting, so it follows that farmers cannot take possession of seed from the previous year's crop in order to reseed it unless they pay the related royalties. This means that it is not true whatsoever that GMO seeds are sterile, as we tend to believe. It is in this specific sense that GMOs must be carefully evaluated, because they represent a reduction in the scope of farmers' freedom of choice and not so much because of the supposed negative effects on health and the environment. Today, evolutionary genomics, based on the combination of innovations such as transgenomics, genome editing, and genomic selection, is able to obtain characteristics of cultivatable crops in our favor without modifying the genetics in a "brusque" manner, as has been done up to now with GMOs. (See Liakos et al. 2018). In essence, evolutionary genomics replicates, by imitation, the mutations that nature from time to time produces.

The good news is that sustainable agriculture, in the medium to long term, will prevail over financialized agriculture, which is defended by neoliberalism, because the economies of scope made possible by the Internet of Things are greater than the economies of scale typical of industrialized agriculture. The same goes for the financialization of agri-food. On one hand, there is the growing importance of financial capital with respect to agricultural capital in generating profit. On the other hand, there is the fact that the majority of profit is realized through the purchase and sale of financial products such as derivatives. While it is true that contracts covering the future prices of agricultural products available for harvest have existed since the nineteenth century, the financial deregulation of the last 40 years has radically changed the situation, allowing the exchange of financial products regardless of production trends. In this way, agri-food goods have been transformed into assets subject to financial speculation managed by actors who have no interest whatsoever in food-related issues. As M. Fairbairn observed (Bonanno and Busch 2015), financialization has been extended to all the components of the agri-food system, including supermarkets and land. In the case of supermarkets, financialization separates the investment from the quality of the service, given that supermarkets are purchased and restructured first and foremost to increase their sales value, rather than the efficiency of the service. In the case of land, its purchase as a financial asset to be utilized for speculative purposes has become one of the most significant global phenomena.

3.2 A Second Set of Changes

A second set of changes that is urgently needed has to do with cultural aspects, and more specifically food and nutrition education. A terminological clarification in this regard may be useful. For example, for the European regulations, "'food' (or 'foodstuff') means any substance or product, whether processed, partially processed or unprocessed, intended to be, or reasonably expected to be ingested by humans." As can be understood, this is a "commercial" definition, aimed at regulating those markets where food is considered a commodity like any other. The "scientific" definition most widely used today is that of Brillat-Savarin is his book *Physiologie du goût* published in 1825 (English translation: *The Physiology of Taste,* trans. Anne Drayton, Penguin Books, 1970), which states: "By food we mean those substances which, being subjected to the stomach, can be animalised by digestion, and so repair the losses suffered by the human body through the wear and tear of life. Thus the distinctive quality of food consists in the property of undergoing animal assimilation." We can see, then, why not every foodstuff is a food. And yet, the agricultural sector continues to be conceptualized in terms of its capacity to produce calories, as if these alone guaranteed food security. Policies focused on improving production of big commodity grains like corn, rice, and wheat—which are not so nutrient rich—should be changed if we want to ensure that people are eating healthy foods from

a variety of sources. So we need to look across the entire food value chain, which describes the full range of activities required to bring a food product from conception, through the various phases of production, to delivery to the end consumers. To fight food insecurity there needs to be a change in the prevailing cultural patterns. It is not enough to act upon the production systems. For example, food insecurity is not just a developing world issue; in fact, about 25% of Americans are food insecure, even though the United States is a high-income country (See Chap. 5).

It is therefore urgent to initiate coherent and robust food education programs right from early childhood, when our cognitive maps are formed. And it is also essential to inform citizens in a non-distorted way about the difference between *food safety* and *food security*. While the former conveys the safety of the food ingested, the latter is about the availability of food in sufficient quantities to prevent the risk of hunger and/or malnutrition.

As regards food safety, it is important to highlight the difference between the notions of hazard and risk. The former is an undesirable event for a person or an object or a situation that may cause harm. A risk is the likelihood that a person may be harmed or suffer adverse health effects if exposed to a hazard. Human beings eat food every day, hence they are exposed to a risk; however, this risk is strictly related to the quantity and quality of food that is eaten. Clearly, the risk for the consumer is not the same in all parts of the world. In the year 2000, Europe decided to apply a theoretical model developed by WHO and FAO—the risk analysis model—indicating the dimensions of the various types of risks. The model is managed by the EFSA (European Food Safety Authority). It is fair to say that Europe has developed one of the best on-going systems for food risk analysis, even though much remains to be done. (For details, see European Commission 2014, "Food". http://www.ec.europe.eu/food/index_en.hnt.EFSA, 2014. http://www.efsa.europe.eu/en/topics.htn)

We have already mentioned the importance of the fight against food waste and the need to reduce meat consumption, as strongly emphasized by the recent EAT-Lancet Report, signed by 37 scientists from different countries (https://eatforum.org/eat-lancet-commission/eat-lancet-commission-summary-report/). In regard to meat consumption, a valuable aid for the environment and for those who, for cultural or other reasons, still cannot give up a diet based on animal proteins, is offered by stem cell biology. With this technique, terminally differentiated cells (for example, muscle or skin cells) can be genetically reprogrammed which, multiplied ad infinitum in an appropriate culture medium, are differentiated into cell types of interest for food production, as well as for medicine. (See Bryant and Barnett (2018), which explains how all this takes place). It is thus possible to produce meat directly in the laboratory, the so-called "eco-friendly burger", thus preventing animal suffering, to the delight of animal rights activists, and at the same time benefiting from the ecological balance of the planet (Tuomisto 2019). It can be surmised that in the near future the cellular meat of the post-animal bio-economy will radically change the entire food industry, although the not insignificant question of the economic feasibility of cultured meat remains open. (For details, see Godfray et al. 2018).

The reformed Committee on World Food Security (CFS) seems best placed to take center stage in implementing a global education compact on sustainable food security and nutrition. It already has provisions for the involvement of a wider range of stakeholders, including the private corporate sector and a number of civil society organizations, and its mandate was broadened following its reform in 2009. The CFS envisages enhancing coordination at national and regional levels, promoting accountability, and developing a global strategic framework for food security and nutrition.

3.3 The Third Urgent Movement

I turn finally to a third direction in which it is urgent to move in order to feed humanity and reduce the overall environmental impact, and that is the importance of intervening on the economic-institutional structure of the entire agri-food sector, which is characterized by a process of oligopolistic concentration never seen before. Today, a handful of mega-corporations control the world seed and agriculture market. In 1981, there were more than 7000 companies operating in this sector, but currently four groups (Bayer-Monsanto, Dow-Dupont, Chem China—Syngenta, BASF) control almost 90% of the entire market. The formal justification for this is well known: in order to fully exploit the economies of scale, and in order to confront the food needs of a population that is increasing by 80 million per year, the company size must be increased. It matters little that agreements of this kind back farmers into a corner, seriously compromise biodiversity, and reduce the spaces of competition, with the inevitable increase in food prices. In other words, mega-mergers are defended on the grounds of greater efficiency in serving farmers and consumers. But whether that efficiency is worth the side effects to massive consolidation—possible price hikes and less competition in the marketplace—is an open question. In essence, should people put faith in a few large companies to shepherd consumers and farmers into a world that can responsibly feed a growing global population?

But there is more. The top ten processing companies control 70% of the entire world food market, acting as funnels, as oligopsonists, to the production of the over five hundred million farms in the world. It is truly a paradox: at the same time as the praises of free competition in the economy are being sung, unprecedented processes of business and capital concentration are tolerated. Not only that, but in a world where international arbitrations are emerging (CETA is a clear example) that offer companies the power to sue national governments accused of implementing actions deemed to restrict free competition, the concentration tolerated on the supply side of the offer greatly reduces the spaces of freedom of citizens and their organizations. This helps us to understand why, in Europe and elsewhere, there has been a rise in farmer's markets, direct sales, experiences of community-supported agriculture, and other initiatives. These spontaneous initiatives speak of the widespread concerns in the face of the strong power held by the major multinational seed companies, whose market share grew from 22% in 1996 to 55% in 2013. According to

the 2013 report of the FAO's ETC Group, 59.8% of the seed market and 76.1% of the agrochemical products sold in the world are controlled by the four aforementioned groups (http://www.etcgroup.org/sites/files/ETCCommonCharityCartel_March2013/pdf).

The main point is that the dominant corporations have become too big to feed humanity in a sustainable way, too big to operate on equitable terms with other food system actors, and too big to drive the types of innovation we need. (See iPES Food 2017).

In light of the foregoing, we can see why it is necessary to adopt a new paradigm for the agri-food sector, built on sturdy pillars (See Chap. 7). Here I will mention just a few of these. First, food prices must be determined taking into account the full cost principle, that is, in business models they must take into account the positive and negative externalities generated by food production. In particular, we must take into account the externalities that impact the natural capital, which continues not to be the subject of any type of assessment. It should not be surprising, then, if our land and water systems continue to degrade more and more, generating real poverty traps in many parts of the world. The argument—too often used—according to which the current method of accounting would be good for consumers because they would only be interested in "paying less, to consume more" is both factually false, as the empirical evidence suggests, and ethically unacceptable. In reality, today's consumers want to "consume better and pay the right price".

Second. Agriculture needs to be included among the strategies aimed at mitigating climate change. This is because protecting and conserving carbon stocks is just as important as the issue of carbon emissions. The carbon stored in agricultural soil must find expression in some metric, whether monetary or non-monetary. Only if we move to macro-level policies based on the accumulation of carbon as a stock rather than on its use as a flow will it be possible to arrive at an appropriate economic assessment standard. (For a concrete proposal, see Porter and Wratten (2014)).

Third. It is urgent to intervene on the current models of consumption, still dominated by ancestral fashions resulting from obsolete social norms of behavior that, today more than ever, are the victim of the many attempts to manipulate people's cognitive maps through the unscrupulous use of personal profiling made possible by the new digital technologies. It is therefore a question of operating at both the cultural level (schools and universities that explain to young people the enormous advantages, for example, of the Mediterranean diet) and the political-institutional level, to ensure that the environmental sustainability of food and its nutritional value are always considered together—and not separately, as still occurs—when it comes to enacting laws or regulations.

Fourth. We need to very quickly address the issue of land grabbing, demanding, in terms of international law, that land deals made by investors in advanced countries and those in transition with African and Latin American states include at least the Equator Principles, the international standards set forth by the World Bank that include clauses intended to allow the export of products grown in the country provided that the local food requirements have been met. These standards also provide

for termination of the contract if the investor behaves in an unfair or malicious manner. In reality, not only are these standards ignored, but what is worse, the BITs (Bilateral Investment Treaties) provide for so-called stabilization clauses: such contracts prevail over any new laws of the host country. This represents a real juridical monstrosity, as well as a serious ethical wound. (The Land Matrix database has been in operation since 2012, built on the basis of information gathered at the local level by civil society organizations and research centers. The initiative, which is private and supported by the German Cooperation Agency GIZ (Gesellschaft für Internationale Zusammenarbeit), deals with the land rights of local communities. The major predators, in addition to the United States, include countries such as the UK, the Netherlands, China, India and Brazil).

Fifth. The time has come to tackle the troublesome question of patents. As we know, the exclusive rights for new plant varieties last for 15 years (30 years for trees). But after 15 (or 30) years, it is obvious that the patented varieties will already have become obsolete and therefore no longer usable in farming. They will therefore be replaced by new varieties, to which another 15 (or 30) years will apply, and so on. Now, since we are talking about food, something that is essential to human survival, it is evident that questions arise such as: is it permissible to patent the genetic variability of plants destined for food according to the modalities in force? Can the patent holder change at will the link between product quality and place of production? What limits should be placed on the economic exploitation of the patent to avert the risk of countries losing food sovereignty? These are questions that do not arise for patents on other goods. In the case of food, however, with the current patent system, the agricultural sector is dependent economically on the industrial one, since, in addition to the purchase of seeds, the farmer is also obligated to buy the raw material needed so that the seeds can produce. It is well known, in fact, that some of the companies that hold a patent, in order to protect themselves from the illegal use of their patent, tend to insert genes in the seed that allow its germination only if a special substance sold together with that seed is used. This strategy is known as "traitor technology" in the jargon (HLPE, FAO 2017).

4 Instead of a Conclusion

As can be gleaned from the argument developed here, the serious problems related to agriculture that is both sustainable and able to feed a growing population are connected more to unequal power relations than to a lack of specific technical-scientific knowledge. This is why a more "political" approach is needed to the themes developed from various angles in this book. In 1963, FAO and GATT (now WTO) created the "Codex Alimentarius Commission" (CODEX), the main forum for international cooperation on food safety and quality standards. The Codex rules were then incorporated into the "Sanitary and Phytosanitary" agreement of the Uruguay Round concerning multilateral trade negotiations. Entering into force in 1994, the agreement was one of the first to be ratified. But since the end of the 1990s, this Forum

has in fact been abandoned to its fate. Today we need to resume that initiative, naturally adapting it to new times, if we want to avoid serious risks like the one feared by G. Mann and J. Wainwright in their recent book, *Climate Leviathan*, London, 2018. The authors foreshadow—in gloomy shades, perhaps a bit excessive—a geopolitical scenario in which the exacerbation of environmental catastrophe, with the inevitable consequence on food systems, will lead capitalist societies to create a new form of planetary government—indeed, a climate leviathan—that will impose authoritarian measures for the declared purpose of preserving life on earth, but which, in reality, will serve to ensure ever higher levels of well-being to the upper classes of the population. The stakes are serious and deserve to be taken into responsible consideration. In fact, we cannot accept trade-offs like the one between democracy and sustainability.

It must be recognized that the problem characterizing the future of agri-food systems is first of all one of public ethos, difficult to solve without bringing into dispute certain ways of organizing society, without questioning ourselves on the ways we live together and on the values held in civil society. It would be ingenuous to think that the diversity of the interests involved does not imply high levels of conflict. But the task is unavoidable if we wish to overcome both the affliction of a rhetoric at all costs and the clear-eyed optimism of those who see in the new technoscience a sort of triumphal march of humanity towards its fulfillment. Responsible people cannot fall victim to traps of this kind. This is why we urgently need to develop a novel and more robust cultural perspective. To this end, I refer to the fascinating analogy between culture and a tree suggested by the famous British poet T. S. Eliot, who observed that you can't build a tree; you can only plant one, tend it and wait for it to sprout in due time. You can, however, speed up its development with proper watering! For, unlike animals, which live in time but have no time, human beings have the ability to alter their times.

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