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Student Paper n. 49

UNRAVELLING THE NEXUS BETWEEN FOOD SYSTEMS AND CLIMATE CHANGE: A LEGAL ANALISYS

A PLEA FOR SMART AGRICULTURE, A "NEW" ORGANIC AGRICULTURE AND A WISER USE OF BIOTECHNOLOGIES IN THE NAME OF HUMAN RIGHTS PROTECTION

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ISBN: 978-88-8443-842-3

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KEY WORDS

Food Law – Climate change – Agriculture – Right to food and water – Environmental rights

ABSTRACT

"What do we eat and why?" is the starting point of this work, which focuses on the correlation between modern food production systems and climate change, considering the serious consequences this phenomenon implies in terms of food and environmental safety.

In 1992, the Union of Concerned Scientists issued a warning to humanity, urging it to promote policies that reverse the worrying trend in terms of exploitation of natural resources. Agriculture and farming were denoted among the main causes of global warming. A first indicator of the close relationship between the agri-food sector and the environment is the very fact that while these activities contribute to one fifth of global CO2 emissions, on the other hand they are directly damaged by sudden climatic changes.

A second manifesto, in 2017, confirmed that this trajectory has not deviated. Questioning the principles that today characterise our food regime is the prerequisite for any discussion about the responsibility to build the foundations of a sustainable production system. The promotion of a legislative framework that favours a green agricultural model and a healthy lifestyle is too often considered a mere political or moral duty. This research intends instead to reflect on the existence of a government's concrete legal responsibility. National governments, ignoring countless scientific opinions drawing attention to the unsustainability of the current *modus operandi*, deny their citizens the enjoyment of fundamental rights, such as the right to food, water, and a healthy environment.

In this context, the jurist can provide added value: the activities of which the Food Supply Chain is constituted form a complex system result of which is a violation of human rights. This conclusion has been possible thanks to the recent jurisprudential development and to an environmental sensibility that has encouraged, for example, a group of breeders, farmers and beekeepers, to denounce the EU policies for the mitigation of climate change in front of the CJEU. It is therefore in the perspective of the respect for human rights that the phenomenon of global warming is investigated, not considering it a mere environmental problem. Of course, the impacts of climate change on the environment are disastrous; however, several other economic, social and health negative externalities affect the structure of the food chain.

The analysis of the international legal system, as well as of the European and Australian legal systems in particular, confirms that environmental problems continue to be addressed following an old blueprint. The policies of mitigation and adaptation to climate change contain few references to the current food production system, even less information about the commercial and financial dynamics developed around food products, and the efforts to involve the major actors of the Food Supply Chain in the necessary reforms are still rare.

Environmental law continues to be considered a minor matter, incapable of informing and regulating all human activities that are likely to have an impact on ecosystems, as would be desirable.

Only when looking at the agri-food sector in light of the principles of environmental sustainability and respect for human life, a more correct assessment of the costs of the entire structure is possible. This is the so-called true cost accounting analysis, which can be applied to both agricultural production systems and food distribution systems and consumption models.

The opening chapters of this research contain a thorough analysis of the main agricultural production systems - conventional, GMO and biological - bringing to light positive aspects but also negative ones of each of them - for example, the paradox of the "industrial organic" and the perverse effect of the organic certification system, which ends up excluding small farmers from the market, favouring large companies that can afford to bear certification costs and bureaucratic obligations.

Also, GMO agriculture: a certain scientific doctrine describes it as the key to establishing a sustainable agricultural model, not needing fertilizers and being best suited to the new climatic conditions on the planet; others highlight problematic issues of intellectual property and civil liability in case of contamination and, even more urgent, the question of the loss of biodiversity caused by the spread of monocultures of so-called "cash crops", such as corn and soybeans, to the detriment of more nutritious but less profitable cereals and legumes.

The research proceeds to investigate the practice of food distribution, which now takes place mainly through global channels, driven in most cases by the same multinational companies that control the stages of cultivation and processing of food crops. Food is now marketed like any other goods on the market, therefore losing its cultural and social connotation; it is also subject to financialisation, a process that has contributed to aggravating the financial crisis that occurred between 2007-2008, when the price of food soared without this having depended on the physical availability of food.

Finally, reference is made to the role of the consumer in the food chain: as a final purchaser of the products, he retains a certain decision-making power, despite the pounding marketing work going on underway. The consumption model that is now imposed in the Western society, which is still expanding, promotes a physical and mental detachment between consumers and producers, and tends to over-consumption. It helps to distort the relationship between humans and the food they consume, resulting in unhealthy eating habits and in the spread of diseases and eating disorders resulting in growing health costs.

The picture stemming from this multidisciplinary analysis is clear: the zero-emissions-target can only be reached through a reform of the agri-food system. The same definition of Food System Governance was born while analysing the connection between global climate change and food security, in particular of their impact on the ecosystem, as well as on a whole series of internationally recognised human rights.

First and foremost, the right to food: the rapid growth of the global population and the simultaneous decrease in agricultural productivity put at risk the ability to produce a sufficient quantity of food. Furthermore, the mere availability of adequate quantities of food is no guarantee of a real and adequate supply, which is linked to economic, financial and political events too. This has been made clear with the definition of food security presented by the FAO at the 1996 World Food Summit and widely adopted on the international scene. According to this definition, the term indicates a situation in which "all people, at all times,

have physical, social and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life."

Also, the right to water, which has been recognised more recently by the UN and is constantly endangered by obsolete agricultural production techniques. Today, the agri-food sector consumes or pollutes 92% of the water resources available to humans. Other factors contribute to water scarcity: reckless choices with respect to the geographical characteristics of the places of production (for example, the breeding of cattle in Australian desert areas to satisfy the ever-increasing consumption of meat), and a global trade structure. These and various other activities lead to an increase in the water footprint of the Food Supply Chain. Increasing quantities of food, feed and bio-fuels are exchanged from one country to another, drawing significant losses and shifts in water resources.

Some jurists theorise that these pressures on human rights are sufficient to justify the ascertainment of a legal responsibility on the part of state governments, which, in the vast majority of cases, are signatories of international agreements to protect human rights. In this context, climate change is the result of an inadequate legal framework that still allows environmental degradation to levels that threaten the survival of the human species itself.

In conclusion, the international recognition of a personal right to enjoy a healthy environment, already declared at constitutional level in different countries of the world, is a fundamental tool to push public and private actors to promote sustainable policies and business models. In the absence of such recognition, the link between a healthy environment and the protection of human rights remains fragile, and, to respond to the initial question, leaves to the individuals the task of giving the effective value to a food product that comes from an environmentally and economically sustainable Food Chain.

The market price of food, in fact, does not reflect the real environmental cost that its production entails nor the impact on farmers and consumers and animal welfare.

ABOUT THE AUTHOR

Alessandra Telch (telch.alessandra@gmail.com) earned her J.D. from the University of Trento (2019). She first developed an interest in Food and Agricultural Law during her fourth year of studies, while working as a trainee for the consultancy firm Euroconsulting (Bruxelles) in the field of agriculture and forestry, agro-industry, food safety and food security. The curiosity for the subject encouraged her to investigate on the connection between Food Systems and Climate Change. She earned her J.D. in Law discussing a thesis that was the basis of this paper, which is the result of a research period at the University of New England, Armidale (Australia), and was drafted under the joint supervision of Prof. Umberto Izzo from the University of Trento and Prof. Mark Perry from the University of New England. All opinions expressed and possible errors are attributable exclusively to the Author.

«Some people say that we are not doing enough to fight climate change. But that is not true. Because to "not do enough" you have to do something. And the truth is we are basically doing anything.

Yes, some people are doing more than they can but they are too few or too far away from power to make a difference today. Some people say that the climate crisis is something that we all have created. But that is just another convenient lie. Because if everyone is guilty then no one is to blame. And someone is to blame.

Some people – some companies and some decision makers in particular – have known exactly what priceless values they are sacrificing to continue making unimaginable amounts of money.

I want to challenge those companies and those decision makers into real and bold climate action. To set their economic goals aside and to safeguard the future living conditions for humankind.

I don't believe for one second that you will rise to that challenge. But I want to ask you all the same. I ask you to prove me wrong. For the sake of your children, for the sake of your grandchildren. For the sake of life and this beautiful living Planet.

I ask you to stand on the right side of the history. I ask you to pledge to do everything in your power to push your own business or government in line with a 1.5 degree world. Will you pledge to do that?

Will you pledge to join me and the people all around the world in doing whatever it takes?»

Greta Thunberg, speech delivered at the World Economic Forum –

Davos, Switzerland, 22-25 January 2019

I would first like to thank the University of Trento for giving me the opportunity to develop my own thinking and independence, creativity and intelligence, and particularly my thesis advisor Professor Umberto Izzo, who allowed me to enhance my genuine interest in Food Systems through this work.

I would also like to thank the University of New England in Armidale and all the people who contributed to make the most out of my experience in Australia. Among them, I am gratefully indebted to Professor Mark Perry for his very valuable guidance and my dear friend Gaynor for her kindness and hospitality.

I must also express my very profound gratitude to my beloved family and partner for providing me with unfailing support, confidence and courage throughout my studies and through the process of researching and writing this thesis.

Finally, I would like to express my sincere gratitude to the Slow Food movement for teaching me to be thankful to the outstanding art and skills of women and men capable of producing food that is good, clean, and fair.

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INTRODUCTION

The human race is faced with a number of major ecological and economic problems: the warming of the planet, drought, floods, famines, widespread poverty and mass migrations. In 2017 only, 8.6 million people sought refuge from floods, 7.5 million people from storms, and 1.3 million people from desertification - running away from their homeland.[1] According to UN researchers, there will be 200 million people escaping all sorts of weather and climate extreme events in 2050.

The causes of these problems are wide-ranging and complex, but there is a common denominator: climate change. Climate change is the ultimate aftermath of humankind evolution since the industrial revolution, which has taken more from Earth than it has offered back. The quest for continuous growth and ever-expanding markets and production is having such disastrous impacts on Earth's ecosystems, that most scientists agree that humanity is facing a distinct geological age, dubbed the *Anthropocene* – from the Greek '*anthropos*'.[2] The impacts of human activity will probably leave trace in the geological stratigraphic record for millions of years, thus suggesting that a new Era has begun.[3] However, the formal definition of *Anthropocene* is still controversial, and rises questions that go beyond geology - making scientists 'arbiters' of the human-environment relationship. By defining a start date, for example, scientists could assign historical responsibility to particular countries or regions, or 'normalise' worldwide environmental change, as suggested by the scientific literature.[4]

Almost 30 years ago, the Union of Concerned Scientists and more than 1,700 independent scientists, including the majority of living Nobel laureates, penned the 1992 'World Scientists' Warning to Humanity'. These professionals called on humankind to curtail environmental destruction and cautioned that 'a great change in our stewardship of the Earth and the life on it is required, if vast human misery is to be avoided.' In their manifesto, they showed that humans were on a collision course with the natural world. They expressed concern about current, impending, or potential damage on our planet involving ozone depletion, freshwater availability, marine life depletion, ocean dead zones, forest loss, biodiversity destruction, climate change, and continued human population growth. They proclaimed that fundamental changes were urgently needed to avoid the harmful consequences our present course would bring. Today, looking back at their warning and evaluating the human response by available data, humanity has failed to solve all the foreseen environmental challenges (with the exception of stabilising the stratosphere ozone layer). This is the gloomy conclusion of more than 15,000 scientists from 184 countries that signed a second warning, 'World Scientists' Warning to Humanity: Second Notice', published in 2017. Especially troubling is the current trajectory of potentially catastrophic climate change due to rising greenhouse gas emissions

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[1] De Weert O 'Flucht vor dem Klima' (November 2018) 11 *Arte Magazin* 28-29.

[2] Crutzen P J and Stoermer E F 'The Anthropocene' 41 IGBP Global Change Newsletter 17–18 (2000); Steffen W, Crutzen P J and McNeill J R 'The Anthropocene: are humans now overwhelming the great forces of nature.' 36 Ambio 614–621 (2007).

[3] Zalasiewicz J et al 'The Anthropocene: a new epoch of geological time?' A 369 Phil. Trans. R. Soc. Lond. 835–841 (2011).

[4] Lewis L S and Masin M A 'Defining the Anthropocene' 519 *Nature* 171-180 (2015).

from burning fossil fuels, deforestation, and agricultural production - particularly from farming ruminants for meat consumption.

Until recently, the relationship between food production and climate change was not taken into consideration. Nevertheless, the interest in the impact of food systems on the natural environment has risen in recent years, as scientific literature reveals the devastating effects of industrial agriculture on Earth's ecosystems and activists denounce the uneven and unsustainable commercial practices that characterise the entire Food Supply Chain. Eventually, also the impact of consumers' choices and their behaviour concerning food purchasing and consuming – or better, wasting – has been given more and more attention.

Now more than ever, it is time to take advantage of the outcomes of scientific research and academic literature to maximise common people's awareness on the nexus between food and climate change. Governments all over the world are asked to act to tackle climate change and its disastrous effects on nature and human livelihood: such an important task will not be accomplished without a fundamental reformation of the current food systems governance, both at an international and regional level.

The aim of this work is to identify the main obstacles to a shift towards sustainable food systems and develop proposals to overtake them. The method of true cost accounting is implemented, thus revealing the hidden costs of food production, retailing and consumption, and how these activities are affecting the Earth's ecological balance and threating humans' well-being. A glance on current and developing policies and legislations accompanies scientific and academic considerations on the evidence of climate change and its impacts on wealth. Particular importance is given to European and Australian laws, rulings and policies: the two continents express differentiated approaches to the climate change issue, which are reflected in both their legislative and regulatory framework. A comparative approach of this kind is more likely to give a complete overview of the various attitudes adopted towards the common challenge of global warming mitigation and adaptation.

First of all, scientific evidence of the occurring climate change and its main sources – among which agriculture and food production play a particular role - is provided. Concerning food production, a depiction of the widespread industrial agricultural model is followed by the description of diverse possible future scenarios, supposing that biotechnologies, organic agriculture, or alternative farming systems are embraced as solutions for nowadays climate-related problems.

Once aware of the interconnectedness of food production and food retailing and consumption, further reasoning concerns the evolution of the agri-food sector and the rise of multinational companies. Their businesses are affecting the environment as well as farmers and consumers' livelihood, the latter being the protagonists of the last section of this writing.

Through the process of sketching the Food Supply Chain, this work aspires to discover the real price of food, not merely in terms of price payed by the consumer at the moment of purchase, but more widely in terms of environmental, economic, and social costs. This entails enlightening the interrelation of a wide range of activities and outcomes, as well as different actors, which can be regrouped and identified as participants of the 'food system'.

Being broader than the prevalent concept of Food Supply Chain, the idea of 'food system' has been more recently developed to assess the externalised costs of food production and consumption. The practice of true cost accounting is not an end unto itself, indeed, it becomes the starting point of a deeper analysis on the possibility of reforming the existing

food system to make it suitable for adapting to current global challenges and desired outcomes. The required properties are far from simple to obtain, given the inextricable web of actors involved, and the multiple and unforeseen side effects that could be generated by a single alteration of the food system network.

The impacts of food production and consumption on humans' livelihood appear in their alarming extent, suggesting that fundamental human rights are heavily threatened by the conventional asset of food production, trading and consumption model. This breach can no more be ignored by states and international organisations. In the final chapter, the conventional depiction of a sustainable development framework is evaluated as incomplete and likely to fail in ensuring concrete action against global warming. A human rights-based approach is needed to replace the scant legislative framework in this field, adequately recognising the deep connections between agriculture, environmental protection, and a healthy life.

Currently, despite appreciable efforts on international fora, environmental laws are going backwards, their legitimacy and feasibility being challenged.[5] Perceived as an exceptional and secondary body of rules, environmental law is more and more isolated. Environmental crisis brings new regulations which, instead of being implemented, are ignored and intended to regress while the 'business-as-usual' approach inevitably succeeds. Whereas both the UN and the majority of national governments acknowledge that climate change and the responses to it can impact on human rights, there is poor agreement on the correlated obligations of governments and private actors to address the problem. Approaches to the framing and implementation of environmental policies are contorted and increasingly reductive.

The main reason for such problematic formulation does not originate from poor knowledge or information in itself; rather, from the manner this information is interpreted and strategically applied to fragmented and sterile policies. To stop this adverse cycle, which now threats to bring humanity to the brink of extinction, the environmental impact of *all* laws, regulations, and policies on human livelihood and human rights should be taken into account – rather than insisting with inefficient, disconnected environmental provisions. The 'back-and-forth' regulatory cycles would thereby be avoided, and a rigorous protection would be ensured.

The critical assessment of true environmental, social and health impacts of current human activities (agricultural practices and all activities which can be traced back to the Food Supply Chain in particular) is an essential tool to highlight the necessity of a formal recognition of the human right to a healthy environment. The latter, in turn, is key to the process of reforming the agri-food systems in order to make them compatible with the current environmental situation.

[5] Bartel R 'Is environmental law the poor cousin or the canary in the coalmine? The case for treating all regulatory failures as having common cause(s)' Speech delivered at The Rural Crime and The Law Conference (29-30 November 2018, Armidale, Australia).

1 THE (UN)SUSTAINABLE INTENSIFICATION

Everything that contributed to build modern human society is provided by nature. Humans will continue to need Earth's natural resources to survive and thrive. Increasingly, research demonstrates nature's incalculable importance to people's health, wealth, food and security. All human activity relies ultimately upon services provided by ecosystems, agriculture above them all, confirming that the planet's natural resources are fundamental to social and economic development. However, the impact of such activities has been largely ignored until recent times, when an ever-increasing number of research and policy papers built the case that anthropogenic pressure on natural resources is far too high. In particular, the impacts of food production models and food consumption patterns are gaining attention worldwide as they are gradually recognised among the main drivers of climate change.

1.1 The physical science basis of climate change and the emergence of agriculture as a leading cause for global warming

The consensus of the international scientific community is that the world is warming, due mainly to the 'greenhouse effect' generated by rising levels of anthropogenic greenhouse gases (GHGs) emissions in the Earth's atmosphere. The initiation of various feedback loops, which are difficult to predict and ever-more frequent, exacerbates the problem. Global warming is often stated as a mere threat to humankind, but as writer and environmental activist Branagan M points out, it is a current reality.[6]

1.1.1 The Intergovernmental Panel on Climate Change (IPCC)

The starting point for any in-depth analysis of the physical science basis of climate change is the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC). The IPCC embodies the leading international authority for the assessment of climate change. It was established by the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO) in 1988, to provide globally a clear scientific view on the current state of knowledge in climate change and its expected impacts on natural and human environment. That same year, the UN General Assembly endorsed the action by WMO and UNEP in jointly establishing the IPCC.

The IPCC itself does not conduct any research nor does it monitor climate related data or parameters. Its role is to review and assess updated and relevant scientific, technical and socio-economic information available worldwide, to offer a better understanding of the dynamics of climate change. The body refers to climate change as a change in the state of the climate that can be identified by deviations in the mean and/or in the variability of its properties, and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcing (such as modulation of the solar cycles or volcanic eruptions) and/or persistent anthropogenic changes in the composition of the atmosphere or in land use.

The Fourth Assessment Report of the IPCC is of particular importance because it builds upon more comprehensive data, a broader and more sophisticated analysis of data, and a

[6] Branagan M 'Global Warming, Militarism and Nonviolence: The Art of Active Resistance' (Palgrave Macmillan, 1st ed., 2013) 1.

more complex analysis of statistics and figures. As a result, it provides a more in-depth scrutiny and assessment of uncertainty ranges as compared to previous reports. It clearly categorizes human activities as drivers of climate change, its major effects being changes in the atmospheric abundance of greenhouse gases and aerosols, in solar radiation and in land surface properties, which are destabilising the energy balance of the climate system.

> 'Global atmospheric concentrations of carbon dioxide, methane and nitrous oxide have increased markedly as a result of human activities since 1750 and now far exceed pre-industrialised values determined from ice cores spanning many thousands of years (…) The global increases in carbon dioxide concentration are primarily due to agriculture (…). The understanding of anthropogenic warming and cooling influences on climate has improved since the Third Assessment Report, leading to very high confidence that the global average net effect of human activities since 1750 has been one of warming with a radiative forcing of +1.6 Wm^{-2}.[7]

The report underlines that human influences have very likely (that means a greater than 90 percent probability of occurrence) contributed to sea level rise during the latter half of the 20th century; likely (that means a greater than 66 percent probability of occurrence) contributed to changes in wind patterns, affecting extra-tropical storm tracks and temperature patterns; and likely increased temperatures in extreme hot nights, cold nights and cold days.

As Sir Stern N stated in his paramount review, human pressures on the natural capital and the abuse of ecosystems are clearly a concause of the observed trends in temperatures both at the surface and in the oceans. Natural effects alone could not explain the global warming phenomenon.[8] However, the effects of global warming - climate change and all the correlated complications in terms of access to water, food safety, human health and biodiversity conservation - can be mitigated through the deliberate adoption of sound and effective management patterns. According to the author

> '[c]limate change is the greatest market failure the world has ever seen, and it interacts with other market imperfections. Three elements of policy are required for an effective global response. The first is the pricing of carbon, implemented through tax, trading or regulation. The second is policy to support innovation and the deployment of low-carbon technologies. And the third is action to remove barriers to energy efficiency, and to inform, educate and persuade individuals about what they can do to respond to climate change.'[9]

These first assessments rose political awareness about the importance of addressing global warming in order to mitigate its negative impact on human livelihood. The complex dynamics of global warming and climate change were further analysed by the IPCC, which continued gathering scientific evidence and statistics in the following years. As stated in its

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[7] IPCC, Working group I 'Contribution to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Climate Change 2007' (Cambridge University Press, 2007) 2-3.

[8] Stern N 'The Economics of Climate Change. The Stern Review' (Report to Prime Minister and Chancellor of the Exchequer, 2006).

[9] Ibid.

Fifth Assessment Report the evidence for human influence on the climate system has been growing since the previous assessment.[10]

By then, there already was evidence that a large share of the increase in the global average surface temperature from 1951 to 2010 is ascribable to anthropogenic increase in GHG emissions and other human polluting activities. Basing their conclusions on the available scientific literature, the working groups concluded for a growing number of aftermaths attributed to anthropogenic-induced climate change, in comparison to previous decades. In particular, impacts on physical systems (glaciers, snow, ice, rivers, lakes, floods and drought, coastal erosion and/or sea level effects), on biological systems (terrestrial ecosystems, wildfire, marine ecosystems) and on human systems (food production and livelihoods, health and economics).[11]

In October 2018, the IPCC released a last report, responding to the invitation contained in the Decision resulting from the 21st Conference of the Parties of the UNFCC to adopt the Paris Agreement. The report provides an insight on the impacts of global warming of 1.5°C above pre-industrial levels and related global GHG emissions trends.

According to the latest findings, global warming is likely to reach 1.5°C between 2030 and 2052 if it continues increasing at the current rate, largely due to anthropogenic activity. Warming from anthropogenic emissions will persist for centuries to millennia, causing further long-term changes in the climate system. Climate-related risks for both natural and human systems are higher for warming of 1.5°C than at present, but lower than at 2°C. Reduced risks to marine biodiversity, fisheries, ecosystems and their functions, and services to humans, are not the only reason to limit the rise of global temperatures. In fact, climate-related risks to human health and livelihood, food security, water supply, human security and economic growth too, are projected to further be exacerbated with global warming of 2°C.

The good news in this alarming evidence is that there is also positive indication that rapid and radical implementation of adaptation measures can reduce the risks of climate change. In pathways limiting global warming to 1.5°C, with no or limited overshoot, as well as in pathways with a high overshoot, CO_2 emissions are reduced to *net zero worldwide* around 2050. Emissions of non-CO_2 emissions forcers (e.g. methane, nitrous oxide, black carbon emissions) are also reduced, but they do not reach zero globally. These pathways require far-reaching transitions in energy, land, urban and infrastructure, and industrial systems. As stated in the Stern review

> '[s]uch large transitions pose profound challenges for sustainable management of the various demands on land for human settlements, food, livestock feed, fibre, bioenergy, carbon storage, biodiversity and other ecosystem services (*high confidence*). Mitigation options limiting the demand for land include sustainable intensification of land use practices, ecosystem restoration and changes towards less resource-intensive diets (*high confidence*). The implementation of land-based mitigation options would require overcoming socio-economic, institutional,

[10] IPCC, Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change 'Summary for Policymakers' in *Climate Change 2014: Impacts, Adaptation and Vulnerability. Part A: Global and Sectoral Aspects* (Cambridge University Press, 2014).

[11] IPCC, Contributions of Working groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change 'Synthesis Report' (Cambridge University Press, 2014).

technological, financing and environmental barriers that differ across regions (*high confidence*).'[12]

1.1.2 How did agriculture become world leader sector in GHG emissions?

The human relationship with plants has shaped communities and driven civilisations. Around 13,000 years ago, our hunter-gatherer ancestors who inhabited the Euphrates valley collected over a hundred different species of edible seeds and fruits to supplement their diet. Approximately 11,000 years ago, the environment changed to a much colder and drier climate. Many of the grasses and cereal plants on which people depended, ceased to grow. In order to survive, they took the seeds of the most easily grown wild plants from the low-lying areas and began cultivating them in the surrounding moist soils. As cereal plants such as rye, lentils and wheat would not have been able to out-compete the natural shrubs of the area, it was necessary for the early cultivators to clear the natural vegetation. In doing so, the first agriculturalists were born.

As a more amiable climate returned to the Near East, the farming of cereals spread through the region and communities became reliant on being able to grow enough food to support their expanding populations. To increase the crops' productivity and receive the most nutrients from the cereals and vegetables they grew, the agriculturalists selected the hardiest plants for cultivation. As a consequence of this selection, the crops that were farmed began to look different from their wild counterparts. Of the 20,000 known edible plants, only around 3,000 are eaten by humans, and only around 200 of these have ever been domesticated through agriculture. Today a mere 12 cultivated plant species make up over three-quarters of human calorie intake across the world: potatoes, rice, wheat, sugar cane, sorghum, soya beans, cassava, bananas, maize, millet, beans and sweet potatoes.

For many thousands of years, since humankind began to farm and selectively breed crops, there was no real understanding of the processes by which plants of a certain size or shape passed on their characteristics to the next generation. Not until the 1850s, when an Austrian monk named Gregor Mendel gave the world the first outline of the concept of genes and an explanation of how desirable traits could be selectively bred from a plant. Consequently, botanists and farmers were able to create hybrids containing the best of various strains.

Experiments in the early twentieth century by American geneticist and maize breeder Donald Jones gave life to super maize crops, which grew faster and stronger than any others and were higher in protein. Between 1930 and 1960 crop yields rose significantly across the globe, due to the combination of breeding techniques and major advances in technology and the use of pesticides. Nevertheless, the achievements of this period, known as the 'Green Revolution', could not have been realised without *ad hoc* national and global policies. The latter incentivised farmers to increase their production, without considering the negative externalities that the deployment of the natural resources on which agriculture and food systems themselves depend would cause.

This is the reason why crops, livestock, fisheries and forestry are today listed among the major contributors to greenhouse gas emissions, land and water pollution, and soil erosion.

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[12] IPCC 'GLOBAL WARMING OF 1.5°C. An IPCC special report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. Summary for Policymakers' (Report, accepted by the 48th Session of the IPCC, Incheon, Republic of Korea, 6 October 2018) 23.

Earth's ecosystems and humankind are threatened by intensive industrial agriculture systems that are encouraging the extreme, variable and unpredictable weather conditions to which we are all subjected.

These unique characteristics place agriculture at the centre of the recent global efforts to mitigate and adapt to climate change. Notwithstanding the potential to adapt farming to changing environments, humanity's exertion will increasingly challenge conventional, resource-intensive agricultural systems, which depend on chemical inputs derived from fossil fuels and contribute significantly to GHG emissions.

1.1.3 Main challenges

In light of these considerations, the major concern is to mitigate and adapt to global warming while maintaining the capacity of the agricultural sectors to meet the world's food needs. That means, assuring food and environmental security through the building of a resilient and sustainable food system.

Global food demand is projected to increase by at least 60 percent above 2006 levels by 2050, driven by population and income growth, as well as rapid urbanisation.[13] There is scientific evidence that the environmental impacts of meeting this demand depend on how global agriculture expands. Consequently, the world now faces a threefold challenge: matching the rapidly changing demand for food from a larger and more affluent population; doing so in ways that are environmentally and socially sustainable; ensuring that the world's poorest people are no longer undernourished.[14] This challenge requires huge mutations not only in the way food is produced, but also in the way it is stored, processed, distributed, and accessed. These objectives are ambitious and will require a swing as radical as those that occurred during the Industrial and Agricultural Revolutions which occurred between the 18th and 19th century.

Since the first impacts are already evident and both drivers of and responses to climate change involve long-term time lags, urgent action must be taken now. Worldwide, climate change mitigation is needed to avoid the risks of predictable food insecurity and adapt to current or anticipated climate changes, thus reducing their harmful effects. Closing the yield gap is no easy endeavour: a diverse range of options including all the sectors of the food chain needs to be pursued simultaneously.[15] Ideally, scientific and technological innovation will bring new solutions for future farming systems, but there is no time to lose.

It is now widely recognised by scientific literature that a shift towards more sustainable farming practices will not be effective in challenging climate change without a process of radical rethinking of the whole agri-food system. That includes food production, processing, retailing and consumption. Only a holistic approach will enable us to understand the critical

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[13] Goldfray H C J et al 'Food security: The challenge of feeding 9 billion people' (2010) 327 *Science* 812-818.

[14] Von Braun J 'The world food situation. The challenge of feeding 9 billion people' (Food policy reports, International Food Policy Research Institute, 2008).

[15] Evans L T 'Crop Evolution, Adaptation, and Yield' (Cambridge University Press, 1st ed., 1993). Before agriculture, 'yield' was the ratio between the energy derived from food and the energy invested in obtaining it. Once the sowing of crops was established as a common practice, the definition shifted from an energy ratio to the ratio between the numbers of seed harvested and seed sown.

issues relevant to the solution of the food systems failure and correlated environmental, societal and economic global crisis.

In a recent report, the International Panel of Experts on Sustainable Food Systems (IPES-Food) calls for a transformation of global food systems by moving from large-scale industrial monocultures to diversified food and farming systems following agro-ecological principles.[16] It then highlights the major lock-ins that keep food systems from changing, the critical one appearing to be the concentration of economic and political power over the food system in the hands of large multinational corporations. In the case of food and farming systems, power impacts everything from the natural resource base of farms, to markets, to social relations, to policy.[17]

One central conceit of recent years holds that it is only a matter of time before trade liberalization, expanding food markets and technological development rendered hunger an obsolete issue. However, the spike in global food prices that occurred in 2008, commonly recognized as a shock to the global food system, brought back to light the challenge of localised food scarcity and the need for an adequate response to the world's food demand.

At a first sight, understanding the causes of the global food crisis proved to be difficult because of the abundance of competing contributing factors: the transformation of grain into biofuel, the rapid population growth, the escalating middle-class demand for more complex produced foods such as meat and dairy products, the process of urbanisation and the growing demand for imported food commodities in developing countries, supply side effects, and lack of investment in agriculture that resulted in diminished productivity gains and accentuated environmental degradation.[18]

At a later date, explanations accounted for the diverse factors distorting food commodity prices as a 'perfect storm'. On March 2009, an article appeared in The Guardian, reporting the words of UK government's chief scientist Professor John Beddington.[19] In a major speech to environmental groups and politicians, he warned about the 'perfect storm of food shortages, scarce water and insufficient energy resources' that threatens to unleash public unrest, cross-border conflicts and mass migration by 2030. This metaphor implied that the global food system functions well under normal conditions, while the running failure concerned the unfortunate simultaneous pressures on food commodity supplies and prices.

More recently, the media have begun to reconsider the food crisis and its causes as an event with clearly identifiable boundaries, following the explanations given by global food system experts as such as Watson R, Pretty J, Ziegler J and Lang T. Their common conclusion is that external causes originating from the interrelation of global financial crisis and food commodity prices played a major role. The disruptive dynamic of *financialization* and the

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[16] IPES-Food 'From uniformity to diversity: A paradigm shift from industrial agriculture to diversified agro-ecological systems' (Report, 2016).

[17] Gliessman S 'Toward a political economy of sustainable food systems' (2018) 42 *Agroecology and Sustainable Food Systems* 1077-1078.

[18] Rosin C, Stock P and Campbell H 'Introduction: shocking the global food system' in Rosin C, Stock P and Campbell H (eds.) *Food systems failure. The global food crisis and the future of Agriculture* (Routledge, 2012) 1-14.

[19] *The Guardian*, Sample I 'World Faces 'perfect storm' of problems by 2030, chief scientist to warn' (19 March 2009) <https://www.theguardian.com/science/2009/mar/18/perfect-storm-john-beddington-energy-food-climate>.

correlated speculation on food commodity futures are recognized as the most destructive effects of treating food as a commodity, which value is only determined on the basis of its potential return on investment compared to other commodities traded on the market.[20]

A deeper analysis sheds some light on the crisis, which is finally indicative of significant flaws in the global food system as a whole rather than of an isolated unfortunate event. There are *systematic* problems, which are likely to recur, exacerbated by factors such as climate change.

1.1.4 The implications of a global food system

Various and different food systems characterise the history of food in self-sufficient countries and regions, with occasional food crisis depending on natural catastrophes or armed conflicts. The transition towards a global food system has occurred more recently, in the late 1940s. While the developed world invested massively in agricultural intensification and industrialisation, corporations grew larger and stronger, privileging the market reasoning that facilitates the movements of goods across vast areas and the centralisation of market relations in the global economy. Farming, too, has been reduced to a mere component in a larger system of agri-business, with many small farmers becoming subcontractors to large corporations. Acting solely for profit, the big agri-business companies ignore the many social and environmental negative externalities that act as premises for the functioning of the system itself.

The whole Food Supply Chain (FSC) has experienced fundamental changes and has become more globalised and marked by upward trends in scale of production and economic concentration. Farmers are increasingly confronted with a distant power structure composed of a few multinational firms that dominate the retention, distribution, and inputs of the agri-food chain. As the High Level Panel of Experts on Food Security and Nutrition (HLPE) pointed out in a recent report, complexification and growing concentration in food systems gave birth to agri-food industries that produce, sell and promote foodstuffs responding to market incentives, consumer behaviour, policy signals (in particular taxes and subsidies) and regulations.[21] Currently, the incentives tend to favour the

> 'selection of varieties for high and consistent yield rather than nutrition or health properties; production of poultry and pig meat and milk from intensive farms; processing that increases shelf-life, reduces food preparation time and still tastes palatable but often entails increased fat, sugar and salt content; vigorous marketing especially to children, which can contribute to overconsumption and increased consumption of less healthy foods.' [22]

The report addresses a further, often hidden, aspect of food production systems: the nutrient content of the food. Paradoxically, there still is unequal access to nutritious food while overconsumption and obesity are arising, as a result of a food production systems poorly

[20] On commodity markets economic assets are converted into financial instruments and traded accordingly. Return on Investment (ROI) is a performance measure used to evaluate the efficiency of an investment or compare the efficiency of a number of different investments.

[21] HLPE 'Sustainable agricultural development for food security and nutrition: what roles for livestock?' (2016).

[22] Ibid, 55-56.

matched to dietary behaviours and needs.[23] In the next chapters, multiple channels across the food system will be found to threaten human health, and their impacts are even more severe when examined systematically. Usually, health impacts are perceived as unrelated to food systems governance. Their interrelationship becomes visible only when adopting a holistic view. These impacts disproportionately affect the most poor and vulnerable in our societies, and are compounded by climate change, poverty, inequality, poor sanitation, and the profound disconnection between food production and consumption.

Reasoning about an alternative food system requires an open-minded approach that considers not only environmental issues but social, economic and health issues as well. A sustainable food system, capable of dealing with the multiple challenges of climate change, is founded on the recognition of the qualities of food, including the moral value of the right to food and its importance as a vital part of communities, families and traditions.

1.2 Focusing on the connection between agriculture, food and climate change

Adopting the goals of the UN 2030 Agenda on Sustainable Development and the Paris Agreement on Climate Change, the international community took responsibility for building a sustainable future. However, meeting the targets of eradicating hunger and poverty by 2030 while addressing the threat of global warming will require a profound transformation of food and agriculture systems worldwide. Raising awareness about the true costs of food production is a prerequisite for a successful shift towards sustainable food systems, thus providing concrete responses in the face of climate change. How can true cost accounting contribute to this process, and how can farming provide a meaningful support to the achievement of the common goals set by the international community?

1.2.1 The interdependency between agriculture and climate

There is science-based evidence that agriculture and the food sector as a whole bear a major responsibility for climate change. Taken together, agriculture, forestry and land-use change, account for about one-fifth of global GHG emissions.[24] Carbon dioxide emissions from agriculture are mainly attributable to losses of above and below ground organic matter due to changes in land use, such as conversion of forests to pasture or cropland, land degradation and erosion, salinization and compaction of soil. The bulk of direct emissions of methane and nitrous oxide, two potent GHGs, is mainly the result of enteric fermentation in livestock, application of nitrogen fertiliser and manure and rice production in flooded fields. The flow of phosphorus through the food chain is for the most ascribable to the expansion of the livestock sector.[25] All these harmful impacts can be reduced through the implementation of better management practices, aiming to achieve an optimal level of livestock and crops.

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[23] Butler C and Dixon J 'Plentiful food? Nutritious food?' Rosin C, Stock P and Campbell H (eds.) *Food systems failure. The global food crisis and the future of Agriculture* (Routledge, 2012).

[24] FAO 'The State of Food and Agriculture 2016 - Climate Change, Agriculture and Food Security' (Report, 2016).

[25] RISE Task Force 'Nutrient Recovery and Reuse in European Agriculture. A review of the issues, opportunities and actions' (Report, 2016).

Nevertheless, these efforts will not be enough. In fact, the share of the food system at large in total global GHG emissions is even greater: further emissions are generated by the manufacture of agrochemicals, by fossil energy use in farm operations, and in post-production transportation, processing and retailing.

Given the reliance of agriculture on natural finite resources, as planetary processes such as climate change or resource exhaustion become more prominent, agriculture becomes central in social and academic debates. At the same time, farming is affected by climate change: weather and climatic conditions continue to be a dominant factor for the success of any agricultural practice, which primary task is to provide essential nutrients and other natural products for the human population.

Human beings are omnivores and consume, in varying proportions, a diet of vegetable and animal products. Current and expected impacts of climate change on the agricultural sectors are alarming. Food security and nutrition in different parts of the world, under different global warming scenarios, are threatened. In many regions, agricultural production and livestock are already affected by climate related phenomena such as rising temperatures and increased temperature variability, changes in importance and frequency of precipitation, desertification, increasing frequency of extreme weather events, salinization of arable land and freshwater. The rising sea levels and the acidification of the oceans are pushing millions of farmers away from their homes. Farmers depend on healthy soils and access to safe freshwater for their survival, therefore these threatening events impact directly their livelihoods.[26]

The crops that humans grow for their sustenance need specific conditions in order to thrive, including optimal temperature and sufficient water resources. If the temperatures exceed the plants' optimal level, or if enough water or nutrients are not available, yields are destined for falling. An increased frequency of extreme events, especially floods and droughts, also harms crops and reduces yields. Many weeds, insect pests and diseases thrive under warmer temperatures, wetter climates and increased levels of atmospheric CO_2. Also, more extreme temperatures, combined with decreasing rainfall, can prevent crops from growing at all. Heat waves, which are expected to become more common under climate change, straightforwardly threaten livestock: heat stress increases animals' vulnerability to diseases, thereby reducing fertility and meat and milk production. Climate change is also likely to modify the prevalence of livestock parasites and diseases.[27]

According to the IPCC Fifth Assessment report, the negative effects of climate change on crop and terrestrial food production are evident in several regions of the world, while positive trends are visible only in some high-latitude regions.[28] The damaging effects of increasing temperatures on crop yields, already identified by the previous report, are confirmed. Changes in climate and CO_2 concentration will probably enhance the distribution and increase the competitiveness of agronomically important and invasive weeds, although the effects on disease pressure on food crops are still uncertain. Climate change will negatively

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[26] Gerrard M B 'Climate Change and Human Trafficking After the Paris Agreement' (2018) 345 *U. Miami L. Rev.* 345-368.

[27] FAO 'The State of Food and Agriculture 2016 - Climate Change, Agriculture and Food Security' (Report, 2016).

[28] IPCC, Contributions of Working groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change 'Synthesis Report' (Cambridge University Press, 2014).

impact the production of major crops (wheat, rice, maize) in tropical and temperate regions. The noxious effects on yields will be consistently in low-latitude countries in Africa, Europe, Asia and Central and South America. Projected impact varies across crops and regions and adaptations scenarios, but generally the risk of more severe impacts increases after 2050. Climate trends are affecting the abundance and distribution of aquatic species and aquaculture production systems too.

The body of scientific evidence that climate change is a serious global threat, affecting all aspects of food and environmental security, is at this point overwhelming. Food systems, as integrated activities affected by the impacts of climate change on the supply and demand for food, were not strongly represented in the Fourth Assessment Report (AR4). Indeed, the Fifth Assessment Report (AR5) deepens and evaluates the evidence of the impacts of climate change on both production (crops, livestock, fish, forestry) and non-production (incomes, processing, transport, storage, and retailing) factors.[29]

AR4 analysed food, fibre and forest production as single compartments, rather than as parts of the complex of food system activities that give birth to a number of food and environmental security outcomes related to availability and utilization of, as well as access to, food. Since its publication, dating back to 2007, there have been several periods of rapid food and cereal price increases following climate extremes in essential producing regions. These and other major events contributed in drawing large attention from the international community and the scientific literature towards a holistic approach.

According to IPCC's Special Report, mitigation and adaptation options in the agriculture and land use sector are key.[30] They comprise agricultural and forest options, sustainable diets and reduced food waste, soil sequestration, livestock and manure management, and reduced deforestation combined with afforestation and reforestation.

The disruptive impact of climate change on agriculture and the implications for food security are by now evident, as evident is that agriculture and food production play a major role in finding a way to keep the increase in global temperature below the crucial ceiling of 1.5°C.[31]

Meeting this goal while addressing the threat of climate change will require a profound transformation of food and agriculture systems worldwide. Climate change already has important implications on food security in all his dimensions: food availability, access to food (because of increasing food prices and food price volatility), utilisation of food (especially the nutrition status of poor and vulnerable people) and stability in the access and availability of food.

How can the world feed more than 9 billion people by 2050, simultaneously advancing economic development and reducing pressures on the environment?

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[29] Ibid.

[30] IPCC 'GLOBAL WARMING OF 1.5°C. An IPCC special report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. Summary for Policymakers' (Report, accepted by the 48th Session of the IPCC, Incheon, Republic of Korea, 6 October 2018) 28.

[31] The 197-nation Paris Climate Treaty considers that limiting global warming to 2° Celsius will not prevent destructive and deadly climate impacts, as once hoped, and vows to halt warming at 'well under' 2° Celsius compared to mid-19th century levels, and 'pursue efforts' to cap the rise at 1.5° Celsius.

As the world's population grows, so does the need for more resilient food and agricultural systems that address human needs while minimizing environmental damage and further biodiversity loss. An environmentally sustainable food system is key to ensuring nutritious food and water availability, to preserving natural resources and to mitigating climate change. To act effectively, the agro-industrial system needs to undertake a reformation, in line with the multiple requirements deriving from political institutions, NGOs, academic and scientific communities. Without consistent policy signals, autonomous and uncoordinated efforts are unlikely to create sustainable, productive and resilient agricultural sectors.

1.2.2 What is the real cost of adaptation and mitigation?

Although estimates vary, several global studies suggest that the cost of inaction far outweigh the costs of adaptation and mitigation of climate change. The latter interventions are the two main types of actions conventionally referred to as ways to reduce the impacts of climate change on human and natural environment. Mitigation indicates a reduction in GHG emissions, which should lead to a reduction in the number and gravity of climatic changes. Adaptation refers to changes made to a system affected by climate, e.g. the agri-food sector, which improve the outcome of climate change in relation to no adaptation.

The scientific advice is to seriously commit in these two actions as soon as possible. Not only adaptation and mitigation are key to human survival in face of climate change, but they make economic sense too. The costs of stabilising the climate are manageable, while delay would be dangerous and costlier.[32] To reduce the hazards linked to the worst global warming scenarios, stabilising GHG levels in the atmosphere is a matter of the utmost importance. This goal can be achieved through sustained long-term action, which has lower costs in comparison to those related to inaction. Obviously, the expense is not evenly distributed across sectors, or around the world. Sound and equal policies are needed to permit both developed and developing countries to do their best to contribute to the common cause, according to their economic possibilities. For instance, carbon markets are already delivering flows of finance to support low-carbon development.

Action on climate change will also create significant business opportunities, as new markets are created in low-carbon energy technologies and other low-carbon goods and services. According to the Stern Review, the economic benefits of implementing policies to avert climate change are multiple and can promote growth and development; indeed, ignoring climate change will eventually damage countries' economic growth.[33]

Tackling climate change is described as a 'pro-growth strategy for the longer term', feasible without holding back the aspirations for growth of rich and poor nations. Mitigation and adaptation costs, estimated at around 1 percent of global GDP, could be even lower if there were major gains in efficiency, or if the strong co-benefits (for example from reduced air pollution) were effectively measured.

Inspired by the Stern Review, which revealed the economic inconsistency of inaction with regard to climate change, the Environment Ministers from the governments of the G8+5 countries agreed to meet to initiate a process of analysing the global economic benefit of

[32] Stern N 'The Economics of Climate Change. The Stern Review' (Report to Prime Minister and Chancellor of the Exchequer, 2006).

[33] Ibid.

biological diversity, the costs of the loss of biodiversity and the failure to take mitigation and adaptation measures versus the costs of effective conservation.[34] The Economics of Ecosystems and Biodiversity (TEEB) is the major result of this decision.

TEEB differs from the Stern Review and the conventional debate on climate change in that the effects of global warming on natural and human environment are real and potentially catastrophic, but do not emerge from within. The focus is on the reasons for valuing nature itself, and thereby understand the pros and contras for action (and inaction) in different contexts. TEEB applies a holistic approach that underlines the impacts and dependencies between natural systems, human systems, and agriculture and food systems. The latest TEEBAgriFood report considers the extent of positive and negative externalities in relation to the 'eco-agri-food systems' as a whole, thus underpinning the lack of a coherent universal framework in policy making.[35] The recommended system thinking approach is innovative in that it assures better understanding and forecasting concerning the effectiveness and outcomes of policy decisions, by illustrating how the components of a system are interconnected with one another and highlighting the elements that are likely to determine and impact the drivers of change.

It is paramount to have an overview of the diversity of agricultural models and food systems, each presenting different contributions to global food security, varying impacts on natural resources, and countless ways of working through the Food Supply Chain. In fact, all of them are affected by economic and political pressures, which result in invisible flows across the food systems. Through an overall view, these forces are finally made clear. Furthermore, it becomes easier to identify ways to reorient food value chains and build resilience by working with natural systems, farmers, rural and urban communities, and entire societies.

1.2.3 True cost accounting: revealing the hidden costs of food

An 'eco-agri-food system' finds itself at the nexus of the three systems involved in growing, processing, distributing and consuming food. These are, namely, the economic system, the ecological and climatic system, and the social system. True Cost Accounting (TCA) aims at underpinning the impacts, both positive and negative, that agricultural practices and food systems at a large have on these three areas. By incorporating the negative externalities into the retail price of food, TCA could help lower the cost of food produced sustainably. Hidden costs are associated with a broken food system: costs for workers, for human health, for the state of the environment, for animal welfare, for farmers. The spread of food-borne illnesses and obesity, the long drought periods in California, the waste of large amounts of freshwater, the loss of topsoil, the massive decline in insect numbers, are all examples of negative externalities that True Cost Accounting is able to capture. Among the social and economic costs, gender inequality plays a big role. Women's rights are put at risk all the way through the Food Supply Chain, while children are often victims of child labour.

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[34] The G8+5 group includes the heads of government from the G8 Nations (Canada, France, Germany, Italy, Japan, Russia, the United Kingdom and the United States) and the heads of government of five emerging economies (Brazil, China, India, Mexico and South Africa).

[35] The Economics of Ecosystems and Biodiversity (TEEB) 'TEEB for Agriculture & Food: Scientific and Economic Foundations' (UN Environment, 2018).

The conventional food value chain is composed by various elements: land preparation for growing food, planting, growth, harvest, transport, processing, distribution, and consumption.

Several flows act as inputs to this value chain: labour, fertilisers, and knowledge; ecosystem services as well, as such as freshwater and pollination. There are also several outflows along the same value chain, mainly food and other agricultural products, and related incomes; but also, atmospheric emissions and excess fertiliser in runoff. These flows can lead to further outcomes: farming incomes support rural households financially; emissions can lead to negative health outcomes; fertiliser in runoff can lead to adverse environmental consequences such as eutrophication.

The outcomes of these various flows can be negative or positive on human well-being. For example, health outcomes of emissions can negatively impact labour productivity and quality of life for people both near and far; farm incomes, instead, can positively impact human wellbeing for farmers and farm labourers. Also, various stocks are connected with these flows: the quality and quantity of stocks impacts the flows. Ecosystem services (such as freshwater, belonging to the 'flows') depend on the quantity and quality of upstream forests (natural capital, belonging to the 'stocks').

While some of these connections are visible in market transactions, many of them are hidden and not incorporated in observed prices and values. For instance, while incomes and consumption outcomes of a particular production system are made visible by being captured by GDP, the spread of these outcomes across gender and social classes are not. Similarly, while inputs of ecosystem services can be indirectly captured by yields and reflected as income, current yield measures do not reflect the capacity of ecosystems to deliver these services into the future.[36]

An analysis of the invisible externalities of the agri-food sector, which are found to be larger than that of any other sector, reveals the real price of food production, thus showing the true costs and benefits of tackling climate change through agricultural development.

On the basis of such outcomes many among academics, climate and social scientists, and NGOs, provide a critical assessment of the contemporary global food system. The heightening food crisis, according to them, is an evidence of the failure of affirmed food systems to achieve worldwide food security. An essential reason for this failure is identified in the neoliberal strategies that emphasise industrial efficiencies, commodity production and free trade ideologies underlying agricultural and food policies. In addition, these models do not provide the environmental and social services that they are meant to grant. That means, environmental security too is overlooked by the influential actors of today's FSC.

1.2.4 Food systems failures

Food is no longer considered a source of nourishment or a cultural element, but a mere commodity. There is no more place for key concepts, as such as food sovereignty, sustainability both in terms of food and environmental security, health, food justice or fair trade. Despite their seeming distance from the realities of agricultural production and food consumption, the forces shaping the global food economy played a central role in

[36] TEEB 'TEEB for Agriculture & Food: Scientific and Economic Foundations' *Chapter 6, Box 6.1 Demonstrating the scope of a comprehensive assessment* (UN Environment, 2018).

establishing what now seems to be an unremovable, irreplaceable, governance model. Their actions built a highly fragile world food economy, characterised by a propensity for crises affecting farmer livelihoods and people's access to food. Also, ecological negative impacts are striking. The latter are mainly attributable to the prevailing industrial agricultural model: governments, private foundations, and financial stakeholders are responsible for having created norms, governance frameworks, and international trade rules that have shifted control away from farmers and consumers. In doing so, they induced an environmental crisis that uncovers important social, economic, and ecological concerns.

During the years of the Green Revolution, planting commodity crops 'fencerow to fencerow' was agriculture's driving philosophy.[37] Today, we can no longer think of agriculture as production alone. The interconnectedness of agriculture's different economic, social, and environmental roles and functions must be recognised. The goal is no longer to simply maximise productivity, but to optimise agricultural efficiency across a far more complex landscape of production, environmental services, and social justice achievements.

The outcomes of the agri-food industries that prospered in recent decades are very similar worldwide: large numbers of people are still hungry, environmental limits are being approached or have been overtaken, pressures on agricultural resources arise, and consumers remain uncertain about how to exert their power.[38] Despite a significant growth in food production over the past half-century, society is still facing food insecurity. Globally, hunger is on the rise. Today 821 million people still do not get enough food to eat, while a large proportion of the world population is also affected by micronutrient deficiencies (so-called 'hidden hunger').[39] Paradoxically, under-nutrition and obesity coexist in many countries. We cannot deny that production gains have helped millions of people to escape poverty and provided a platform for rural and urban development in many countries. However, the benefits of the past innovations and technological advances are unequally distributed and way too expensive in terms of environmental, social and economic sustainability.

The second biggest failure of modern food governance probably concerns the provision of ecosystem services. The latter are investigated in a RISE Task Force dating back to 2009, which acknowledges that the European modern agri-food system failed in providing (in addition to food products) essential environmental services.[40]

The notion of ecosystem services refers to the various benefits people obtain from ecosystems, which include provisioning services (e.g. food and water), regulating services (e.g. floods and droughts), supporting services (e.g. soil formation) and cultural services as well, as such as recreational, spiritual, religious and other non-material remunerations.

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[37] Former US Secretary of Agriculture (1971-1976) and Purdue Dean of Agriculture Earl Butz urged American farmers to do so.

[38] Pretty J 'Agriculture and food systems' in Rosin C, Stock P and Campbell H (eds.) *Food systems failure. The global food crisis and the future of Agriculture* (Routledge, 2012) 17-29.

[39] FAO, IFAD, UNICEF, WFP and WHO 'The State of Food Security and Nutrition in the World 2018. Building climate resilience for food security and nutrition' in *The State of the World* (Report, 2018).

[40] RISE Task Force 'Public goods from private land' (Research Report, 2009). RISE is an independent foundation with a pan European board of directors, devoted to the promotion of sustainable agriculture and of a living countryside.

Evidently, this notion considers the various interactions between food production and the environment.

Europe's land is mostly privately owned and managed by farmers and foresters. Market failures originate from the fact that the land provides much more food, feed and other materials, but insufficient environmental services. The average production has dramatically increased due to the implementation of modern science solutions, technologies, and farm subsidies policies. At the same time, Europe is bearing the effects of severe ecosystem deterioration due to years of intensive and industrialised agriculture: biodiversity loss, landscape degradation, and pollution of water and atmosphere. The reason for these imbalances is that while there are functioning (even if imperfect) markets in food and fibre, there are no spontaneously occurring markets for environmental services. As a result, farmers tend to provide fewer 'goods', such as habitats and cultural landscapes, and too many 'bads'.

How can environmental, public goods be delivered? Who pays for the environmental damage? Answering these questions is no easy endeavour. Environmental services could be included in farming practices through a variety of interventions: cap and trade systems, offsets, contracts for services; also, the cost of environmental degradation could be assumed by farmers, as suggested by the pollution pays principle, or by consumers, for the food they are purchasing. Such a complex evaluation is up to the legislator.

In order to respond effectively to today's climate challenge, an all-embracing approach considering the multifunctional character of the agricultural sector is fundamental. Surely, agricultural policies play a major role in giving value to these services. The establishment of tools to submit ecosystem maintenance and enhancement to the market system could assure a proper development of such an innovative paradigm. Countries' structural fund systems should be reshaped in order to better respond to these cross-border needs.

Concerning the extent of negative and positive externalities in the agri-food sector, Trucost published an interesting report that brings under light the wide range of impacts of private businesses' activities on the natural environment.[41] Effects, which are not usually reflected in the market prices of associated financial transactions, having altogether a very high price, indeed. The research states that the 'top 100 externalities' achieve an estimated cost of US $4.7 trillion per year in terms of environmental and social costs of lost ecosystem services and pollution. More precisely, 11 out of the 'top 20 externalities' are related to agri-food sectors.

Here again, the question of the real value of a healthy environment and lively rural landscapes arises. Such valuations are not straightforward and examples of directly observable market values for environmental services are still rare. An advancement in the true cost accounting approach remains central to trigger the much-needed evolution towards sustainable farming paradigms. Moreover, for agriculture to deliver the right scale of public environmental goods can be achieved only within the context of international cooperation.

[41] Trucost 'Natural Capital at Risk: The Top 100 Externalities of Business' (Research Report, 2013).

1.3 Tackling climate change: the international legislative framework

As stated in the previous pages, global climate change has become, since the late 1980s, an issue of critical international significance. It was quickly recognised that, being a worldwide problem, it requires an international, far-reaching response.

However, agriculture and food production in general have been only recently addressed as key causes for global warming. This delay is well reflected in national legislations and policies; a much more comprehensive perspective has been developed within the United Nations (UN) agenda, which promotes effective changes in the way food is produced and consumed, fostering improvement both at international and regional level.

1.3.1 The United Nations

The first international treaty that focused on the troublesome subject of climate change was the United Nations Framework Convention on Climate Change (UNFCC). It was signed in June 1992 during the United Nations Conference on Environment and Development: by that date, the Convention had received 166 signatures. It then entered into force in March 1994 and has been since then adopted by 197 Parties.

According to Article 2, the ultimate objective of the Convention is to stabilise GHG concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. To fulfil this task, various engagements were subsequently promoted, and some agreements were reached by the Conference of the Parties to the UNFCC.

First of all, the Kyoto Protocol was agreed (1997). It imposed legally binding commitment on the Parties to reduce their emissions by 5 percent below 1990 levels during the Protocol's first commitment period (2008-2012).[42] Then, in 2012, the Conference of the Parties adopted the so-called Doha Amendment, introducing new non-legally-binding commitments to be observed in a second period (2013-2020).[43] The amendment is subject to acceptance by the Parties to the Kyoto Protocol. In accordance with Article 20, paragraph 4, it will enter into force for those Parties having accepted it only after the receipt by the Depositary of an instrument of acceptance by at least three-quarters of the Parties, meaning a total of 144 countries. As of 26 December 2018, 123 Parties have deposited their instrument of acceptance.

In 2015, in pursuit of the objectives of the Convention, the Conference of the Parties adopted the Paris Agreement, reiterating the need to give urgent and effective response to the incumbent menace of climate change, acting on the basis of the best available scientific knowledge.[44]

The Parties aimed at limiting warming to 1.5C° above pre-industrial levels and agreed to a long-term goal for adaptation. The arranged process promotes all available solutions that are

[42] Kyoto Protocol to the United Nations Framework Convention on Climate Change, (UNFCC). Opened for signature on 11 December 1997 at COP3 in Kyoto, Japan and entered into force on 16 February 2005. Art 3.

[43] Doha Amendment to the Kyoto Protocol, United Nations Framework Convention on Climate Change (UNFCC). Opened for signature on 21 December 2012 at COP18 in Doha, Qatar.

[44] Paris Agreement, United Nations Framework Convention on Climate Change (UNFCC). Opened for signature on 22 April 2016 at COP21 in Paris, France; entered into force on 4 November 2016.

effective in increasing the resilience to the negative impacts of climate change and lowering GHG emissions, 'in a manner that does not threaten food production.'[45]

In order to achieve these long-term objectives, each country outlined his own efforts in the Nationally Determined Contributions (NDCs), which are at the core of the Paris Agreement, and need to be fully implemented if the latter is to be successful.

The Paris Agreement provides the foundation for a sustainable, low-carbon and resilient development under a changing climate. In occasion of the Global Climate UN COP24, which took place in December 2018 in Poland, negotiators from 196 countries and the European Union worked for two weeks on the Katowice Rulebook, implementing the Paris Agreement.[46] Despite many heads of state, governments and almost 100 Ministers of the Environment and of Foreign Affairs were present, NGOs and environmentalists are disappointed at the lack of more forceful understandings and language. The rulebook covers a multitude of issues, such as how countries should report their GHG emissions or contributions to climate finance, what rules should apply to voluntary market mechanisms. Overall, the agreement tends towards single sets of rules for all countries, with large permissions for those that lack the capacity to meet the agreed objectives. On finance, the rules are relatively permissive too, giving flexibility to rich nations concerning the reporting of their contributions. One failure was the complex Article 6, containing rules for voluntary carbon markets: unable to reach a deal on the matter, the Parties passed the matter to next year's COP25.

The Sustainable Development Goals (SDGs) play an equally important role on the international scene. Set by the UN General Assembly in 2015, they embody a series of 17 internationally agreed and indivisible goals, covering a wide range of issues across the spectrum of development. From poverty, food and water security, through health, equity, access to adequate work conditions, peace, and a stable natural environment, the SDGs are wide-ranging and interdependent commitments. To ensure their efficient implementation, each goal has a separate list of specific targets, which together form the 2030 Agenda.[47] In short, it consists in a plan of action for sustainable development to face food and environmental insecurity.

More than any other sector, agriculture is the common thread that holds the 17 SDGs together.

First of all, SDG number 2 calls specifically to 'end hunger, achieve food security and improve nutrition and promote sustainable agriculture'. Despite the fact that modern agriculture has achieved much, producing today more food than ever and enough calories to feed all people, for the third year in a row there has been a rise in world hunger. According to FAO, the absolute number of undernourished people has increased to nearly 821 million in 2017, from around 804 million in 2016, reaching levels from almost a decade ago. Climate change is among the key drivers behind this recent uptick: poor and vulnerable people are firstly and directly concerned by food insecurity, and the majority of them lives in farmers'

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[45] Ibid.

[46] The Katowice Climate Package is available at <https://unfccc.int/index.php/process-and-meetings/the-paris-agreement/paris-agreement-work-programme/katowice-climate-package>.

[47] Resolution 70/1 'Transforming our world: the 2030 Agenda for Sustainable Development' (adopted by the UN General Assembly on 25 September 2015) paragraph 54.

communities situated in rural areas. Southern countries' GDP is strictly linked to agricultural production, and climate variability is compromising the capacity of thousands of farmers to survive and provide basic needs to their families.

To meet the world's growing population necessities, agricultural productivity needs to be doubled by 2030, and so the incomes of small-scale food producers. According to the World Bank, agriculture is two to four times more effective in raising incomes among the poorest than growth from any other sector.[48] Agriculture development is therefore inextricably linked to economic growth, thus to SDG number 1, calling for poverty alleviation. Being rural people the largest segment of the world's extreme poor, enhancing farmers' living conditions means promoting poverty mitigation.

Even SDG number 4, which refers to education, is linked to the improvement of farmers' livelihood. If farmers will be satisfyingly recompensed for their work, they will be able to access to teaching and technologies, acquiring tools and know-how. To provide education is also a mean to promote farmers' awareness about the impacts of their production models, consequently becoming an important channel for developing more sustainable farming environments.

There are interconnections between agriculture and many other SDGs concerning water use, energy use, gender equality, economic growth and employment, sustainable consumption and production, ecosystem management, and climate change in general. For this very reason, practically none or few among the internationally acknowledged goals will be achieved without a transformation of food production, processing, distribution and consumption models.

1.3.2 International bodies and NGOs

Since the last decade, worldwide well-known international bodies as such as the Food and Agriculture Organization (FAO), the World Bank and the Organisation for Economic Co-Operation and Development (OECD) focused on the interconnection between food production, climate change and nature and biodiversity conservation. Their publications are a prime vehicle for disseminating knowledge about the environmental implications of economic and social development. Outlooks, annual overviews, comparative statistics, and recommendations are often subjected to examination by governments, becoming the basis for discussions and agreements; at the same time, they are key for researchers and citizens who are interested in understanding the strict connection between human activities and their impact on the environment.

In recent times, also significant environmental NGOs such as Greenpeace began promoting the reconnection with food as a mean to combat climate change and protect forests and waterways, in particular encouraging sustainable and healthy dietary patterns. Duncan Williamson, WWF Food policy manager, recently stated that

> '[f]ood – from what we grow, produce and catch to what we put on our plates – is the hidden cause of biodiversity loss. It's also our strongest link to nature.

[48] World Bank 'Ending poverty and hunger by 2030: an agenda for the global food system' (Research Report, 2015).

> Reconnecting people with food is essential if we want to change the food system and build a future of healthy people and a healthy planet'.

The influence that these organisations exercise on the societal environment makes them a point of reference for raising consciousness about the impact of agriculture and consumption patterns on the Earth's climate. Working with business leaders to help them embedding the concept of sustainability in their governance models and with policy-makers both at a local and a global level, they boost the transformation of food systems.

The Slow Food Movement (Slow Food) is a pioneer in the battle against modern food production systems and food consumption patterns. Slow Food is a non-profit organisation founded in Italy in 1989 to prevent the disappearance of local food cultures and traditions, counteract the rise of 'fast life', and combat people's fading interest in the food they eat, where it comes from and how individual food choices affect the world. Since its beginnings, Slow Food has grown into a global movement involving millions of people in over 160 countries, working to ensure everyone has access to 'good, clean and fair food'. Slow Food believes food is tied to many aspects of life, including agriculture and the environment, and one of its commitments is to educate people on the importance of their daily food choices.

The capacity of NGOs to be actors of the food (r)evolution they call for, has been enhanced by the Aarhus Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters adopted by the UN Economic Commission for Europe in 1998. Although its scope is regional, its significance has been perceived globally as a step forward in the area of environmental democracy, so treasured by the United Nations.[49]

The Preamble of the Aarhus Convention recalls the 1972 Stockholm Declaration on the Human Environment and recognises an adequate protection of the environment as key to human well-being and the enjoyment of basic human rights. However, the focus of the Convention is strictly procedural in content, limited to public participation in environmental decision-making and access to justice and information (Articles 6-8). Not only it confers rights directly on individuals, but also allows members of the public and NGOs to bring complaints before a non-compliance Committee (Article 15), the members of which are not only independent of the parties but may be nominated by NGOs. The Committee ruled on the interpretation and clarification of the Convention's provisions, creating a case law on procedural rights in the field of environmental protection.

1.3.3 The European Union regulatory framework

The Directorate-General for Environment (DG ENV) is the European Commission department responsible for EU policy on the environment. Its aim is to protect, preserve and improve the environment, proposing and implementing policies that ensure a high level of environmental protection and preserve the quality of life of European citizens. Among its tasks figures the monitoring of EU environmental law application by Member States and the representation of the European Union at international meetings about environmental matters.

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[49] UNECE 'The Aarhus Convention. An Implementation Guide' (Second edition, 2014).

The EU submitted the Paris Agreement as well as the previous UNFCC treaties, consequently setting ambitious targets to prevent the most dangerous climatic changes. Specific attention is devoted to cutting GHG emissions during the next decades. In particular, the EU aims to achieve three main goals by 2020: cutting by 20 percent its GHG emissions compared with 1990, getting 20 percent of total energy consumption from renewable energy, and increasing by 20 percent energy efficiency. These shares are meant to augment by 2030, reaching respectively 40 percent, 27 percent, and 27 percent. A substantial cut of emissions is wanted by 2050, approximately by 80-95 percent compared to 1990 levels.

According to the Climate Action Tracker (CAT) Assessment the European Union has not yet effectively proposed an adequate policy response to the Paris Agreement's 1.5°C warming limit, despite some progress over the last year.[50] Its current policies are insufficient to meet the 2030 Agenda targets. In recognition of this, the European Union is discussing a large package of measures that offer an opportunity to increase its ambitions.

Currently, climate targets are pursued through a combination of financial support and regulation. At least 20 percent of the EU's budget for the period 2014-2020 (as much as €180 billion) should be spent on protecting the climate. Low-carbon demonstration projects, funded from the sale of emission certificates, include innovative technologies to trap carbon dioxide from industrial installations and store it in the ground (CCS, namely Carbon Capture and Storage).

Concerning regulations, there are four main areas addressed by European legislation.

The EU's emissions trading system (ETS) is certainly key for reducing GHG emissions from the industrial sector.[51] The ETS covers around 45 percent of the EU's total GHG emissions, whereas the National Emission Reduction targets cover the sectors not included in the ETS - such as housing, agriculture, waste and transport (excluding aviation).

The Renewable Energy Regulation incentivise countries to support energy sources such as wind, solar and biomass.[52]

The Energy Efficiency Directive sets rules and obligations to reduce the energy use of buildings and industries, and to improve energy efficiency of a wide array of equipment and household appliances.[53]

Finally, the EU legislation also sets compulsory emission targets for manufacturers, through binding emission targets for new car and van fleets. In November 2017, the Commission

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[50] The Climate Action Tracker has been last updated in September 2018, full assessment is available at <https://climateactiontracker.org/countries/eu/>.

[51] Directive 2009/29/EC of the European Parliament and of the Council of 23 April 2009 amending Directive 2003/87/EC so as to improve and extend the greenhouse gas emission allowance trading scheme of the Community OJ L 140 [2009] 63-87.

[52] Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC OJ L 140 [2009] 16-62.

[53] Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC OJ L 135 [2012] 1-56.

presented a legislative proposal setting new CO_2 emission standards for cars and vans by 2020, in order to incentivise the up-take of zero-and low-emission vehicles. [54]

More recently, Member States began to examine the emerging connection between climate change and agriculture. At the Milan World Expo 2015, European Commissioner for Research and Innovation Carlos Maedas announced the intention to launch a food research area (FOOD 2030) by World Food Day 2016. The high-level event was meant to provide a platform for dialogue, building the base for a coherent research and innovation policy framework for food and nutrition security. Four key priorities were to be discussed: nutrition for sustainable and healthy diets, climate-smart and environmentally sustainable food systems, circularity and resource-efficiency of food systems, and innovation and empowerment of communities. The conference took place in October 2017. The speakers highlighted the need for a combination of different policy areas and value chains for better-based governance systems. Also, integrated approaches are more likely to connect multiple stakeholders of diverse value networks, thus augmenting the capacity to design sustainable and resilient food production and consumption patterns.

In 2018, the Bulgarian Presidency of the Council organised a second conference, focused on the importance of developing a common food policy to link agricultural policy with environment, health, nutrition, investment and trade. Finally, on World Food Day 2018, the FAO and the European Commission organised a thematic discussion on the next actions to eradicate hunger by 2030, and on the contribution of research and innovation to ensuring food security and nutritious diets to all.

Most importantly, the European Commission presented on 1 June 2018 its last legislative proposal on the Common Agricultural Policy (CAP). The proposal aims to make the CAP more responsive to the challenge of climate change.[55] Nine objectives have been identified to shape the future European agricultural policy, including climate change action, environmental care, and landscape and biodiversity preservation. The CAP will surely be an essential policy tool in emphasising the interconnections between farming and climate issues, providing solutions to face the associated challenges.[56]

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[54] Proposal for a regulation of the European parliament and of the Council setting emission performance standards for new passenger cars and for new light commercial vehicles as part of the Union's integrated approach to reduce CO_2 emissions from light-duty vehicles and amending Regulation (EC) 715/2007.

[55] Proposal for a regulation of the European parliament and of the Council establishing rules on support for strategic plans to be drawn up by Member States under the Common agricultural policy (CAP Strategic Plans) and financed by the European Agricultural Guarantee Fund (EAGF) and by the European Agricultural Fund for Rural Development (EAFRD) and repealing Regulation (EU) No 1305/2013 of the European Parliament and of the Council and Regulation (EU) No 1307/2013 of the European Parliament and of the Council.

[56] DGAGRI 'Modernising and simplifying the CAP. Background Document. Climate and Environmental challenges facing EU agriculture and rural areas' (Report, 2017).

These efforts will be paired with the implementation of both the Climate & Energy Package 2020[57] and the 2030 Climate and Energy Framework.[58]

The legislative plans reaffirm the Commission's stated intentions for the next CAP to place greater emphasis on the environment and support the transition towards a sustainable agricultural sector through a new delivery model. Essential environmental tools include enhanced conditionality, a mandatory 'eco-scheme', and the continuation of a minimum spend for the environment and climate under Pillar 2. However, despite offering potential support to a more environmentally sustainable CAP, this new approach is flawed by the persistence of some limits to an effective and ambitious performance.

A recent evaluation on the greening of the CAP led by the Institute for European Environmental Policy (IEEP) on behalf of Alliance Environment found that greening measures had only led to sectorial and small changes in management practices.[59] Similarly, the European Courts of Auditors recently found that greening, as currently implemented, is unlikely to enhance the environmental and climate performance of the CAP 'mainly due to the low level of requirements, which largely reflect the normal farming practice'.[60] It estimated that greening led to a very small change in farming practices, impacting only around 5 percent of all EU farmland. Also, the proposed legislation maintains the focus on direct payments. However, even when coupled with mechanisms of redistribution, these payments do not fit with the recommendations given to design more effective environmental instruments for the agricultural policy post 2020.

Doing so, the legislation perpetrates a system that has been shown to be inefficient and inequitable in supporting policy goals, including the improvement of farmers' incomes. The new 'enhanced conditionality' for decoupled payments announces some welcomed additional components (such as crop rotation and a farm nutrient management tool). Still, it largely maintains the existing requirements and leaves a lot of discretion for the Member States to set their level of ambition.[61]

The mandatory 'eco-scheme' has the potential to reward and incentivise the farmers who wish to integrate and maintain measurable contributions to a more sustainable agriculture policy, offering payments proportional to the level of ambition achieved. These eco-schemes,

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[57] Decision 406/2009/EC on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020 (Effort Sharing Decision). Includes agriculture under (non-ETS) OJ L 140 [2009] 136-148.

[58] The Regulation on the inclusion of greenhouse gas emissions and removals from land use, land use change and forestry (LULUCF) into the 2030 climate and energy framework was adopted by the Council on 14 May 2018, following the European Parliament vote on 17 April 2018.

[59] Alliance Environnement and the Thünen Institute 'Evaluation study of the payment for agricultural practices beneficial for the climate and the environment' (Research Report, 2017). The 2013 CAP reform first introduced into Pillar 1 a payment for a compulsory set of *'greening measures'* (crop diversification, maintenance of permanent grassland, Ecological Focus Areas) accounting for 30 percent of the direct payments budget. These measures are intended to enable the CAP to be more effective in delivering its environmental and climate objectives and thereby ensure the sustainability of EU agriculture.

[60] European Court of Auditors 'Greening: a more complex income support scheme, not yet environmentally effective' (Report, 2017).

[61] *CAP2020*, Stephen M and Bas-Defossez F 'What is the fate of environmental ambition in the proposed EU agricultural policy' (2018) <http://www.cap2020.ieep.eu>.

funded from national direct payment allocations, will be mandatory for Member States, although not for farmers; they are meant to address the European environment and climate objectives in ways that complement the already available tools, going beyond what is requested by the conditionality requirements. It will be up to each Member State to define them as they prefer.

1.3.4 The Australian regulatory framework

Being a federation, Australia presents specific environmental laws and enforcement agencies set up within each tier of government – federal, state or territory, and local.

States and territories are responsible for most environmental matters, each having a Department of Environment setting out environmental policies. An Environment Protection Authority (EPA) enforces them. The Federal tier of government is responsible for those environmental matters that fall within its powers according to the Australian Constitution, as well as for environmental regulation applicable to Commonwealth lands. Remaining powers are given to local governments for local issues.

The Department of Environment and Energy is the Federal Department of Environment. As stated in the Environment Protection and Biodiversity Act 1999 (Cth) s 516A, Commonwealth organisations do have to report on their environmental performance and how they advance the principle of Ecologically Sustainable Development (ESD).

Australia has ratified both the Doha Amendment to the Kyoto Protocol as well as the Paris Agreement, reinforcing its commitment to action on climate change. Adaptation to climate change was first recognised as a priority by the Australian government in 2004, with the announcement of a budget for a National Climate Change Adaptation Programme. In this framework, the federal government established the National Climate Change Adaptation Research Facility (NCCARF, 2008). The latter brings together Australian researchers to address priority questions about climate change impacts and adaptation, and to communicate this knowledge to decision-makers in order to facilitate a more effective adaptation at multiple scales.[62]

The responsibility of adaptation planning is largely placed on municipal councils, reflecting the country's diverse geography and broad scope of potential climate change impacts and adaptations. With that said, effective climate change action certainly requires a multi-governance approach in which each level of government has a shared responsibility.[63]

Today, the Commonwealth government formally aims to achieve a 5 percent reduction in emissions on 2000 levels by 2020 and a 28 percent reduction on 2005 levels by 2030, doubling Australia's renewable energy capacity by 2020 and helping improving energy productivity by 40 percent by 2030.

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[62] Pearce T D et al 'How is Australia Adapting to Climate Change Based on a systematic Review?' 10 9 *Sustainability* (2018).

[63] Nalau J, Preston B L and Maloney M C 'Is adaptation a local responsibility?' 48 *Environ. Sci. Pol.* (2015) 89–98.

However, the 2018 CAT assessment stated, confirming all previous assessments, that the continent's emissions are set to far exceed its Paris Agreement NDC target for 2030.[64] There has been no improvement in Australia's climate policy settings over the last year. While the federal government continues to maintain that Australia is on track to meet the 2030 target, the CAT is not aware of any factual basis, published by any analyst or government agency, to support this statement. To the contrary, Australia's emissions are still projected to grow.

The electricity sector has the potential to reduce emissions faster than it currently is, but the federal government overlooked the recommendations of the 2017 Finkel-Review to adopt a Clean Energy Target.[65] A less challenging reliability obligation and an emissions reduction target on energy retailers and a small number of large electricity users (so-called National Energy Guarantee, NEG) have been proposed. The proposal is debated and still subject to further consultation: to be adopted, the plan needs unanimous agreement from six states and territories governments. According to many, the government's energy target is weak and will achieve next to nothing by way of emissions reduction: that means, Australia will need to contemplate doing more in sectors where it is more expensive to take action (like transport, or agriculture) if the government intends to comply with commitments it made under the Paris Climate Agreement.

Climate Change in Australia's Technical Report provides an alarming assessment of observed outcomes of climatic changes in the whole country, with intensive agriculture and breeding figuring among the main contributors to raising temperatures, salinization of the soils, water scarcity, etc. Nonetheless, the Federal Government recently stated that

> 'The agriculture sector is well placed to prosper and will do so through the endeavours of farmers and the maintenance of an open and competitive business environment. The Government has laid the foundations for a stronger agriculture sector. We have reduced regulation, removed the Carbon Tax, increased export market access, invested in infrastructure and refined the settings for foreign investment.' [66]

These are the opening lines of the Agricultural Competitiveness White Paper, which entails a list of measures meant to support farmers' resilience to a changing climate, empower rural communities and promote economic growth.[67] The paper has been published in the context of the National Climate Resilience and Adaptation Strategy, adopted by the federal government in 2015; however, the focus is once more on better returns for farmers in the short-term, rather than sustainable and resilient farming systems.

While the current federal government insists on promoting coal as a viable solution to energy security issues and downplays renewable energy, the reality on the ground for public opinion and across the business sector is very different. Climate change issues are at the centre of 2019 federal elections' campaign. Meanwhile, states and territories governments are pursuing

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[64] The Climate Action Tracker has been last updated in September 2018. Full assessment is available at <https://climateactiontracker.org/countries/australia/>.

[65] Finkel A et al 'Independent Review into the future security of the National Electricity Market. Blueprint for the Future' (Review commissioned by Federal and State governments, 2017).

[66] CSIRO and Bureau of Meteorology 'Climate Change in Australia Information for Australia's Natural Resource Management Regions' (Technical Report, 2015).

[67] 'Agricultural Competitiveness White Paper: Stronger Farmers, Stronger Economy' (Cth, 2015).

their own policies. The NSW government, for example, aims to achieve net-zero emissions by 2050, making the state more resilient to a changing climate. This goal will be achieved through the implementation of emissions-savings policies, consistent with achieving the Commonwealth government's interim and long-term objectives, as well as further policies to plan for climate risks and provision of targeted support for households, communities and businesses.[68]

There is scientific literature attesting that local adaptation actions are underway in Australia, for the most part preliminary or groundwork.[69] A particular focus is on documenting stakeholder perspectives on climate change and attitudes towards adaptation, and modelling or scenario planning in the coastal zone, agriculture, and health sectors. Where concrete adaptations are reported, they are usually in the agricultural sector and are most common in the Murray–Darling Basin, Australia's food basket.

[68] Office of Environment and Heritage 'NSW Climate Change Policy Framework' (2016).

[69] Nalau J, Preston B L and Maloney M C 'Is adaptation a local responsibility?' 48 *Environ. Sci. Pol.* (2015) 89–98.

2 EXPLORING AGRICULTURE'S POTENTIAL FOR CLIMATE CHANGE ADAPTATION AND MITIGATION

Addressing climate change will require highly-innovative solutions for farming systems, building upon new ideas, technologies, processes, and techniques in combination with local traditions and cultures. In order to successfully spread them through communities and societies, many stakeholders need to be involved and an adequate economic and institutional environment has to be provided.

The potential of agricultural systems to adapt to climate change is both promising and poorly understood. This is mainly due to the fact that climate change is not confronting a static world. In order to provide 'quantitative' measures of climate change, scientists and academics rely on numerical models embracing different areas – climate, agricultural and economic systems. These models are key to estimate outcomes and impacts of global warming outcomes, but they are only simplified representations of reality, which do not provide certain knowledge.[70]

Also, the variety of producers' and consumers' possible responses to a changing natural, social, and economic environment, constitutes an obstacle for an accurate analysis of possible paths towards agriculture's sustainable intensification. The first difficulty is to ascertain the capacity of these reactions to counterbalance otherwise disrupting impacts; the second one is to imagine the role of public and private institutions investments if these responses are inadequate.

2.1 Main fields of intervention

The magnitude and the speed of the climatic changes expected over the next years raise serious concerns about the capacity of humanity to adapt agriculture to such adverse and hastily-changing environmental conditions. Doing more with less is imperative. The environmental, social and economic needs that the agri-food sector has to satisfy are various and complex. According to the scientific literature, usual on-farm measures will not be enough to offset expected losses in food production. Innovative options for keeping the food systems within environmental limits are needed. That means, larger investments in alternative farming research and breeding technologies, development of innovative farming policies and promotion of efficient irrigation infrastructures, among other broader economic adjustments and interventions. The goal is to achieve an incrementation in agricultural productivity while supporting people to make the most of natural finite resources through sustainable forestry, fisheries and aquaculture, crop and livestock practices. Different fields of intervention can be identified, reflecting the core issues that an advantageous and sound debate on agricultural policy has to take into consideration.

2.1.1 Crop management

Soil quality, changes in temperature and precipitation, and atmospheric concentration of CO_2 and ozone will be significant in shaping future crop yields at the global scale. Agricultural productivity is a main concern when talking about food security: surely, improvement in

[70] Burke M and Lobell D 'Introduction' Burke M and Lobell D (eds.) *Climate Change and Food Security. Adapting Agriculture to a Warmer World* (Springer, 2010) 5.

agricultural practices is not the only factor impacting food security, but it is particularly emphasised by the science community. Sources of growth in agricultural productivity are, in turn, multifaceted and include various possibilities, from funding for public and private research and development, to changes in environmental conditions. So far, there is little evidence of the ability of on-farm adaptation measures to improve food security outcomes and simultaneously promote a shift towards sustainable agricultural systems. Also, research has been restricted to a few, more diffused crops (e.g. grain, maize).

As already stated in the previous pages, the business-as-usual solutions to increase agricultural productivity are today unavailable. In this context, three major obstacles, which are likely to weaken farmers' capacity to undertake relevant changes in crop management, have been already identified.[71]

First of all, climate *variability*. Climate variability plays a central role in global and regional food systems. The crops farmers decide to grow, where and when they grow them, as well as the actual amount of food produced in a given year: all that depends on climate variability even before depending on climate change. Surely, long-run climate conditions exert significant influence on agricultural decision making, but climate variability can constrain long-term adaptation to climate change. In fact, it makes production riskier, thus inhibiting farmers from undertaking broader adaptation measures; also, it makes it harder to recognise that climate change is actually occurring.

The other main obstacle to both *ex ante* (e.g. shifting planting date, switching varieties and crops) and *ex post* (e.g. drawing down cash reserves or stores of grain, borrowing from credit markets, and selling assets such as livestock) adaptation measures, is their high costs. The poorest households are incapable of fully shielding consumption from the effects of climate variability, which has major impacts on health and economic outcomes.[72] Therefore, adaptation measures are often unaffordable for the poorest communities.

Finally, the farmers encounter difficulties in detecting the shifts in the external environment and concluding that they would favour a change in behaviour. While farmers and breeders in wealthier countries have access to climate and weather data, this is not usually the case in poorer countries, where people rely on various traditional methods for climate forecasting. In addition, there is a tendency to underestimate the need to evolve land management in the face of new climate conditions.

These elements, altogether, magnify the complexity in the innovation process that the planet requires. As climate change adds to the stress of variability, current strategies for adaptation are more and more unlikely to be adequate for a worsening scenario.

Even if a climate signal is detected and an associated change in management is perceived as necessary, defining a strategy still remains problematic. The 'correct' answer is not always evident: farmers could shift planting date in case of a lengthened growing season, except if limited by cold temperatures; they could switch varieties or crops, if other better suited varieties and crops are available; they could expand irrigation to alleviate moisture constraints

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[71] Burke M and Lobell D 'Food Security and Adaptation to Climate Change: What do we know?' in Burke M and Lobell D (eds.) *Climate Change and Food Security. Adapting Agriculture to a Warmer World* (Springer, 2010) 133-154.

[72] Maccini S and Yang D 'Under the Weather: Health, Schooling, and Economic Consequences of Early-Life Rainfall' (Ford School of Public Policy, University of Michigan, 2008).

- but this kind of intervention can be expensive and often requires large government investments (not to mention that water resources are more and more limited). Even though new areas could become suitable for agriculture because of the changing climate, expansion of agricultural land has significant environmental costs. Given that the ultimate goal is to place food production and consumption on a truly sustainable footing, further land use change is no option.

The science of crop management and agricultural practice needs to be given particular weight. Current approaches to maximise agricultural production are unsustainable and have to be replaced by new science-based methodologies, such as better soil management, exploitation of populations of beneficial soil microbes, water flow regulation, pollination and bio-control of insect pests and diseases, development of advanced breeding technologies, and valorisation of biodiversity.

2.1.2 Livestock management

The livestock sector poses unique challenges that need to be examined with particular attention.

On the one hand, livestock currently is key to food security. Meat, milk and eggs provide 34 percent of the protein consumed globally as well as essential micronutrients.[73] Also, they provide further goods and services, such as animal manure and traction. Hundreds of millions of vulnerable and poor people rely on livestock in a changing climate, because of animal's resilience to climate shocks and extreme weather conditions.

On the other hand, livestock products are responsible for more GHG emissions than most other food sources. These emissions are primarily caused by feed production, enteric fermentation, animal waste, and land use change. In particular, livestock supply chains account for 7.1 GT CO_2, namely 14.5 percent of global anthropogenic GHG emissions (cattle are responsible for about two-thirds of the total). Enteric methane emissions represent 30 percent of global methane emissions in the atmosphere: being methane a short-lived climate pollutant, reducing its emissions could significantly help mitigate climate change in the short-term.[74]

Many developing countries have included the livestock issue in their NDCs under the Paris Climate Agreement. However, the sector is producing an ever-increasing amount of meat products, encouraged by the growing human population rate, higher incomes and urbanisation. In particular, the rising numbers of middle-class people in developing countries and the high concentration of populace in cities and metropoles, are largely contributing to a shift in consumption patterns, notably towards high-value animal protein.

Global production of meat is projected to increase from 229 million tonnes in 1999/2001 to 465 million tonnes in 2050; the production of milk from 580 to 1,043 million tonnes.[75] In light of these projections, the environmental impact per unit of livestock production should be cut by half just to avoid damages beyond the present levels. A combination of effective

[73] FAO 'Livestock solutions for climate change' (Research Paper, 2017).

[74] Ibid.

[75] Steinfeld H et al 'Livestock's long shadow: environmental issues and options' (FAO Research Paper, 2006) xx.

policies and profoundly committed institutions is fundamental to substantially reduce emissions from livestock production.

A major obstacle to a successful shift towards sustainable livestock management is represented by the economic interests of the meat lobby. The big meat corporations are promoting unsafe patterns, proceeding on the path of intensification and industrialisation of livestock production, with increased usage of inputs and large amounts of waste. The process also entails the marginalisation of smallholders and pastoralists, the exertion of the industry's power to discredit scientists whose research could threaten their profits, and the funding of studies that conclude with favourable outcomes for the meat industry, even when that means acting against public health interests.[76]

As a result, the meat industry thrives. The total area occupied by grazing alone is equivalent to 26 percent of the ice-free terrestrial surface on Earth, while the area dedicated to feed crop production amounts to another 33 percent. Altogether, livestock production accounts for 70 percent of all agricultural land and 30 percent of the land surface of the planet.[77]

The overall picture is alarming: not only the demand for meat diverts food away from poor people who are unable to afford anything but cereals; also, concentrated animal feeding operations (CAFOs) focusing on industrial production have widely reported negative environmental and health externalities. Feeding cereals to mounting numbers of livestock will not only aggravate poverty and environmental degradation, but also exacerbate the negative health effects of meat consumption. For example, nitrates contained in processed meat (additive E250) have been recently recognised by the WHO as carcinogenic and thus harmful for human health.[78] In particular, the conversion of nitrates into nitrosamines, potent carcinogens that can induce tumour growth in humans, has been found to play an important role in the pathogenesis of gastric and colon cancers. The WHO announcement came on advice from 22 cancer experts from 10 countries, who reviewed more than 400 studies on processed meat, covering epidemiological data from hundreds of thousands of people. The consumption of processed meat has been linked to an additional 34,000 worldwide cancer deaths a year.

The complications deriving from industrial cereal-fed livestock production and the uncontrolled expansion of pastures are various and must be addressed urgently. As governments are hesitantly elaborating broader regulatory frameworks to address these challenges, the inefficient use of resources by livestock is rightly being questioned in relation to both the costly production of the feed livestock itself consume and the over-consumption of livestock products by humans.

The global implications on the natural environment and human health (e.g. high GHG emissions, atmospheric and water pollution, biodiversity loss from land use change) can no longer be overlooked. Evidence has accumulated, that the livestock sector is out of balance.

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[76] In the movie 'The Meat Lobby. Big business against Health?' (2016) Guillaume Coudray and Sandrine Rigaud (writers and directors) conduct a deep investigation to reveal the unfair attitude of the meat lobby towards the emerging connections between meat consumption and health risks.

[77] Steinfeld H et al 'Livestock's long shadow: environmental issues and options' (FAO Research Paper, 2006) xxi.

[78] Bouvard V et al 'Carcinogenicity of consumption of red and processed meat' (2015) 16 16 *The Lancet Oncology* 1599-1600.

Key recent publications have identified three possible on-farm intervention areas to return into the 'safe operating space' for livestock, which

> '(…) lies between the lower boundaries defined by level of livestock production and consumption which offer sufficient health, cultural, environmental, social and psychic benefits of farmed animals, and the upper boundaries defined by the sustainable thresholds for the negative impacts on health and environment and acceptable animal welfare.'[79]

Firstly, productivity improvements to reduce emissions intensities could be achieved through the upgrading of the feed quality and the development of successful breeding techniques. These techniques proved essential in increasing productivity by improving traits such as live-weight gain, milk yield or fertility. Moreover, they can attain better adaptation capacity of livestock to changing environments and diseases, thus ensuring farmers the access to the best animals in a peculiar type of environment. Besides, by increasing the wealth status and welfare of the animals, production per unit of livestock improves.

Secondly, an innovative carbon sequestration management is key to restore the quality of pastures and diminish livestock's environmental footprint. Grazing in itself has various ecological functions and roles: biomass removal, prevention of wildfires, regulation of hydrology and water quality. Unfortunately, a combination of livestock sector growth and poor grazing management and policy neglect led to overgrazing, which is linked to a number of socio-economic losses (environmental *bads*). Significant and practicable solutions to these issues are: adjusting grazing pressures, improving fertilisation and nutrient management, introducing new plant species and integrating trees and pastures.

The RISE foundation recently published a report about Nutrient Recovery and Reuse (NRR) in European agriculture, according to which the growing leakage of nutrients from agriculture into the environment is undoubtedly affecting Europe's environmental security.[80] NRR from waste streams, such as animal manure, is a practice that offers an important contribution to increasing the efficiency of nutrient management and promoting a circular economy-approach. The integration of the meat industry in the circular bio-economy is indispensable to minimise the dispersion of energy and materials, which are re-introduced in the production chain. Recovering nutrients and energy from animal waste is part of this process, as well as increasing the share of by-products or waste in the livestock feed ratio.

International studies and research have quantified the flow of nitrogen and phosphorus through the food chain, showing that a large proportion of the undesirable effects from nutrient flows is attributable to the expansion of the livestock sector. The growth in nutrient flows shows every sign of continuing in coming decades, therefore the scale of associated damages is expected to grow.

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[79] The RISE Foundation 'What is the Safe Operating Space for EU livestock?' (Research Report, 2018); FAO 'Livestock solutions for climate change' (Report, 2017); Steinfeld H et al 'Livestock's long shadow: environmental issues and options' (FAO, Research Paper, 2006) xx; Sutton M A et al 'The European Nitrogen Assessment' (Cambridge University Press, 2011); Van Dijk K C, Lesschen J P and Oenema O 'Phosphorus flows and balances of the European Union Member States' (2016) 542 *Science of The Total Environment* 1078–1093. Rockström J et al 'A safe operating space for humanity' (2009) 461 *Nature* 472–475.

[80] The RISE Foundation 'Nutrient Recovery and Reuse (NRR) in European agriculture. A review of the issues, opportunities, and actions' (Executive Summary, 2016).

Three main levers are identified as potentially capable of containing the mounting harmful effects of these flows. First of all, a change of dietary goals towards lower consumption of livestock products. Secondly, the improvement of crop and animal nutrient use efficiency through innovative precision agriculture; nutrient leakage can also be tackled by de-concentrating livestock production and re-integrating it with cropping systems including more rotations and making greater use of legumes. Thirdly, the reduction of all waste.

The proposed approaches to improve efficiency are nothing new. Therefore, without innovative technology and renewed motivation, it is unlikely that efficiency rates will be upgraded and leakage reduction rates ameliorated. This is why scholars are calling for a proper regulatory framework, publicly funded science, and policy action.[81] Most importantly, environmental externalities need to be highlighted, while obstacles such as existing subsidies on inputs (e.g. fossil fuel and fertilisers) have to be removed.

The correct pricing of natural resources is a crucial component in achieving greater efficiency; otherwise, free or unpriced resources are condemned to overexploitation and pollution. In this context, securing rights to water, land, and use of common land, as well as regulating waste and waste sinks, are premises for effectively influencing businesses' behaviour.

Progress might speed up as a consequence of the growing sensitivity on the people's part concerning the nexus between climate change and the livestock industry. Science-based solutions and informed public debate are more likely to drive a proactive regulation. Today, many public and private resources are deployed to promote policies that aim to reducing methane production in cattle and better managing of manure.

2.1.3 Water management

All life on Earth is dependent on water. Water is the most precious resource that marine and freshwater ecosystems provide among a wide range of goods, services, and other natural resources. Rivers, basins, coastal areas, and seas have many vital functions: filtering, diluting and storing water; preventing floods; maintaining the climate balance at local and global levels; safeguarding the biogenetic diversity of plants and animals.

Earth's oceans and seas are threatened by overfishing and marine pollution, environmental issues that are now exacerbated by climate change, which is likely to frustrate recent gains in protecting marine resources.

Among the Sustainable Development Goals adopted within the UN Agenda 2030, some reflect the importance that the international community places on water.[82] The UN General Assembly agreed on a stand-alone water goal calling for 'access to safe water and sanitation and sound management of freshwater ecosystems' (number 6). Another pillar focuses on the conservation and sustainable use of the oceans, seas and marine resources for sustainable development (number 14).

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[81] Royal Society of London 'Reaping the Benefits: Science and the Sustainable Intensification of Global Agriculture' (Royal Society, 2009).

[82] Resolution 70/1 'Transforming our world: the 2030 Agenda for Sustainable Development' (Adopted by the United Nations General Assembly on 25 September 2015).

The usefulness of developing an international water governance has been emphasised by the work of the UN Office to Support the International Decade for Action 'Water for Life' 2005-2015. The team concluded that a globally-shared water governance is key for human health, environmental sustainability, and economic prosperity. Among the UN Office tasks figured the managing of complex issues concerning water management on a global scale, and the promotion of increased interactions between stakeholders. Although some opportunities have been missed, many efforts have been made to fulfil international commitments in the water sphere. The international profile of water has been raised on the global agenda, becoming a priority for politicians, policy makers, governments and water managers.[83]

Future water security is under pressure, mainly due to the expected population growth, urbanisation, demographic redistributions, limited water resources, and climate change. The combination of biofuel and food demands on the same areas, entailing greater fertiliser use and an ever increasing amount of water dedicated to agriculture, is listed among the major causes of water depletion and pollution.

Today, seven out of ten people can count on running water to be available in their homes, whenever they need it and whatever needed. However, cities such as London, Sao Paulo, Jakarta, Istanbul, Tokyo, and Mexico City could be facing 'Day Zero' (the day they will run out of water) in the next two decades, unless their water use radically changes. Experience teaches that there is chance of success. Cape Town, for example, was supposed to face its 'Day Zero' in April 2018; its citizens, alarmed by the countdown, averted it simply by limiting their water use up to 50 percent.[84]

Less than 1 percent of the world's water supply is available for human use and a large part of it gets lost because of leaky pipes, pollution, and inefficient management practices (such as growing the most-intensive crops in dry areas of the globe or raising cattle in the desert). While the necessity of reducing anthropogenic carbon footprint is generally recognised, the equally urgent need to minimise humans' water footprint is often overlooked.

There are three main indicators of the water footprint (WF).[85] The 'green' WF indicates the water deriving from precipitation that is stored in the soil and evaporated, transpired or incorporated by plants; it is particularly relevant for agricultural, horticultural and forestry products. The 'blue' WF, indeed, regards water that has been sourced from surface or groundwater resources (e.g. irrigated agriculture, domestic water use, industry). Lastly, the 'grey' WF refers to the amount of fresh water required to assimilate pollutants to meet specific water quality standards; intensive conventional agriculture, livestock in particular, is responsible for a large share of global water pollution.

The resulting overall water footprint of a food product, for example, shows the amount of water that is consumed and/or polluted all over the Food Supply Chain. In other words, it tells how much pressure the growing, production, and delivery process has put on freshwater resources. Research has shown that agriculture bears a major responsibility for water

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[83] UN Department of Economic and Social Affairs (UNDESA), International Decade for Action 'WATER FOR LIFE' 2005-2015 '*We're finally at the end of the UN Decade for Water 2005-2015 – It is time to say good-bye*' <http://www.un.org/waterforlifedecade/>.

[84] Netflix show 'Explained. Episode 2: the world water crisis'.

[85] Water footprint network '*What is a water footprint?*' <https://waterfootprint.org/en/water-footprint/what-is-water-footprint/>.

consumption and pollution: about 92 percent of humanity's WF relates to the agri-food sector, revealing that food production is the leading cause of freshwater scarcity.[86]

The link between water usage and food production can be easily understood: while daily drinking water requirement pro capita is 2 to 4 litres, it takes many more litres of water to compose one person's daily food intake: around 500 litres of water to produce 500 grams of wheat, 1,000 litres of water to produce 1 litre of milk, and more than 4,500 litres of water to produce just 300 grams of beef.[87] However, until recently scientists and policy-makers were giving little attention to the relationship between agricultural products, in particular meat and dairy, and water use. Today, it is known that about 27 percent of the water footprint of humanity is linked to animal products. Compared to crop products, animal products do not only require more land to obtain a certain nutritional value, but also more energy and water. By far, the largest contribution to the total WF of animal products comes from the first step, growing the feed: the 40 percent of all crops produced today are for feeding animals. If that amount was used directly for human consumption, there would be enough food to feed 9 billion in 2050.[88]

Scientific data suggests that if the anthropogenic WF is to be diminished, responsible and effective governance mechanisms have to be implemented to improve agriculture efficiency. At the same time, a global change in dietary patterns is needed, namely, the replacement of animal products by nutritionally equivalent local crops and other vegetables.

The protection of fresh water resources can no longer be addressed as a local or national issue. Rising consumers' awareness on the water footprint of the products they purchase is the first step to shed some light on the deep relationship between their decisions and the issues of water scarcity and degraded water quality in river basins all around the globe. Widening the scope of water management from the national to the international level permits a more intelligent use of water resources in agriculture and in the Food Supply Chain at a large. In fact, not only agriculture is intimately linked to water, but food processing and trade as well.

Processing is responsible for an important share of food products' and beverages' WF. The simple addition of ingredients such as syrup, sugar, oil, starch, sweetener, and other additives and conservatives (usually deriving from corn or other major crops) increases the water footprint of food and beverages.

Further water problems are closely tied to the structure of global economy: although in some countries most of the food still comes from the country itself, huge amounts of food, feed and other agricultural products (e.g. biofuels) are internationally traded in the form of agricultural commodities. Doing so, all countries virtually import and export water. About one-fifth of the global WF in the period 1996-2005 was not meant for domestic consumption, but for export. Many nations have significantly externalized their water footprint, without caring at whether the products they import cause water depletion or

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[86] Hoekstra A Y and Mekonnen M M 'The water footprint of humanity'109 *Proc. Natl. Acad. Sci. USA* (2012) 3232-3237.

[87] Chapagain A K and Hoekstra A Y 'Water footprint of Nations' (UNESCO-IHE, Value of Water Res. Rep. Ser. No.16, 2004). The water footprint can change according to the farming or breeding model adopted.

[88] Mekonnen M M and Hoekstra A Y 'National water footprint accounts: The green, blue and grey water footprint of production and consumption' (UNESCO-IHE, Value of Water Res. Rep. Ser. No. 50., 2011); FAO 'Livestock and Landscapes' (Fact Sheet, 2012).

pollution in the producing countries. Among them, some highly water-scarce countries as Malta, Jordan, and United Arab Emirates; also some water-abundant Northern European countries apparently depend upon freshwater resources in other nations (even if not for necessity).[89] Establishing links between importing and exporting countries is crucial to the development of foreign and trade policies that ensure a sustainable and secure import of the commodities that cannot be grown domestically.

The Western corporate-dominated agri-food system that emerged after the Second World War influences agricultural production frameworks, market dynamics, and consumption around the world. That means, it influences the way water resources are managed too. Agribusiness corporations such as ADM, Bunge, Cargill, and Louis Dreyfus have close ties to political and economic elites in the main agricultural regions of the world: therefore, they are the biggest traders of 'virtual water' embedded in commodities.[90]

Research into the allocation of water resources and the critical water and food nexus is growing, mainly via international collaborations and the adoption of an interdisciplinary approach including computer science, mathematics, economics, law, and social sciences.

According to the water analyst Betsy Otto, to ensure water allocation to the highest-valued uses water should be priced through the market as an economic good. The problem is, water is 'special' in comparison to other economic goods: not only it is essential and scarce, as food, but also fugitive, indivisible, bulky. All these factors contribute to make its trading and pricing unattractive. Besides, water must be considered a public good in many situations, and markets would fail in providing water to all in the desirable amount, damaging in particular the interests of the poor.[91]

How to value an invaluable resource, while ensuring that everyone gets access to it, being water access a human right?

A first step could be a differentiated treatment for different water uses. The formal recognition of the human right to water and sanitation access has been recently accomplished with a UN Resolution calling upon states and international organizations to translate this human right in national legislations and policies.[92] People are rights-holders and states are duty-bearers of this legal obligation. This very recognition does not give access to an uncontrolled, excessive use of water: everyone has the right to an estimated 80 litres water a day. That means, people could pay for the water usage exceeding this share on the basis of their income or according to which use is made of the additional amount (e.g. agricultural use, domestic use, etc.).

To solve the most impelling global water challenges, in particular the task of producing more food with less water, scientific research outcomes have to be translated into leadership decisions and consequent sustainable actions. Conventional industrial agriculture will be

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[89] Hoekstra A Y 'The hidden water resource use behind meat and dairy' (2012) 2 2 *Animal Frontiers* 3-8.

[90] Murphy S, Burch D and Clapp J 'Cereal secrets. The world's largest grain traders and global agriculture' (Oxfam Research Reports, 2012); Sojamo S et al 'Virtual water hegemony. The role of agribusiness in global water governance' 37 2 *Water International* (2012) 169-182.

[91] Van Der Zaag P and Savenije H H G 'Water as an economic good: the value of pricing and the failure of markets' (UNESCO-IHE, Value of Water Res. Rep. Ser. No. 19, 2006).

[92] Resolution 64/292 'The human right to water and sanitation' (adopted by the United Nations General Assembly on 28 July 2010).

questioned and involved in this decision-making process to ensure the right to safe, sufficient, and affordable water.

2.2 The international commitment to ensure food and environmental security

Crops, livestock, and water management are central in international and local debates on food and environmental security. Academics and scientists stress that more food will need to be produced from the same amount of land - or even less, if global crop demand is to be met with minimal environmental impacts.[93] Innovative solutions are required in order to trigger a sustainable intensification of the food system. Generating more food with less, while even reducing the environmental footprint, presumes a complex arrangement of agricultural practices, policies and management, together with the development and employment of new technologies.

In this context, true cost accounting would be a valid argument to help counteracting the conventional production philosophy that the food industry has imposed. The necessity of a new food system governance, which considers all costs and benefits of agriculture and food production, is made even greater by the outcomes of global warming, i.e. climate change. Agriculture and food production can no longer be analysed separately from environmental, economic and social issues. Food and environmental security, in particular, go hand in hand.

2.2.1 A new concept of food security

In the past, the preferred response to food shortages was generally an increase in the inputs: bringing more land into agriculture, using more chemical substances, exploiting a growing number of resources, depleting fish stocks.[94] This path is no longer viable. Competition for land from other human activities, mushrooming urbanisation, desertification and salinization, exploitation of major fisheries, and other consequences of unsustainable farming, are all evidences that render this solution unreasonable.

Agriculture has negatively affected the environment in many ways, through overuse of natural resources as inputs, or their use as a sink for waste and pollution. These negative externalities are imposing hidden costs on the human and natural environment, which are not reflected in the market and now threaten the life on Earth.[95]

The business-as-usual approach is clearly irreconcilable with the prior need to protect biodiversity and provide public goods from natural ecosystems.[96] However, there are different opinions about how this objective should best be achieved: some authors still affirm

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[93] Tilman D et al 'Global food demand and the sustainable intensification of agriculture' (2011) 108, 50 *Proceedings of the National Academy of the United States of America* 20260-20264.

[94] Goldfray H C J et al 'Food security: The challenge of feeding 9 billion people' 327 5967 *Science* (2010) 812–818.

[95] Dobbs T L and Pretty J 'Agri-environmental stewardship schemes and multi-functionality' (2004) 26, 2 *Review of Agricultural Economics* 220-237.

[96] Balmford A, Green R E and Scharlemann J P W 'Sparing land for nature: exploring the potential impact of changes in agricultural yield on the area needed for crop production' (2005) 11,10 *Global Change Biology*.

that agriculture needs to expand in new lands, others that agricultural systems should embrace biotechnologies or become solely organic.[97]

Food security is anything but a new issue on the international agenda. Nations have long agreed on the importance of improving food production methods, including through the application of science, to ensure food security. Governments all over the world expressed this certitude in various occasions - conferences, meetings, international treaties and agreements. The most commonly definition of food security was established by the 1996 World Food Summit, as the situation in which

> '(…) all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life.'

Immediately after the 2008-food crisis (which was the result of biofuel market tension, speculation, and export restrictions rather than of a production crisis) the debate focused on the balance between agricultural supply and demand. The discussion developed in the following years, evaluating long-term solutions to feed 9 billion people by 2050; the calls for global food production to be doubled grew consistently.

The landmark 2015 Paris Climate Agreement has underscored the importance of ensuring food security for all. The Agreement recognises 'the fundamental priority of safeguarding food security and ending hunger' and identifies some of the many weaknesses of current food production systems in the face of 'the adverse impacts of climate change'.

However, there are many reasons why it would not be wise to continue addressing the problem of granting food security solely as a global food supply issue.[98] Currently, the world is not suffering an overall food shortage, there is enough food to feed everyone. Besides, population growth is no longer the main driver of demand in agriculture food systems: increasing incomes, urbanisation, and changing dietary patterns, are exerting a strong influence too.[99]

The discussion must shift beyond productionism, which professes productivity as the sole norm for ethically evaluating agriculture. The challenge is to highlight food production methods and food consumption patterns, the whole organization of food systems, the correlated social and economic inequalities, the suffering of small-scale food producers and processors. Smallholders and family farms are left behind by initiatives focused on increasing production, despite the fact that they produce around 80 percent of the food consumed in the world and represent more than four fifths of the 570 million households living from agriculture.[100]

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[97] Pretty J 'Agriculture and food systems' in Rosin C, Stock P and Campbell H (eds.) *Food systems failure. The global food crisis and the future of Agriculture* (Routledge, 2012) 17-29.

[98] Fouilleux E, Bricas N and Alpha A 'Feeding 9 billion people: global food security debate and the productionist trap' (2018) 24, 11 *Journal of European Public Policy* 1658-1677.

[99] HLPE 'Sustainable agricultural development for food security and nutrition: what roles for livestock?' (2016)

[100] HLPE 'Second Note on critical and emerging issues for food security and nutrition. A note by the High-Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security' (2017); Bruno L 'Family farming: At the Core of the World's Agricultural History' Sourisseau JM (ed.) *Family farming*

2.2.2 Achieving food security through sustainable farming practices

The real novelty is the recognition of the urgency of a successful transformation of whole agri-food systems to ensure food sustainability in the face of climate change. The key to success is the reorganisation of agriculture and food production and consumption patterns, to ensure sound management systems of the Food Supply Chain in relation to international environmental goals.

This awareness has influenced the drafting of both the National Adaptation Plans (NAPs) and the Nationally Determined Contributions (NDCs).[101] During COP23, which took place last year in Bonn, the Koronivia Joint Work on Agriculture was adopted 'opening the doors to transformative action to make farmers' livelihoods and food supply more resilient, while mitigating climate change.'[102] The overall purpose for agriculture and food systems is to make the greatest possible contribution to the achievement of the SDGs, realising sustainability in terms of environmental, social, nutrition, and health outcomes.

Agricultural sectors are among the major responsible for GHG emissions in the Earth's atmosphere and for soil and water pollution. This is a valid argument to address agriculture first. In particular, this is the reason why it is so important to identify agricultural practices and technologies that aim to reduce the sector's carbon footprint, save water and energy, and reduce pollution and contamination.

All the already known 'sustainable' production paradigms exhibit some common attributes, despite their peculiarities, such as: the use of crop varieties and livestock breeds with a high ratio of productivity to use of externally and internally inputs; the quest for minimisation of external inputs; the predilection for technologies or practices that do not have adverse impacts on environment and human health; the harnessing of agro-ecological processes such as nutrient cycling, biological nitrogen fixation, predation and parasitism; a more productive use of human capital.

There is no universally validated technology or practice, no *panacea* to ensure sustainable intensification. This uncomfortable truth does not change the fact that the world needs new, sustainable mechanisms to make the best of both crop varieties and livestock breeds, promoting superior agro-ecological and agronomic management patterns.

Past debates about the use of new technologies for agriculture tended to adopt an either/or approach, emphasising the merits of particular agricultural systems or technological approaches while criticising others. This has been the case with respect to genetically modified crops, the use of pesticides, and the arguments for and against organic agriculture.

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and the worlds to come (Springer, 2015) 13-36; Lowder S, Skoet J and Raney T 'The number, size, and distribution of farms, smallholder farms, and family farms worldwide' (2016) 87, 16 *World Development.*

[101] Caron P et al 'Food systems for sustainable development: proposals for a profound four-part transformation' (2018) 38, 41 *Agronomy for Sustainable Development.*

[102] Dinesh D et al (CCAFS) 'A step forward for agriculture at the UN climate talks – Korovinia Joint Work on Agriculture' (CGIAR, Research Program on Climate Change, Agriculture and Food Security, 21 November 2017) <https://ccafs.cgiar.org/blog/step-forward-agriculture-un-climate-talks-—-koronivia-joint-work-agriculture#.W8BiyK17H_Q>.

There will always be trade-offs and local peculiarities to consider. Global agriculture demands a diversification of approaches, so that localities, traditions, crops varieties, and many other circumstances are given importance.

A successful agricultural policy should reflect a shared vision of the future of agricultural sustainability. The FAO recently devised the Climate-Smart Agriculture paradigm, to promote a *consensus* solution concerning sustainable and resilient food systems.[103] Climate-Smart Agriculture is an innovative approach pursuing three main objectives: sustainable increase of the productivity; improved adaptive capacity and resilience to shocks (adaptation); reduction in GHG emissions (mitigation). Surely, there may be compromises to accept as well as synergies between these goals, depending on natural resources allocation, socio-economic characteristics, and political systems. The share of the costs incurred by producers and consumers depends largely on policy and institutional environment; there is no 'one-size-fits-all' solution for producing more food in a circular economy. Indeed, there are different solutions embedded in diverse local contexts.

The polarised approach that characterises the issue of farming practices is the major obstacle to the development of a transparent conversation on sustainable agriculture. The barrier between scientific evidence and civil society is the result of misinformation and disinterest. Neither journalism nor politics are promoting the diffusion of academic reflections, papers, and scientific contributions, thus backing civil society's apathy. Major decisions impacting food production systems and food consumption patterns are left to the private sector, which is market-driven and inclined to the diffusion of incomplete, incorrect, or misleading information to hide forms of mismanagement.

It is now time for a renewed dialogue, which embraces civil society, farmers, scientists, stakeholders, and government representatives. Innovation is possible where bottom-up and top-down contributions are combined through interdisciplinary cooperation and transdisciplinary research. A sober look at today's achievements is the first step towards change.

[103] FAO 'The State of Food and Agriculture 2016' (Report, 2016).

3 THE ROLE OF GENETIC ENGINEERING

Today's challenges call for investments in agricultural knowledge, both formal and traditional, science, and technology. Agriculturalists have two main options to increase the productivity of the sector in a sustainable way: finalising better management practices or developing better agricultural technology.[104]

While our ancestors had no concept of genetics, they were still able to influence the evolution of organisms by a process called 'selective breeding' or 'artificial selection'. Charles Darwin coined these terms to describe the way humans choose the organisms with the most desirable traits and mate them to propagate these traits through their offspring. The repeated use of this practice over many generations resulted in dramatic changes to some of the foods we consume today (e.g. wheat, corn).

By contrast, what we typically consider 'genetic modification' today is a recent technology that permits to alter the genetics of an organism in a more specific and fast manner. Since genetic engineering of plants was first developed in the 1980s, plant biotechnology has evolved enormously. Plant breeders have made incremental gains in yield under climate stress. Over the last decades the research investment in plant response to drought and heat has increased significantly, largely driven by improvements in technology. Much of this investment has been promoted by the private sector in high-value crops such as maize; more recently, the investment in wheat and rice has also increased.[105]

Today, genetic engineering is the basis of a major multinational industry. Genetically modified plants for human consumption or animal feed are mainly grown in the US and Canada, with increasing production in Brazil, Argentina and China. Europe cultivates only a small amount of GM crops (mainly GM maize), though this is likely to increase in the future.

Globally, regulations on GMOs can mostly be divided into two inherently different types.

The regulation typified by the US relies on the principle of substantial equivalence. That means, the question posed by the legislator is whether or not a GM product is substantially the same as its generally accepted non-GMO counterpart. If it is found so, little further regulation other than food safety requirements is needed. Very recently, the U.S. Department of Agriculture (USDA) released its long-awaited proposed regulation for the mandatory disclosure of foods produced using genetic engineering.[106] The latter will regulate in detail the implementation of the 2016 federal law requiring the above-mentioned disclosures, marking the final step in a decades-long process of demanding and securing genetic engineered food labelling in the US. The USDA proposal presents a range of alternatives and makes few decisions, leaving uncertainty about the final outcome on critical points. The labelling law required regulations to be finalised by 29 July 2018 - nonetheless, USDA allows companies to postpone GMO labelling until as late as 2022.

Europe initiated a different viewpoint, based on the precautionary principle. It focuses on the method of production, arguing that GMOs are produced by a different technology or

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[104] Trethowan R M, Turner M A and Chattha M A 'Breeding strategies to Adapt Crops to a Changing Climate' Lobell D and Burke M. (eds.) *Climate Change and Food Security. Advances in Global Change Research* (Springer, 2010) 155-174.

[105] Ibid.

[106] USDA, Agricultural Market Service 'National Bioengineered Food Disclosure Standard' (3 May 2018).

production process, and therefore require specific regulation. A broad array of legislation, embracing detection, traceability, and labelling of GM organisms supports this policy.

By now, more than 40 countries have introduced traceability and labelling regulations, following mainly the US or the EU regulatory pattern. These regulatory frameworks usually differ according to whether labelling is mandatory or voluntary, and as to whether there is a tolerated threshold for the adventitious presence of genetically modified matter in non-GM products.[107]

Traceability has to be understood from a regulatory viewpoint as well as for its economic and social function. Clear and transparent labelling allows trust to be established between consumers and producers, ensuring the right to be informed and the right to a fully conscious purchase choice. The detection methods for analytically tracing GMOs are more and more accurate, and able to provide reliable information to end-users. A correct information is perceived as particularly important, due to the profound contrasts within the public opinion on the issue.

Some people are convinced that genetic engineering is an innovative technology, essential to tackle hunger and malnutrition, ensure food security, and contribute to climate change adaptation and mitigation. Many others distrust genetic modified foods, for two main reasons.

Firstly, they fear the consequences of GM technology's widespread use on biodiversity and human health. Experience has shown that there could be unintended bio-logical outcomes. The StarLink Affair is a case in point: the GM StarLink corn variety, prohibited for human consumption due to it containing substances similar to human allergens, happened to contaminate some corn supply in various US states, leading to depressed prices and risks to human health.[108]

Secondly, people are worried about the implications of the already consolidated monopoly of genetic engineered food and feed markets by few multinational companies.

Similarly, the latest genome editing methods are either welcomed as contributions to the progress of the food production system or feared as *Frankenfood*.

Concurrently with the foregoing trends, policy-makers did not successfully combine the technological and scientific progress with an adequate legal framework. As a result, the most debated issue in agricultural science is whether New Breeding techniques (NBTs) have to be considered, and consequently regulated, as traditional GM techniques. In recent years, the biotech-and agro-industry developed several new techniques, procedures and concepts, which are supposed to contribute to the building of sustainable and resilient farming systems. The term 'new breeding techniques' defines this category, which embraces various techniques allowing to modify plants and animals by intervening directly into their genomes. Most of them are gene-editing techniques, generally using enzymes to 'cut' parts of the genome, who then repairs itself.

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[107] European Commission, Directorate-General for Research and Innovation Biotechnologies, Agriculture, Food. 'A decade of EU-funded GMO research (2001-2010)', (Research Paper, 2010) 216.

[108] Perry M, 'Sustaining Food Production in the Anthropocene: Influences by Regulation of Crop Biotechnology' *Food Systems Governance: Challenges for Justice, Equality and Human Rights* (Routledge, 2016) 127-142.

In absence of an appropriate legislative framework and a genuine debate between scientists, policy-makers, and civil society, there is no agreement on how these new genetic engineering techniques should be categorised and consequently regulated. The private sector is obviously lobbying for a favourable statute and more permissive provisions, arguing that these new technologies are safer, more precise and less invasive than their conventional counterpart.

3.1 Legislation on GMOs

3.1.1 The European legislation

GMOs have an unpleasant reputation in the European Union, mainly due to the persistent fights of environmentalists and civil society against their spreading. Genetically modified organisms became a public issue in the 1990s, when transgenesis, the process by which foreign DNA is introduced in a cell, was perfected by the seed and agrochemical industry. In various European countries GMOs were massively rejected by the populace, be it in the food or in the fields. The restrictive EU regulation contributed to extremely low cultivation rates of GM crops within the European borders, and the rare usage as ingredients in processed food.

The Directive (EC) 2001/18[109] (GMO Directive) regulates the deliberate release into the environment of genetically modified organisms and their placing on the market within the Union. Regulation (EC) 1829/2003[110] on genetically modified food and feed, indeed, lays down a procedure for issuing decisions granting or rejecting authorisations that concern the placing on the market of GM food and feed; it regulates cultivation for the production of GM food and feed as well.

According to Article 2 GMO Directive

> "genetically modified organism' (GMO) means an organism, with the exception of human beings, in which the genetic material has been altered in a way that does not occur naturally by mating and/or natural recombination'.

The organisms covered by the Directive must be authorised after an environmental risk assessment. GM foods are also subject to strict traceability, labelling and monitoring obligations. The importance of labelling and traceability is exemplified by the fact that in absence of any mention of GM feed, EU farm animals are fed for a significant part by imported GM soya, maize and canola - despite consumers' general mistrust.[111]

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[109] Directive 2001/18/EC of the European Parliament and of the Council of 12 March 2001 on the deliberate release into the environment of genetically modified organisms and repealing Council Directive 90/220/EEC - Commission Declaration [2015] OJ L 106/1

[110] Regulation (EC) No 1829/2003 of the European Parliament and of the Council of 22 September 2003 on genetically modified food and feed [2003] OJ L 268/1

[111] GM crops amount for 55% of the protein-rich feed in the EU.

Directive (EU) 2015/412[112] authorised the cultivation of GMOs in Europe, giving Member States the choice to decide whether or not to apply restrictions on the cultivation of GM crops. That does not mean that states do have an unconditioned choice; indeed, they have the opportunity, during the authorisation procedure, to ask for an amendment to the geographical scope of the application. Doing so, they ensure that their territory will be excluded by the authorisation. In addition, after a GMO has been authorised, a Member State may prohibit or restrict the cultivation of the crop on grounds related to environmental and/or agricultural policy objectives, or other compelling basis such as town and country-planning, land use, socio-economic impacts, co-existence and public policy. Currently, one GM maize (MON810) is cultivated in the EU.

The European legal framework on GMOs has evolved through further legal initiatives. The European Food Safety Authority (EFSA), founded in 2002, is the body responsible for conducting the environmental and health risk assessment of any GMO to be marketed within the EU. More generally, efforts were made and are continuously being made to ensure that research addresses the main public concerns regarding GMOs. Various projects have been funded during the past decade, providing interesting sights and tools to better understand the challenges related to the introduction of GMOs in EU markets.[113] These projects dealt with biosafety research, risk analysis, coexistence and regulatory issues, consumer choice as well as risk/safety communication. Their findings could serve as a basis for future policy making.

Concerning the latest genome editing techniques, the European Commission has been wondering how to handle them since a while now, without reaching any definitive decision. Civil society is asking for an adequate and transparent legislation, while in the European Parliament there is no majority to support the deregulation of these biotechnologies. Pressures in the other direction come from the US and Canada, whose representatives had the opportunity to express their strong opposition to NBTs being defined as GMOs by the European legislator in occasion of the TTIP and CETA negotiations.

Recently, the French *Conseil d'État* submitted to the EU Court of Justice four questions on mutagenesis and oligonucleotide-based techniques.[114] The plaintiffs, *Confédération paysanne and others*, argued that some of the most recently developed techniques present risks for health and the environment; therefore, they brought judicial proceedings before the referring court, asking for the annulment of a national provision that exempts organisms obtained by mutagenesis from the obligations applying to GMOs.

In fact, Article 3 Directive 2011/18/CE read in conjunction with Annex I B, states that the Directive itself shall not apply to organisms obtained through certain techniques of genetic modification, such as mutagenesis. Mutagenesis involves the alteration of the genome of a

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[112] Directive (EU) 2015/412 of the European Parliament and of the Council of 11 March 2015 amending Directive 2001/18/EC as regards the possibility for the Member States to restrict or prohibit the cultivation of genetically modified organisms (GMOs) in their territory [2015] OJ L68/1.

[113] European Commission, Directorate-General for Research and Innovation Biotechnologies, Agriculture, Food. 'A decade of EU-funded GMO research (2001-2010)', (Research Paper, 2010).

[114] *Confédération paysanne and others v Premier ministre and Ministre de l'agriculture, de l'agroalimentaire et de la forêt*, C-528/16 [2018].

living species; unlike transgenesis, it does not, in principle, entail the insertion of foreign DNA into a living organism. As Advocate General Bobek pointed out in its opinion

> '[t]he Court is invited to clarify the exact scope of the GMO Directive, and (…) the ambit, rationale and effects of the mutagenesis exemption. More broadly, the Court is invited to ponder the question of time, more precisely on what role the passing of time and evolving technical and scientific knowledge should play with regard to both legal interpretation and the assessment of the validity of EU legislation, carried out with the precautionary principle in mind'. [115]

In July 2018, the EU Court of Justice stated that organisms obtained by mutagenesis are GMOs, thus, in principle, subject to the obligations laid down by the GMO Directive 2001/18/EC. However, the Court outlines,

> '[O]rganisms obtained by mutagenesis techniques which have conventionally been used in a number of applications and have a long safety record are exempt from those obligations, on the understanding that the Member States are free to subject them, in compliance with the EU law, to the obligations laid down by the directive or to other obligations.'[116]

According to the Court, excluding these organisms from the scope of the GMO Directive would compromise the objective pursued by the legislation itself, namely, to avoid adverse effects on human health and the environment. Besides, it would fail to respect the precautionary principle upon which the Directive is based. The European legislator is expected to provide an adequate legal framework, which is likely to have far reaching consequences on the development of the farming sector.

3.1.2 The Australian legislation

The use of genetically modified crops in Australia is regulated under a national scheme. The major contributions are contained in the Gene Technology Act 2000 (Cth) and in the Gene Technology Regulations 2001 (Cth). They are designed to protect the health and safety of people and the environment by identifying risks posed by the gene technology; also, they manage identified risks through regulating dealings with GMOs.

The Gene Technology Act 2000 (Cth) presents several key components. Firstly, it establishes the position of the Gene Technology Regulator, supported by the Office of the Gene Technology Regulator (OGTR) and several advisory committees that provide expert advice. Secondly, it regulates all dealings with live and viable GMOs in Australia, including research, manufacture, import, production, propagation, transport, and disposal of GMOs. Dealings involving the intentional release of a GMO into the environment are illegal, unless conducted pursuant to a licence from the Gene Technology Regulator. The licence applies to both limited, controlled releases (e.g. field trials) and commercial scale releases. Before issuing it, the Gene Technology Regulator must prepare a risk assessment and a risk management plan,

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[115] Opinion Of Advocate General Bobek, delivered on 18 January 2018.

[116] *Confédération paysanne and others v Premier ministre and Ministre de l'agriculture, de l'agroalimentaire et de la forêt*, C-528/16 [2018].

to identify any potential risks to the health and safety of people and the environment; eventually, the means of managing those risks have to be indicated.

According to the Australian law, a genetically modified organism is

> '(…) an organism that has been modified by gene technology; or an organism that has inherited particular traits from an organism (the initial organism), being traits that occurred in the initial organism because of gene technology; or anything declared by the regulations to be a genetically modified organism, or that belongs to a class of things declared by the regulations to be genetically modified organisms.'[117]

The law distinguishes between GMOs (live and viable) GM products. The OGTR does not directly regulate the use of GM products. Their use is regulated by other regulatory agencies, according to the situation: for example, the use of GM products in food for human consumption is regulated by Food Standards Australia New Zealand (FSANZ). FSANZ provides a centralised and publicly available database of all GMOs and GM products intended for human consumption that have been approved in Australia.

Each state and territory, including Western Australia, presents a legislation equivalent to the Commonwealth Act to ensure all dealings with GMOs are covered by the scheme.[118]

Gene technology is widely used in Australia - not only in agriculture but also in research, in health and medicine, in education, and in industry.[119] Concerning agriculture, several types of GM canola and GM cotton are grown commercially, and GM safflower was approved for commercial production in 2018. Today, over 99.5 percent of the cotton grown in the country is genetically modified: the GMOs are either herbicide tolerant or resistant to major insect pests (such as bollworm) - or both. Wheat is one of a number of GM crops that have been approved for experimental field planting: there have been trials of GM wheat that sought to improve salt tolerance, drought resistance, disease resistance, yield, grain quality and nutrient use efficiency. It is still not grown commercially and is not licenced for commercial release. Occasionally, grains such as canola, maize and soybean are imported in bulk into the country for processing and stock feed use, after the Australian government's agriculture department approval. To date, the Regulator has issued five licences for import into Australia of GM soy (two), maize (two) and canola (one) grain destined for processing and subsequent stock feed use. There are no legal requirements for labelling of stock feed containing authorised GM grains.

In light of the development of New Breeding Techniques within the last two decades, some of which capable of impressive results when compared to the conventional breeding methods, an Expert Advisory Group has been established to provide FSANZ with expert

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[117] Gene Technology Act 2000 (Cth) s 10.

[118] Prior to October 2016, GM crops in WA were regulated by the Genetically Modified Crops Free Areas Act 2003 (GMCFAA). By an order made under this Act all of WA was designated as an area where GM crops could not be grown, except by exemption order granted by WA Minister for Agriculture and Food. The Western Australian Government repealed the GMCFAA effective from 28 October 2016.

[119] Australian Government Department of Health, Office of the Gene Technology Regulator. 'Genetically modified organisms in Australia' (Fact Sheet, 2018).

advice. The team will provide information about the state of play of the newest gene engineering techniques and eventual food safety issues associated with their use.

3.2 GMOs worldwide: state of play and recent developments

3.2.1 The never-ending debate on GMOs safety and other fundamental issues

Research in agricultural biotechnology should aim at solving current constraints, with regard to productivity, health care and environmental protection. Developments in both public and private research sectors are closely dependent on the design and implementation of adequate regulatory frameworks. Modern biotechnology can contribute to human well-being only if the national and international regulatory frameworks are science-based, predictable, transparent and balanced. To achieve this goal, it is crucial for policy makers and the general public to be genuinely informed about the objectives and characteristics of the ongoing progress in agricultural biotechnology. At the same time, the research sector needs to be informed about, and involved in, regulation processes - so as to be better aligned with broader policy developments for food security, environmental protection and sustainable development. Therefore, it is paramount to involve public sector scientists in international negotiations and policy discussions.

Unfortunately, the recent developments of biotechnology have been characterised by both a gap in information and participation from the public sector and civil society, and a lack of transparency from the private companies. As a result, the driving force for biotechnology improvement is the big private industry of GMOs, which is not demonstrating a collaborative approach in responding to the questions and doubts arising on the issue of biosafety, both for humans and for the natural environment.

Despite the huge amount of time and resources dedicated to biosafety research, the scientific literature still complains about the insufficient quantity and quality of data about GMOs impact on Earth's ecosystems. A broad community of independent scientific researchers and scholars challenged recent claims of a *consensus* over the safety of GMOs. In a joint statement published in 2015, 300 scientists pointed out that

> 'the totality of scientific research outcomes in the field of GM crop safety is nuanced; complex; often contradictory or inconclusive; confounded by researchers' choices, assumptions and funding sources. It has raised more questions than it has currently answered. (…) Research for the public good has been further constrained by property rights issues, and by denial of access to research material for researchers unwilling to sign contractual agreements with the developers, which confer unacceptable control over publication to the proprietary interests.' [120]

According to them, the European research project, which is cited internationally as evidence for GM crops and food safety, presents no decisive data that could provide such

[120] Hilbeck A et al 'No scientific consensus on GMO safety' (2015) 27 4 *Env. Sciences Europe.*

confirmation.[121] The project, they argue, was designed to focus on the development of safety assessment approaches, rather than to test the safety of any single GM food. Therefore, it provides no evidence for claims about the safety of any single GM food or of GM crops in general.

Further concordant and opposite position statements contributed to the protracted controversy on whether GMOs are safe or not for human consumption and for the environment. Giving a closer look, the debate missed a more fundamental question. The application of genetic modification techniques was expected to boost agricultural production and promote sustainability. Has this happened, as forecasted by GMOs supporters? The debate needs to go beyond scientific and societal uncertainty on GMOs safety, and issues of risk perception, emotionality, tradition, and public opinion; also, the majority of assessments conducted only recognizes the toxicological health risks to humans of ingesting GM foods, and not broader environmental and social impacts. The attention needs to be focused on the core of the issue, which often remains undiscussed.

3.2.2 Genetic engineering outcomes so far

GMOs were presented as a twofold solution for both world's growing population and ecological concerns. By making crops immune to the effects of weed killers and resistant to many pests, genetic modification should have become strategic in the fight against global food insecurity, while benefiting the environment due to fewer applications of sprayed pesticides and herbicides. Nonetheless, there is scientific evidence that biotech achievements have not materialised as initially prophesied. While Europe largely rejected genetic modification as a response to the evolving agricultural reality, the United States and Canada welcomed it. Independent, academic, and industry research too show that the GM technology has fallen short of the promise.

A recent New York Times investigation illustrates that, according to FAO data, the US and Canada have gained no discernible advantage in yields (food per acre) when measured against Western Europe[122] - a region with comparably modernised agricultural producers.[123]

For example, Canada and Western Europe grow both various varieties of rapeseed, but Canadian farmers have adopted genetically modified seed, while European farmers have not. Well, the trend lines in rapeseed yields have not shifted in Canada's favour since the introduction of GM crops. In the last three decades, corn yields in Western Europe have largely kept pace with those in the US, while sugar beet yields in Western Europe have increased in the last decade more sharply than those in the US.[124]

Similarly, the last report of the National Academy of Sciences found that 'there was little evidence' that the introduction of genetically modified crops in the US led to yield gains

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[121] European Commission, Directorate-General for Research and Innovation Biotechnologies, Agriculture, Food. 'A decade of EU-funded GMO research (2001-2010)', (Research Paper, 2010).

[122] Western Europe is France, Germany, Belgium, Luxembourg, Switzerland, the Netherlands and Austria.

[123] *The New York Times*, Danny Hakim 'Doubts About the Promised Bounty of Genetically Modified Crops' (29 October 2016) <https://www.nytimes.com/2016/10/30/business/gmo-promise-falls-short.html>.

[124] Ibid.

beyond those seen in conventional crops.[125] At the same time, herbicide use is now increasing in the US, even as major crops like corn, soybean, and cotton have been converted to modified varieties. The report, trying to clear up the confusing landscape for the public and policy-makers, uses evidence accumulated over the last two decades to assess purported negative effects and benefits of currently commercialized genetically engineered (GE) crops.

Genetically engineered crops' most appreciated traits are insect-and-herbicide resistance.

Insect-resistant crops contain genes from *Bacillus thuringiensis* (Bt), a soil bacterium that provides crops with a built-in insecticide. Plants with this characteristic can kill targeted insects that ingest them. The crops have generally offered favourable economic outcomes for producers in the first years of adoption; however, gains in the long-term depend from a number of variables (e.g. institutional support, profitable and local markets). The sum of experimental evidence indicates that GE herbicide and insect resistance are contributing to immediate but not enduring increases in yield; at the same time, there is no evidence from USDA data that the average historical rate of increase in US yields of cotton, maize, and soybean has changed. Target insects have been slow to evolve resistance to *Bt* proteins, but where resistance-management strategies were not followed, damaging levels of resistance evolved in some of them.

Herbicide-resistant crops, indeed, can survive the application of an herbicide which would otherwise kill it. Most of them are engineered to be resistant to glyphosate (commonly known as the active ingredient of Roundup®, Monsanto's most diffused herbicide). Herbicide-resistant crops have been found to contribute to greater yield where weed control is improved due to the specific herbicides that can be used in conjunction with the herbicide-resistant crop. Total kilograms of all types of herbicide applied per hectare of crop per year declined when herbicide-resistant crops were first adopted. However, the decreases have not generally been sustained, and in many locations certain weeds have evolved resistance to glyphosate. In conclusion, further research is needed to improve strategies for management of resistance in weeds.

While reaffirming the inherent difficulty in detecting subtle or long-term effects for human health and the environment, the National Academy of Sciences found 'no substantiated evidence of a difference in risks to human health' between currently commercialized engineered crops and conventionally bred crops, 'nor did it find conclusive cause-and-effect evidence of environmental problems'. One thing is for sure: neither herbicides nor pesticides have been eradicated, indeed, they are still widely used in GM agriculture; glyphosate, in particular, has been at the centre of an international debate in recent years. Environmental Sciences Europe recently published a study which analyses this very issue.[126] The aim of the report is to understand why the US Environmental Protection Agency (EPA) and the International Agency for Research on Cancer (IARC) reached entirely opposed conclusions on the genotoxicity of glyphosate-based herbicides. In fact, the EPA considered the substance not likely to be carcinogenic to humans; indeed, the IARC classified it as probably carcinogenic to humans. One consideration above all demonstrates the reliability of the respective outcomes: while the EPA cited industry-commissioned and often unpublished

[125] National Academy of Sciences, Engineering, Medicines, Board on Agriculture and Natural Resources 'Genetically Engineered Crops. Experiences and prospects' (2016).

[126] Benbrook C M 'How did the US EPA and IARC reach diametrically opposed conclusions on the genotoxicity of glyphosate-based herbicides?' (2019) 31 2 Environmental Sciences Europe 1.

studies that focus on glyphosate alone, the IARC based its findings on independent, published and peer-reviewed studies, considering glyphosate derivatives too.

In the future, supporting science-based political decisions and improving the communication on 'green' genetic engineering will be paramount. The heart of the matter is to understand if New Breeding Techniques, otherwise than GM techniques in the past, will be effectively helpful in improving production and fostering resilience to climate change.

3.2.3 New Breeding Techniques

Upcoming biotechnologies are blurring the once clear distinction between genetic engineering and conventional breeding. In the past, crop-improvement has been achieved by farmers and scientists through interspecies crossing, polyploidy, and mutagenesis. Their aim was to create enhanced fruits, vegetables and other plants. These activities, categorised as conventional breeding, involve sexual reproduction, that means, selectively combining the genetic complement found in parental gametes in offspring in new ways. These traits are subjected to artificial selection, but resulting organisms are considered 'normal' and undergo no special safety or allergen tests.

The molecular and more precise technique generally known as transgenesis has been used to develop the overwhelming majority of GM drugs, such as insulin, and crops. First developed by scientists in the 1980's, it differs consistently in relation to its conventional counterpart. This process of genetic modification of organisms involves the creation of entirely new combinations of genes in an organism; given the complexities and uncertainties of genomic processes and genotypic-phenotypic interactions, GM organisms have been widely regulated.

Today, technologies such as RNA interference (recombinant techniques), CRISPR, and other cisgenic breeding techniques, face a great deal of regulatory uncertainty. They pose, similarly to the previous methods, environmental and health concerns. However, unlike their predecessors, they permit to intervene on genes enhancing or suppressing their activity in a less 'intrusive' manner.

The conventional distinction between *mutagenesis*, *transgenesis* and *cisgenesis* is largely used in academic writings, political debates and legislation as well, but does not accurately reflect the nature of the introduced genotypic changes. The lack of a proper and explicit terminology has resulted in little comprehension and appreciation of gene technology. K M Nielsen, together with some other exponents of the scientific literature, is calling for a new 'conceptual' organisation, based on a product-based perception, rather than a process-based one. The proposed categorisation would permit a net distinction between the different tools available to obtain genetic modifications, according to the low or high genetic distance attained in the resulting product. The terms *intragenic* and *famigenic* correspond respectively to a modification within a genome or within species in the same family; the expression *linegenic* corresponds to a modification within species in the same lineage; *transgenic* relates to solely modification within unrelated species; finally, *xenogenic*, refers to laboratory-designed genes, for which no naturally evolved genetic counterpart can be found or expected in nature.[127] Adopting this new conceptualisation, a more precise communication of the sources of

[127] Nielsen K M 'Transgenic organisms – time for conceptual diversification?' 21 *Nature* 227-228 (2003).

genetic variability would be possible, therefore overtaking some biological, ethical and religious unease.

The above-mentioned report of the National Academy of Sciences analyses how the whole asset of New Breeding Techniques might contribute to future crop improvements, and what technical and regulatory challenges they may pose.[128] The study committee delved into more than 900 research and other publications, attended public meetings and webinars, and read more than 700 comments from members of the public, to draft its conclusions.

Broadly speaking, emerging technologies promise to increase the precision and speed with which changes can be made to plant genomes and expand the array of characteristics that can be changed or introduced. Insect-and-disease resistance is likely to be introduced into more crop species and the number of pests targeted is also likely to increase. If deployed appropriately, such characteristics will almost certainly increase harvestable yields and decrease the probability of crop losses to major insect or disease outbreaks. However, the study committee concludes, it is too early to know whether these complex genetic changes will be successfully implemented.

In conclusion, the study strongly recommends balanced public investment in emerging genetic-engineering technologies to address food security issues. The report finds, regulation should focus on novel characteristics and hazards, rather than on the technology employed to obtain a certain plant or animal. Actually, any technologies developed for improving plant genetics, whether requiring genetic engineering or conventional breeding, can mutate foods in ways that are susceptible to raise safety issues; hence, the *product* should be regulated, rather than the *process* to obtain it.

Fully aware of the current limits in evaluating genetic engineering's *pros* and *contras* in terms of productivity and environmental impact, a further step seems essential for an adequate approach towards genetic engineering and sustainability issues. It is by now clear, that the global process of climate change adaptation and mitigation will be successfully dealt with, only by adopting a multi-sectorial approach. That means, policy regarding GE foods production and consumption needs to be analysed in all its dimensions – scientific, legal, social, and economic. Not all of them can be addressed by science alone.

Many seems puzzled by the strong social and cultural resistance to GM products. In the recent debate over GM labelling in the US, many GMO proponents criticised labelling as unscientific, because there is 'no substantial biological difference' between GMOs and traditional crops. Perhaps, this is not the point. The discussion is also about respecting people's cultural connection to food and their right to know where it comes from and what agricultural system they support when buying it.

Worldwide, governmental bodies still don't have figured out a proper blueprint to make effective and sustainable use of plant genetic resources for food and agriculture. So far, the development and deployment of GMOs has been a response to production challenges facing capitalists. Monsanto has long held out its products as a tool to help meet the food demand of a growing population. Today, the company still promotes GE as an instrument to

[128] National Academy of Sciences, Engineering, Medicines, Board on Agriculture and Natural Resources 'Genetically Engineered Crops. Experiences and prospects' (Scientific Report, 2016).

> '(…) help us feed the world in a sustainable way, by using less of our precious resources, conserving water and land, preserving natural habitat around the world.'[129]

That remains an industry mantra. Newer genetically modified crops claim to do many things (some may be effective, some not). It is nonetheless true that in practice, by shifting crucial crops like corn, soybean, cotton and rapeseed almost entirely to genetically modified varieties in many parts of the world, the industry is merely fulfilling a marketing opportunity. Monsanto acquisition by Bayer, just like the acquisition of Syngenta by the state-owned China National Chemical Corporation, aims at creating corporate giants that are even more adept at selling both GE seeds and chemicals. Why should these immense capitalist establishments promote the free-agrochemicals agriculture the planet is claiming?

3.3 Is genetic engineering itself a threat to biodiversity and sustainable development?

Through selective breeding in agriculture and animal husbandry, human beings became a dominant force of selection. Over the course of history, selective breeding was largely consistent with local environments, complementing other natural selective agents, such as local pests, soil conditions, and climate. The many animal and plant species, i.e. the genetic diversity, that characterises indigenous farming systems is the result of a complex co-evolutionary process between natural and social systems.[130] In most cases, the indigenous knowledge behind the agricultural modification of the physical environment is very detailed, thus permitting a resilient and sustainable production over time. Indeed, the advent of generalised commodity production and global markets entailed a shift of interest towards the production and selling of foodstuff products to make profits.

The worldwide area dedicated to transgenic crops expanded from about 3 million ha in 1996 to about 150 million ha by 2010.[131] The massive diffusion of transgenic crops cultivation under conditions of capitalist production is still ongoing. According to ISAAA, the global area of biotech/GM crops reached 189.8 million ha in 2017, compared to 185.1 million ha in 2016.[132] Biotech soybean varieties account nowadays for 50 percent of the global biotech crop area. In terms of the global area for individual crops, 77 percent of soybean, 80 percent of cotton, 32 percent of maize and 30 percent of canola were planted to biotech varieties in 2017. The four main global GM crops – soybean, maize, canola and cotton - are among the major commodities traded on world market.

This intensive, industrialised agriculture based on monoculture is unlikely to drive social-ecological change in a positive and sustainable direction in the long-term. One of the principal factors in decline of taxonomic diversity is precisely monocrop agriculture, which

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[129] Monsanto 'Looking for Information on GMOs? These Are the GMO Facts' (1 December 2016) <https://monsanto.com/innovations/biotech-gmos/articles/gmo-facts/>

[130] Altieri M A and Nicholls C I 'Agroecology and the Search for a Truly Sustainable Agriculture' (UN Environment Programme. 2005).

[131] FAO 'FAO Statistical Yearbook' (2012) 312–14.

[132] ISAAA 'Global Status of Commercialized Biotech/GM Crops in 2017: Biotech Crop Adoption Surges as Economic Benefits Accumulate in 22 Years' (Brief n 53, ISAAA, 2018).

also reduces genetic diversity. Population genetic diversity is key for ecosystem functions: it helps plant populations resist invasive species and pathogens and recover from climate extremes. Furthermore, genetic variation is a prerequisite for adaptive selection to occur, and without genetic variation populations cannot adapt in the face of environmental change. Its loss becomes a threat to ecosystems and organisms, including the crops we depend on, especially in an epoch of global climate change.[133]

3.3.1 Biodiversity conservation and environmental protection

The enormous diversity of living things on our planet co-evolved and exists within a network of biotic and abiotic relationships, constituting communities and ecosystems. The processes that govern ecological communities occur at various scales: they are dynamic, interactive, synergistic, and complex.[134] A broad *consensus* of biologists has determined that biodiversity and its complex interactions are crucial for essential ecosystems functions. In the words of John Muir, 'When we try to pick anything out by itself, we find it itched to everything else'.[135]

Overall, six regions are the sources of plant genetic richness providing the base for fully 95.7 percent of global food production. These regions correspond, generally speaking, to all of the world developing countries, while North America, Australia, Mediterranean and Euro-Siberia are totally reliant on non-indigenous crop diversity.[136] No region of the world can afford to be isolated from access to plant germplasm if it is to thrive. This statement is at the heart of the interdependence of the global food system; Plant Genetic Resources are a common heritage of humankind.

The current dependence of the global food system on only three major crops (maize, wheat and rice) is an emblematic representation of the poor state of agricultural biodiversity, which, in turn, is the result of decades of structural and ideological faults in agricultural production.

Between the eighteenth and nineteenth century, the US and most of Europe promoted a public sector-driven R&D in agricultural science, replaced by the private sector at the time of the Green Revolution. In the words of Kloppenburg Jr, the breeding programs of the developing nations 'made the seed the catalyst for the dissolution and transformation of pre-capitalist agrarian social formations' and promoted an establishment that 'grabbed plant germplasm from the Third World.'[137] Further developments reduced the global agricultural production to the control of a handful of seeds and their genes by a few companies, genetic information and data being by now highly privatised.

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[133] *Monthly Review*, Friedman M 'GMOs: Capitalism's Distortion of Biological Processes' (1 March 2015) <https://monthlyreview.org/2015/03/01/gmos-capitalisms-distortion-of-biological-processes/>

[134] Gonzalez A, Rayfield B and Lindo Z 'The Disentangled Bank: How Loss of Habitat Fragments and Disassembles Ecological Networks' (2011) 98, 3 *American Journal of Botany* 503-316.

[135] Muir J 'Nature Writings: The Story of My Boyhood and Youth; My First Summer in the Sierra; The Mountains of California; Stickeen; Essays' (Library of America, 1997).

[136] Oguamanam C 'Reintegrating farmers into the global food system' Kennedy A and Liljeblad J (eds.) *Food Systems Governance. Challenges for justice, equality and human rights* (Routledge, 2016).

[137] Kloppenburg Jr J R 'First the Seed: The Political Economy of Plant Biotechnology, 1492-2000' (Cambridge University Press, 1988).

Reduction of biodiversity has been associated with increased vulnerability to invasive species and pathogens, increased instability in the face of environmental change, and decreased productivity. The preservation of just one (seemingly) insignificant plant or animal can prevent a loss that could have a whole series of unpredictable consequences. The loss of a plant may entail the loss of an insect, the loss of an insect can mean that a bush loses its pollinator, and the loss of a bush can mean that an animal loses its food resource.

The rate and speed at which plant and animal species are currently disappearing, is leading the Earth into the next global extinction event. Scientists and academics have already issued a warning about the sad legacy that humans' behaviour today will leave for the upcoming generations. The overwhelming evidence that anthropogenic activities are changing the planet in unprecedented ways led to the (still controversial) proposal to recognise the '*Anthropocene'* as a new interval of geologic time.[138]

Still, humans have the know-how to mitigate and slowly reverse this trend: crop varietal selection, plant breeding, cropping patterns, and innovative ecosystem management approaches can all enhance production while conserving and even restoring natural resources. In this context more than ever, plant genetic resources for food and agriculture are the biological cornerstone of global food security and need to be protected for present and future generations.[139] Increasing the global yields of food crops will depend on combining genetic traits from a wide range of origins, wild species included.

For these many reasons, it is paramount to ensure that plant and animal genetic resources are *fairly and equitably* accessible by those farmers who need them. Genetic engineering techniques are key to secure the survival of the human species and all life on Earth. Currently, GM organisms are a patented commodity controlled by a few multinationals. Their irresponsible use threats the environment, the genetic agricultural and natural diversity, traditional food cultures, and the livelihoods of small-scale farmers all over the world. This is clearly in contrast with the intentions and provisions of the International Treaty on plant genetic resources for food and agriculture (Plant Treaty).[140]

The Treaty acknowledges multiple sovereign rights of nations over their genetic resources (without formally declaring them a common heritage) promoting an equitable sharing of the benefits arising from their use. Signed by 145 countries all around the world, the Treaty recognises the enormous contribution of farmers to the diversity of crops that today feed the human population. To provide farmers, plant breeders, and scientists with a facilitated access to plant genetic materials, it also creates a global information system. The most innovative solution to access and benefit-sharing is the establishment of a pool of genetic resources available for the purpose of utilisation and conservation for research, breeding, and training for food and agriculture (Article 10). This pool entails 64 of the world's most important crops, making up between eighty and ninety percent of the key food plants to guarantee food security.

Surely, the Treaty means to facilitate research, innovation and exchange of information, thus cutting down the costly and time-consuming processes of negotiation with individual gene

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[138] Ellis E C 'Anthropocene: A Very Short Introduction' (Oxford University Press, 2018).

[139] FAO 'Genetic resources for food security and nutrition' (Fact Sheet, 2015).

[140] The International Treaty on Plant Genetic Resources for Food and Agriculture, FAO Ref. No. 37 (opened for signature on 3 November 2001, entering into force on 29 June 2004).

banks. However, some important crops such as soy, tomatoes, and cassava are not included in the list (Annex I). Moreover, the crops listed in Annex I are not automatically participating in the Multilateral System: they also need to be under the management and control of the Contracting Parties and in the public domain (Article 11). Getting access to these genetic materials means being able to work with, and potentially improve, crops.

The current asset of intellectual property rules and the multiple inequities in accessing Plant Genetic Resources are not the only threats to biodiversity conservation. In fact, the misuse of agricultural biotechnologies can be as harmful as the strengthening proprietary control of genetic resources.

Today, the majority of GM acreage goes to industrial soy, canola, cotton and corn, for which the principal end-uses are biofuels, industrial animal feed, oils and ingredients for processed foods. Flying over areas like El Corralito indigenous community, Argentina, is a good rendering of the reality of GM crops massive diffusion. As denounced in a recent article on The Guardian, only a few years ago this region was still forest, home to the Wichì people and part of the majestic Gran Chaco forest that spreads across northern Argentina, Bolivia, Paraguay and Brazil.[141] This area, second only to the Amazon forest, is being cut down at a tremendous speed since 1996, when the Argentinian government authorised the introduction of GM soya bean and the country experienced the clearing of nearly a quarter of its native forests. Scientists estimate that over 1.2 million ha have been lost in the last two decades; a large share of that land has been converted to GM soybean cultivation for the extraction of oil, which is mainly used for biofuel and for animal feed. Around 43 million tonnes of soybean products are exported to Russia, the Middle East, Australia, Asia, and principally Europe (over a third of European soy meal imports is provided by Argentina). The country heavily relies on soybean, which is at the heart of its economy and makes up 31 percent of the national exports. Currently, there is no legal requirement for companies to document the origin of their products, nor to provide any evidence that they have cultivated and transformed them legally. Traceability remains obscure and the forests continue being devastated.

All in all, an array of detrimental consequences arises questions related to ecosystems survival and biodiversity loss. Earlier experiences suggest that environmental impacts start affecting the production functions of agricultural ecosystems and successively spread to the surroundings, disrupting other useful ecosystem services. Although the need for genetic diversity is increased in the face of climate change, current usage of genomic sequencing is heading towards a loss of genetic biodiversity, further mining the farmers' resilience and therefore their ability to counteract extreme weather events and diseases.

Genetic diversity is essential for livestock too. Between 2000 and 2014 nearly 100 native livestock breeds worldwide became extinct, as a result of farmers either turning to cross-bred cattle or replacing them with a small handful of industrial breeds.[142] With genomic sequencing, breeders select cattle with genes optimising meat and milk production, generating an entire population from just a few individuals. Meanwhile, genes that may offer immunity are lost, and farmers need to compensate buying vitamins and drugs to give to

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[141] *The Guardian Weekly*, Villalobos N 'Spotlight. The forests torched to help fill the world's dinner plates' (Australian ed., 26 October 2018) 199 21 15-16.

[142] *The Guardian Weekly*, David Cox 'Bad milk: the dangers of inbred dairy cows' (Australian ed., 26 October 2018) 199 21 30-31.

their cattle, or frozen semen containing the original genetic material to inject it into females in the herd. Production costs rise for the farmers while the resilience of livestock fades generation after generation.[143]

In some regions, such as Uganda and Burkina Faso, farmland is dwindling due to the growing urbanisation and local herders have responded to the pressures on land by cross-breeding local Ankole cattle with European Holsteins. The first have evolved over millennia to withstand long droughts and many local diseases but require vast areas to graze in comparison to the highly-productive European industrial species Holstein. The latter hybrid cattle breed produces more milk and meat, requiring less land. However, the genetic adaptations of the local Ankole are lost in the process and farmers are spending their money on antibiotics and pesticides, reaping no profits. Farmers all over the world are facing similar problems.

The path humanity chooses today will have far-reaching consequences on food and environmental security alike. The convergence of climate, energy, food and economic crises, are indicative of the need to reorient current food and agricultural systems towards sustainability, health, bio-cultural diversity, ecological resilience, and equity.

3.3.2 Social and ethical concerns

Besides environmental issues, substantial issues concerning social and health impacts of GMO diffusion remain unanswered. This happens mostly because of lack of transparent communication by manufacturers of genetic engineering technologies, but threats to social equity are posed by intellectual property rules, the increasing corporate ownership of genetic resources, and the extent of transnational agribusinesses' influence over public policy too. Moreover, the promotion of unfair global trade policies is partly attributable to the GMO big corporations lobbying through various channels.

The IAASTD presented a four years' work by more than 400 scientists and development experts from over 80 countries, who examined the interconnected problems of global agriculture, hunger, poverty, power and influence.[144] This work has been sponsored by the UN Environment Programme (UNEP), the FAO, the World Bank, and other relevant institutions. It represents the first-ever comprehensive global assessment of food and farming policies.

The report clearly indicates that chemical-intensive industrial agriculture is a major responsible for the degradation of natural resources on which human survival depends; furthermore, it is a threat to water, energy and climate security. The IAASTD warns that continued reliance on 'simplistic and often expensive technological fixes, including transgenic crops, is not a solution to reducing persistent hunger and poverty'. Indeed, the current management of natural resources could worsen environmental problems and exacerbate social inequity. Technologies such as high-yielding crop varieties, agrochemicals, and mechanization have primarily benefited transnational corporations and the wealthy, rather than the poor and hungry of the world.

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[143] Ibid.

[144] IAASTD 'Feeding the World, Greening the Planet. Summary of Findings of the International Assessment of Agriculture Knowledge, Science and Technology for Development' (Fact Sheet, 2009).

Little solid evidence exists to support claims that transgenic crops have contributed to equitable or sustainable development - or will do so in the future. In light of these considerations, the attitude of small farmers, fishers, pastoralists, and indigenous communities around the world shouldn't be mistaken for ignorance, lack of education, or unjustified fear. Producers are not afraid of biotechnologies *per se*; indeed, their approach reflects apprehension at the prospect of submitting to large multinational companies. As Pope Francis stated in its encyclical letter *Laudato Sì*

> '[F]ollowing the introduction of these crops, productive land is concentrated in the hands of a few owners, due to the progressive disappearance of small producers. As a consequence of the loss of their exploited lands, smallholders are obliged to withdraw from direct production. The most vulnerable of these become temporary labourers; many rural workers end up moving to poor urban areas (…) [T]he expansion of these company-owned crops destroys the complex network of eco-systems, diminishing the diversity of production and affecting local economies.'[145]

A grounded and sensible reasoning leads to concluding that the biggest problem associated with genetic engineered organisms is how they are implemented into the real world, rather than the biotechnology itself. Despite early promises, as soon as GE organisms are contextualised they end up being disappointing. Multinational companies largely benefited from cultivating GE crops and rearing GE livestock, pursuing their profits at the expense of food and environmental security.

The reckless usage of such powerful technologies needs to be reoriented towards public and transparent processes of evaluation, regulation, and improvement. Three main ethical concerns are linked to the cultivation and commercialisation of genetically engineered organisms. These issues are indicative of some broader considerations, arising from the investigation of the relationship between agricultural development, technology, and the environment.

Firstly, the proprietary nature of the enabling technologies used today. Private corporations aren't likely to share their genetic engineering technologies, currently held under strict patent and licensing agreements.

Secondly, the (in)capacity of modern biotechnology to achieve the greater food security that its supporters kept promising since the beginning. The experience of the Green Revolution led many observers, academics, and scientific researchers to concluding that, unlike small-scale farmers, leading companies in the genetic engineering sector firstly and disproportionately enjoyed economic benefits. Their monopoly diminishes the chances of achieving the desired outcomes in terms of sustainable food supply.

Finally, net benefits reach only some very circumscribed areas, while the powerful GM industry has vicious impacts on the economic and social environment worldwide, not even only where GM crops are cultivated. In fact, more abundant and cheaper food has been made available in certain regions of the globe, at a huge social, economic, and environmental cost. Consumers are fully aware of the price tag only, but they are ultimately paying for all sort of negative externalities - environmental pollution, health problems, poorness, and

[145] Encyclical Letter *Laudato Si'* of the Holy Father Francis on Care For Our Common Home (24 May 2015).

weaker social infrastructures. Moreover, families' consumption patterns in poor rural areas have been impacted through the loss of traditional crops and changes in land use models.

In the words of Manning R '[w]hat agriculture grows is not food but commodities, grain not to eat, but to store, trade and process'.[146] The focus of industrial agricultural corporations controlling seeds and genes is simply on wealth and capital creation. Food security and agricultural biodiversity concerns are completely overlooked. The complex chain of activities managed by these corporations only aims at creating and exploiting opportunities in the processing, preservation, marketing, branding, packaging, transportation, and customisation of food commodities.

All in all, the arguments for the intensive, emotional charged and constant debate on GMOs are perfectly clear. Although modern technology has opened up new opportunities in a wide range of sectors, including agriculture, moral and political concerns arise, polarising scientists, farmers, consumers and public interest groups, governments, and policy-makers alike.

3.4 Judicial responses

Legislators have not kept pace with the rapid technology developments in the field of genetic engineering. As a consequence, there is a widening gap in the regulatory systems around the globe in relation to farmers' rights to use genetic resources, to plant and exchange seeds, and to be safe from contamination from genetic engineered crops. The current situation undermines the capacity of justice institutions to fulfil their proper function and grant farmers an appropriate defence in the face of multinational corporations. National and international courts cover a role of primary importance in managing conflicts; they could create the enabling environment for social, economic and environmental progress if only a legislative basis would be provided.

The only mention of farmers' rights and contributions for the conservation and development of plant genetic resources can be found in the Plant Treaty. These rights entail the protection of traditional knowledge in the field of genetic resources for food and agriculture, the right to equitably participate in sharing benefits arising from their utilisation, and the right to participate in decision-making processes concerning the conservation and sustainable use of plant genetic resources (Article 9.2). The Plant Treaty, though, vests the responsibility to implement these rights to national governments. The latter governments did not fulfil this expectation yet.

In absence of an appropriate legislative framework, a human rights based approach would be a useful tool to ensure everyone's right to adequate food (Article 11), the enjoyment of the highest attainable standard of physical and mental health (Article 12), and other socio-economic rights enshrined in the International Covenant on Economic, Social, and Cultural Rights (ICESC).

The ICESC recognises some fundamental human rights. Among them, people's right to self-determination, by virtue of which 'they freely pursue their economic, social and cultural development' and 'all peoples may (…) freely dispose of their natural wealth and resources' (Article 2). Most relevant, the Parties to the Covenant recognise the right of everyone to

[146] Manning R 'Against the Grain: How Agriculture has Hijacked Civilization' (North Point Press, 2004).

work, including the right to the opportunity to gain his or her living by work which he or she freely chooses or accepts, and committed to take appropriate steps to ensure this right.

The explicit recognition of those rights should be taken into consideration when dealing with litigations involving farmers over GM seeds and coexistence of farming techniques. Indeed, as of today, these rights still have to enter the judicial debate. Higher courts have yet to prove their sensibility on issues affecting farmers (and consumers alike) in face of leviathan companies such as Monsanto.

On more occasions organic farmers unsuccessfully claimed their right not to be contaminated by GM crops. Organic seed – which is by definition free of GM contaminates - is the foundation of organic agriculture. Because of GM contamination, the organic seed's integrity is compromised, with broad-reaching impacts on the viability of organic farms and the credibility of organic products themselves. Furthermore, organic farmers face the threat of patent litigation. Seed and plant patent and intellectual property schemes, oblige farmers to buy their seeds from the seed company, being prohibited to retain the seeds from the previous harvest. The current regulatory framework causes hardship through loss of autonomy, harassment, and litigation across the globe.

In 2011 three agrochemical firms (Monsanto, DuPont, and Syngenta) already controlled 53 percent of the global commercial seed market, while the top ten seed firms, with a majority stake owned by U.S. corporations, accounted for 73 percent.[147] The increasing concentration of power has fundamentally changed farming: instead of continuing the historical tradition of farmers having full access to seeds that they had cultivated over centuries, these few companies now own the *sine qua non* of cultivation.[148] Further implications of the present seed patent regimes on farmers' livelihood surely are: higher seeds' prices, reduced seed options, and barriers to development and innovation. What is equally serious is the lack of a clear will on the part of the authorities to deal with these and further matters, such as violations of independent scientific research, a significant loss of plant biodiversity, and the spreading of weeds that are by now resistant to herbicides and insecticides used in GM farming.

Since 1997, Monsanto filed suit against farmers 147 times in the US; some of them ended in confidential settlements, some others in winning judgements against farmers that have been found to make use of Monsanto seeds without paying the required royalties. Seventy-two lawsuits ended in recorded damages awarded to the company, for a total award of more than $23 million.[149] This sum does not consider other costs incurred by farmers, such as expert witness fees, post judgement interests, plaintiff's attorney fees, and costs of testing fields. Other seed giants such as Syngenta, Pioneer, and BASF also sue farmers to enforce their patents.

The number of lawsuits is likely to increase as the companies obtain more patents. The short-sightedness of legislators, regulators, and courts allowed, if not encouraged, the use of patent law as a weapon against the farmers. Similarly, the absence of any responsibility of GM patent

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[147] Action Group on Erosion, Technology and Concentration 'Who will control the Green Economy?' (22 December 2011).

[148] Center for Food Safety 'Seed Giants vs. U.S. Farmers' (Report by the Centre for Food and Safety and Save our Seeds, 2013) 2.

[149] Ibid.

owners for the negative externalities GM crops cultivation involves, left non-GM farmers defenceless. The analysis of the following cases suggests that there are still no adequate legal tools nor equitable rights to invoke vis-a-vis the courts.

3.4.1 Monsanto Co. et al. v. Geerston Seed Farms et al

Monsanto Co. et al. v. Geerston Seed Farms et al.[150] involves a challenge to the decision issued by the Animal and Plant Health Inspection Service (APHIS)[151] approving the unconditional deregulation of Roundup Ready Alfalfa (RRA). RRA is a variety of alfalfa that has been genetically engineered to tolerate the herbicide Roundup®. Petitioners are the owner and licensee of the intellectual property rights to RRA. Respondents are conventional alfalfa growers and environmental groups.

In response to the petitioners' deregulation request, APHIS prepared a draft Environmental Assessment (EA) and solicited public comments on its proposed course of action. The agency concluded that the introduction of RRA would not have any significant adverse impact on the environment, and accordingly decided to deregulate RRA unconditionally and without preparing an Environmental Impact Statement (EIS).

Respondents filed an action challenging that decision, complaining that it violated the National Environmental Policy Act (NEPA) and other federal laws. The District Court held, *inter alia,* that APHIS violated NEPA when it deregulated RRA without first completing a detailed EIS. To remedy that violation, the court vacated the agency's decision completely deregulating RRA; enjoined APHIS from deregulating RRA, in whole or in part, pending completion of the EIS; and entered a nationwide permanent injunction prohibiting almost all future planting of RRA during the pendency of the EIS process.

Petitioners and the government appealed, challenging the scope of the relief granted (without disputing that APHIS's deregulation violated NEPA). The United States Court of Appeals for the Ninth Circuit affirmed that the District Court had not abused its discretion in rejecting APHIS's proposed mitigation measures in favour of a broader injunction.

The U.S. Supreme Court ruled on the case in June 2010, concluding, contrary to the lower court's ruling, that the District Court abused its discretion in enjoining APHIS from effecting a partial deregulation and in prohibiting the planting of RRA pending the completion of a detailed environmental review. According to the Supreme Court, before a court may grant

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[150] Monsanto Co. et al. v. Geerston Seed Farms et al. 561 US 139 (2010).

[151] The Plant Protection Act (PPA) provides that the Secretary of the Department of Agriculture may issue regulations "to prevent the introduction of plant pests into the United States or the dissemination of plant pests within the United States." Pursuant to that grant of authority, the Animal and Plant Health Inspection Service (APHIS) promulgated regulations that presume GM plants to be "plant pests" - and thus "regulated articles" under the PPA—until APHIS determines otherwise. However, any person may petition APHIS for a determination that a regulated article does not present a plant pest risk and therefore should not be subject to the applicable regulations. APHIS may grant such a petition in whole or in part. In determining whether to grant nonregulated status to a GE plant variety, APHIS must comply with the National Environmental Policy Act of 1969 (NEPA), which requires federal agencies "to the fullest extent possible" to prepare a detailed environmental impact statement (EIS). The agency need not complete an EIS if it finds, based on a shorter statement known as an environmental assessment (EA), that the proposed action will not have a significant environmental impact.

such a permanent injunction, the plaintiff must satisfy four requirements. In particular, he has to demonstrate

> 'that he has suffered an irreparable injury; that remedies available at law, such as monetary damages, are inadequate to compensate for that injury; that a remedy in equity is warranted; and that the public interest would not be disserved by a permanent injunction'.[152]

According to the Supreme Court, none of the factors supported the District Court's order, and, mostly important, respondents could not show that they would have suffered irreparable injury if APHIS would have been allowed to proceed with any partial deregulation. This is due to two main reasons

> 'First, if and when APHIS pursues a partial deregulation that arguably runs afoul of NEPA, respondents may file a new suit challenging such action and seeking appropriate preliminary relief. Accordingly, a permanent injunction is not now needed to guard against any present or imminent risk of likely irreparable harm. Second, a partial deregulation need not cause respondents any injury at all; if its scope is sufficiently limited, the risk of gene flow could be virtually non-existent'.

Reversing the judgment of the Ninth Circuit, the Supreme Court left the farmers defenceless.

The dissenting of J Stevens contains a deeper investigation of the peculiar background of the litigation, offering an interesting point of view.[153] His conclusions back the District Court, which, in his opinion, 'may have felt it especially prudent to wait for an EIS before concluding that APHIS could manage the RRA's threat to the environment'. J Stevens interprets the lower court's ruling as an exercise of its *equitable discretion* to balance the interests of the parties and the public.

The Justice complains that the Supreme Court did not dispute the District Court's critical findings: that Roundup Ready Alfalfa (RRA) can contaminate other plants; that even planting in a controlled setting had led to contamination in some instances; and that the APHIS has limited ability to monitor or enforce limitations on planting. Indeed, the majority condemned the court for 'enjoining APHIS from partially deregulating RRA'. However, he expresses certainty that such relief has not been ordered, and the Supreme Court should not have readily assumed that it did so.

In fact, he continues, until petitioners' reply brief neither petitioners nor the government submitted to the Supreme Court that the District court had exceeded its authority enjoining APHIS from partially deregulating RRA – 'in any sense, even in accordance with the procedures established by the law'. Only after respondents alleged that Monsanto's injury would not be redressed by vacating the injunction, insofar as RRA would still be a regulated article, did petitioners bring the issue to the Supreme Court's attention. According to J Stevens, the lower court's order can fairly be read to address only total deregulation orders and the particular partial deregulation order proposed by the court by APHIS. This interpretation is more consistent with the District Court's accompanying opinion, and with

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[152] Monsanto Co. et al. v. Geerston Seed Farms et al. 561 US 139 (2010) 3.

[153] Monsanto Co. et al. v. Geerston Seed Farms et al. 561 US 139 (2010) 3, J Stevens dissenting, 1.

APHIS own decision not to contest what according to the Court, was an infringement of the agency's statutory authority.[154]

Anyway, even assuming that the Supreme Court has correctly interpreted the District Court's judgement, the dissenting Justice does not agree with the majority. In his opinion,

> '(…) when faced with an unlawful agency action, a set of parties who have relied on that action, and a prayer for relief to avoid irreparable harm, the court is operating under its power of equity (…) And historically, courts have had particularly broad equitable power, and thus broad discretion, to remedy public nuisances and other purprestures upon public rights and properties, which include *environmental harms*.'

A deeper analysis of APHIS conduct is paramount to understand the dissenting opinion. In the midst of a deregulatory trend in the agricultural sector, Monsanto presented its petition, asking APHIS to deregulate RRA to allow it to be sold and planted nationwide. APHIS allowed public comment on its draft EA, receiving 663 comments - 520 of which opposed deregulation. Evidently, farmers and scientists opined that RRA could effectively contaminate non-GM alfalfa crops, thus destroying the American export market for alfalfa, and other plants alike. Despite substantial evidence that RRA genes could transfer to other plants, APHIS issued a finding of 'No Significant Impact' and agreed to deregulate RRA unconditionally.

With no EIS to wait for, and no regulation blocking its path, Monsanto began selling RRA, while farmers and environmentalists brought a lawsuit to challenge APHIS's decision. The District Court found APHIS's reasons unconvincing: the agency rested its decision on the assertion that 'contamination risk is not significant because it is the organic and conventional farmers' responsibility to protect themselves and the environment', and, 'if weeds acquire Roundup® resistance, farmers can use alternative herbicides'.[155] In light of these facts, the District Court concluded that it was likely to be a serious environmental harm, and granted summary judgments for the plaintiffs.

At this point, the question of the remedy needed to be faced. The parties proposed final judgements. While considering them, the District Court explained that, ordinarily, the remedy for failure to conduct an EIS is to vacate the permit that was unlawfully granted. In its preliminary injunction, the court ordered that no new RRA could be planted until APHIS completed the EIS or the court determined another appropriate relief. However, given the difficulties concerning this particular case (some farmers had begun planting genetically modified RRA), the court permitted the growers who had already purchased the seeds, to plant them within the next 3 weeks; and those who already planted them, to harvest, use or sell them. In J Stevens' words, the court 'grandfathered those farmers who had relied, in good faith, on APHIS's actions.'

The parties submitted competing proposals for permanent injunctive relief. On the one hand, APHIS and the petitioners sought a remedy that could facilitate the continued and dramatic growth of RRA, which the Court recognised as a 'deregulation with certain conditions' rather than a partial deregulation. On the other hand, the plaintiffs requested a

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[154] Ibid, 8.

[155] Ibid, 3.

complete ban on planting, growing or harvesting RRA until the full EIS had been prepared. The court declined both proposals on the grounds that

> '[N]either APHIS nor Monsanto had provided evidence that suggests whether, and to what extent the proposed interim would actually be followed, and comparable conditions already proved to fail in preventing contamination. APHIS, moreover, conceded that "it does not have the resources to inspect" the RRA that had already been planted, and so could not possibly be expected "to adequately monitor the more than one million acres of [RRA] interveners estimate [would] be planted" under their proposal'.[156]

Eventually, the court adopted a compromise. Farmers who had already invested time and money planting RRA in good faith couldn't be forced to tear up their crops, and still, small amounts of harvesting could be monitored. Moreover, while contamination is unstoppable and likely to destroy the non-GM crops, alfalfa is only a small percentage of Monsanto's overall business. In light of these considerations, the court vacated APHIS deregulation and stated that before granting deregulation petition, even in part, the federal defendants shall prepare an EIS. Until then, no further RRA may be planted.

Ultimately, faced with two deregulations proposals, the District Court reasonably concluded that any deregulation, even in a limited geographic area and with stringent conditions, requires an EIS under NEPA. The same applies to any deregulation of a genetically modified, herbicide-resistant crop that can transfer its genes to other organisms and cannot be effectively monitored, 'especially when the environmental threat is novel'. Against that background, Monsanto's proposal was incompatible with the court's determination that there is a substantial risk of gene spreading and that APHIS lacks monitoring capacity. While limits on planting or harvesting may operate fine in a laboratory setting, many of them will not be followed and cannot be enforced in the real world. Environmental and economic consequences of gene transfer would be devastating. As J Stevens points out

> 'Although a mere possibility of a future nuisance will not support an injunction, courts have never required a proof that the nuisance will occur; rather, it's sufficient that the risk of its happening is greater than a reasonable man would incur.'

All in all, the District Court's decision that more study was needed to assess whether limits on deregulation could prevent environmental damage, appears a simply and just application of its discretion. However, J Stevens novel perspective found no audience at the time, nor in the following years. There still is no judicial response to the threats posed by GMOs contamination to economy, social infrastructures, and the environment.

3.4.2 Farmer vs Farmer

In September 2013, the U.S. Supreme Court upheld Monsanto's biotech seed patents once more, thus disappointing the expectations of the Organic Seed Growers and Trade

[156] Ibid, 5.

Association (OSGATA), together with dozens of organic and conventional family-farmers, seed companies and public advocacy interests.[157]

OSGATA et al tried to stop Monsanto from suing farmers if their fields incidentally contain a few plants presenting the company's GM traits, asking the company for a pledge. When the company refused, the activists filed an action against Monsanto, and were heard by the District Court. The court sided with Monsanto. OSGATA et al decided to file a brief with the U.S. Court of Appeals for the Federal Circuit, asking to reverse the lower court's decision. The oral argument was heard, but the Court of Appeals confirmed the District Court decision; the plaintiffs did not present a sufficient controversy to warrant adjudication by the courts. Even the U.S. Supreme Court refused to hear the case, failing to grasp the extreme predicament family farmers founded themselves in.

At least, these and other cases attracted global attention on a major worldwide problem: farmers have to sign licence agreements with seed companies, thus giving over many of their rights, just to be able to grow a GM crop. These agreements permit intellectual property rights owners (patent owners), to exercise an onerous level of control on what farmers can do with their crops. Moreover, GMO companies are not held accountable for environmental contamination of other crops, nor responsible for the contamination of entire ecosystems. Current farming and certifying regulations, as any other existent regulatory framework, leave farmer versus farmer in trying to resolve these disputes.

In 2014, the Western Australian Supreme Court has rejected claims by an organic farmer (Marsh) that his organic certified farm was contaminated by a neighbouring farmer (Baxter) growing GM canola.[158] Marsh sued his neighbour claiming that GM canola from his land drifted onto his organic oats, rye and sheep farm. After notification from Marsh, the National Association of Sustainable Agriculture Australia (NASAA) temporarily suspended its organic certification on about 70 percent of the property in late 2010. Australia's legislation dictates a particularly strict policy concerning GM contamination: unlike the US, the EU, and Japan, which allow trace amounts of GM crops in organic foods in acknowledgement of cross-pollination by wind or pollen transfer, Australia maintains a zero threshold.

In 2012, Marsh sued Baxter for the economic losses incurred when he sold his crops at conventional prices, rather than at premium prices as organic. He wanted financial compensation of $85,000 from Baxter, as well as a permanent injunction issued by the Court banning him from planting GM crops in the fields adjacent to his property.

The two causes of action brought against Baxter for damages were for common law negligence (i.e. for breach of an asserted duty of reasonable care owed to Marsh to ensure there was no escape of any GM material into his farm) and for the tort of private nuisance. Marsh only claimed a financial injury against Baxter, not to have suffered any physical damage or injury to himself, his animals or his land. Justice Kenneth Martin dismissed both causes, stating that the decision to withdraw organic certification was made by the NASAA and it was that decision that cost Marsh about $85,000 in reduced income. Indeed, Mr. Baxter was

> 'not to be held responsible as a broad acre farmer merely for growing a lawful GM crop and choosing to adopt a harvest methodology (swathing), which was

[157] Organic Seed Growers and Trade Association, et al. v. Monsanto Company et al. US (10 June 2013).

[158] *Marsh v Baxter* [2014] WASC 187.

> entirely orthodox in its implementation. (…) Nor could Mr Baxter be held responsible, in law, for the reactions to the incursion of the Marshes' organic certification body, NCO.'

No mention is made of the slightest possibility to recognise any sort of liability held by the GMO corporations or the farmers using genetic technologies in the face of organic farmers' socio-economic rights. The disputes concerning farmers' rights against multinational interests are likely to become even more frequent in the years to come, as new areas of development open up for biotechnologies. An illustrative example is that of GM honeybees, recently created in laboratory with the revolutionary gene-editing technique CRISPR. Beginning a decade ago, the decline of honeybees in the whole European continent is still undergoing. The alarming phenomenon is linked to the application of clothiandin to crops, and other disrupting practices of industrial agriculture farming. Since then, scientist around the world are working on genetically modified honeybees: their aim is to create pest-resistant bees. Beekeepers now fear that the only area big agri-food companies do not control yet, i.e. pollination, will be subjected to patents and privatisation.[159]

3.5 Genetic engineering's potential in fostering a sustainable agriculture

Food systems researcher Montenegro M is right in stating that thirty years ago humanity didn't understand what the then-new genetics was, or what it might yield: people thought of genetics as 'the key to scientific mastery of nature, as if there were no context, no agency in the object, no imperfection in human knowledge.'[160]

Today, humankind is slowly understanding the intricate connections between genes and environments, discovering ecosystems whose bonds aren't smooth nor predictable. In a context of continuous development, according to the researcher, there is an opportunity to escape definitions and beliefs of the past – in order to treat agriculture and food as the complex systems they are.

The complexity of the technologies involved calls for a new conversation, as it should happen in democratic societies. Isolating breeding technologies from their historical, political and social contexts is certainly of no help: GMOs have been undoubtedly developed as a tool to boost the scale of industrial agriculture and are still serving this goal. However, new technologies, such as CRISPR, could pave the way for a new approach to GMO research and production schemes.

3.5.1 Are there alternative approaches to business-as-usual models?

Evidently, the lack of an overarching sustainability or justice framework for genomic agricultural science is at the core of the problem. So far, the common goal in livestock and crops editing has been to generate high-profits from cattle, pigs, sheep and a few intensively

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[159] *The GuardianWeekly*, Warner B 'The invasion of the Frankenbees. The dangers of building a better insect' (Australian ed., 26 October 2018) 34-40.

[160] *Ensia*, Montenegro M 'Opinion: CRISPR is coming to agriculture – with big implications for food, farmers, consumers and nature. Gene editing offers dramatic advances in speed, scope and scale of genetic improvement. It also offers an opportunity for more nuanced GMO governance.' (28 January 2016) <https://ensia.com/voices/crispr-is-coming-to-agriculture-with-big-implications-for-food-farmers-consumers-and-nature/>.

cultivated crops. Their commercialisation by the huge corporations dominating the food industry has had various negative implications on small-scale farmers, consumers, and ecosystems. Evidently, their interests have not been considered; this contributes to the growing *a priori* refusal by civil society to accept any kind of genetic engineered product, paying no attention to differences in the engineering process and outcomes.

There is one single example of a different commercialisation scheme, involving Monsanto and its Indian partner Maharashtra Hybrid Seed Company. The latter developed a Bt gene that produces a toxin that kills a boring caterpillar responsible for huge losses of crops (eggplants, in particular). This should avoid repeated rounds of pesticide spraying and ensure more abundant harvests. The gene comes from the soil bacterium *Bacillus thuringiensis*, which has an agricultural history dating back to nearly one hundred years; in recent age, it has been one of the longest-running applications of GM foods.

Instead of proceeding with the usual commercialisation of the GM crops, Monsanto has granted royalty-free, non-profit license to the government-operated Bangladesh Agricultural Research Institute (BARI) with technical assistance from the Cornell University and funding from USAid. Monsanto still owns the technology, but BARI developed a Bangladeshi variety of brinjal (eggplant) called Bt Brinjal, containing the genetic technology, which farmers are encouraged to plant. They have also been permitted to save the seeds to use them in future.

Many contrasting articles and field tests have been published since then, from GMO supporters and anti-GMO activists alike. The Guardian has visited or spoken to all but one of the twenty farmers initially growing the Bt crops and found extremely mixed results concerning the effective capacity of the gene technology to improve production rates. In regions where the results were satisfying, the Bt crops ensured higher profits to the owners, and less costs related to pesticides use.[161] However, they were not always well accepted by the public opinion, interpreting Monsanto's concession as a strategy to warrant the acceptance of the GM technology in South Asia, where it is widely debated. Moreover, the lack of a Bangladeshi GM legislation entails that Bt Brinjal are commercialised without any mention of being GM products, arising further polemics.

The lack of peer-reviewed published data on Bt Brinjal to back up years of trialling (since 2005) and planting (since 2013) is surprising, given the massive interest in hard data of what seems to be the first commercialised 'humanitarian' GM crop, as Claire Robinson from GMWatch addresses it.[162] Even more startling is the recent article published on Frontiers in Bioengineering and Biotechnology, claiming dramatic benefits from the Bt crop. The article has been welcomed in a tweet by the food columnist Tamar Haspel as an 'unequivocal GMO win'.

Actually, the article in question does not refer to any peer-reviewed data, neither concerning the yields increases nor the pesticide use cuts.[163] Moreover, no indication is given as to

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[161] *The Guardian*, Saad Hammadi 'Bangladeshi farmers caught in row over $600,000 GM aubergine trial. Activists criticise pioneering pilot scheme to grow genetically-modified aubergines backed by USAid finance' (6 June 2014) <https://www.theguardian.com/environment/2014/jun/05/gm-crop-bangladesh-bt-brinjal>.

[162] *GMWATCH*, Robinson C 'GM Bt Brinjal in Bangladesh: GMO win or smoke and mirrors?' (3 September 2018) <https://gmwatch.org/en/news/latest-news/18447-gm-bt-brinjal-in-bangladesh-gmo-win-or-smoke-and-mirrors>.

[163] Shelton A M et al 'Bt eggplant Project in Bangladesh: History, Present Status, and Future Direction' 6 106 *Frontiers in Bioengineering and Biotechnology* (August 2018).

whether the Bangladeshi government or private entities are subsidising the programme by giving the farmers free or subsidised pesticides and seeds, when claiming that Bt Brinjal increases farm profitability. The fact that Tamar Haspel has been involved in panels and conferences by the agrochemical industry front-group Genetic Literacy Project and admitted receiving 'plenty' of money from pro-agrochemical industry sources, also contributes to raising distrust concerning the reliability of her GM-promoting activities.[164]

Once again, the problem stems from both deficient legislation and avoidance of public participation in agricultural policies, which are impacting the entire state's production model. Eggplants are the most consumed vegetable in Bangladesh, along with potatoes, and are extremely important for social and cultural reasons. Implementing farming policies that involve GM crops without considering the delicacy of the matter, proves the insensibility and inaccuracy of seed companies and governments. The same mistakes are likely to be repeated within the framework of the latest technologies, such as CRISPR, if no improvements are made in the implementation process.

3.5.2 CRISPR technology

CRISPR is an innovative genetic engineering technology that has been welcomed as a powerful tool to promote just and sustainable food. However, to use it in a fair, equitable, and sustainable manner, it is paramount to develop a policy framework that reflects the nuances of its biology and countless applications.

CRISPR can make precise mutations by substituting existing DNA sequences with desired ones; it can disable whole genes by snipping them out or via imprecise repairs that knock out gene function; the Cas9 enzyme itself can be manipulated to enhance or suppress gene expression, which is *per se* an interesting mean to control genes without any editing. Also, CRISPR can be used to introduce new genetic material, providing a big boost to the emerging technology known as 'gene drive'. This technology works by promoting likelihood of genes inheritance, thus accelerating the spread of a modified gene throughout an entire population. Gene drive can virtually be applied to every sequenced organism to be edited or engineered.

Applied to agriculture and the natural environment, CRISPR is both captivating and dangerous. It opens the door to all kinds of potential food production improvements. Yet, improvements for whom?

Since the first demonstration of this genome editing tool in 2013, it has been widely tested in crops and livestock.[165] The first commercially available gene edited crop, obtained through another gene editing tool known as RTDS, has appeared in the form of an herbicide-resistant oilseed rape. The creation has been commercialised as non–GM, 'since only a few snippets of the plant's existing genes have been changed and no gene has been inserted from a different kind of organism.'[166] Even though RTDS is a different system than CRISPR, the

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[164] As Tamar Haspel herself admitted on the 23 September 2015, answering to Gary Ruskin, Co-Director of the food industry research group 'US Right To Know' <https://twitter.com/TamarHaspel/status/647000616796061696>.

[165] Ibid.

[166] Ainsworth, C. 'Agriculture: a new breed of edits' (2015) 528 *Nature* 15-16.

similarities are sufficient enough that identical policy and regulatory questions could apply to both.

If the European legislator decides to regulate genome-edited organisms the same way it does GM organisms (as the EU Court of Justice recently prophesied) the use and development of the new technology will be largely affected. Once again, only big biotech companies would benefit from developing profitable traits in the major crops, as it has already happened in the past. Despite many researchers and companies persist in calling CRISPR a less intrusive technique, its impressive ability to enhance or suppress gene activity could touch on as many important processes of crop and livestock metabolism, resistance and yield, as any other technology inserting foreign DNA.

Both medias and scientists largely favour agricultural uses of CRISPR, considering it an improvement over conventional breeding and genetic engineering. It is said to offer exactitude, speed and a high degree of control over the outcome.

However, some researchers have questioned the emphasised 'precision' of the process, pointing out the unexpected effects when new genes are added, or existing ones are silenced.[167] CRISPR technology is also known for making unintended edits, despite accuracy is increasing. In addition, there's no guarantee of the desirable outcome: esteemed traits, such as drought tolerance, are associated with many genes and are subject to complex environmental interactions. Moreover, the genetic background of each individual species or crop will also influence the behaviour of genes. Although great attention is being given to avoid the introduction of foreign genes, CRISPR remains highly adept at that kind of modification too. As a result, many edits that don't intentionally involve genes from other organisms are turning out to include exactly that. The way researchers usually get CRISPR technology working in a plant cell is precisely to use a pest bacterium to shuttle in the genes that code for Cas9, and bacterial DNA can wind up in the plant genome too. Scientists are trying to innovate around that unintended foreign introduction in order to strengthen the claim that CRISPR should not be regulated in the same way as conventional genetic modification.

As of today, the most important contribution of CRISPR to the debate about GM products has been that of making clear that the GM/non-GM binaries have become overly simplistic. The discussion has to be wider than the common debate about health benefits and risks of genetically engineered products.

The reductionist approach affects the field of research too: why is the focus still on developing resistance to pesticides and herbicides? There is evidence about the unintended consequences that using gene drives to eliminate wild organisms can have (e.g. destabilisation of food webs, facilitation of invasions by other species). There is also evidence about the risks for human and environmental health related to the use of agrochemicals. Likewise, the focus in the livestock sector is still on gene editing techniques that improve feed to meat conversion ratios. Surely, the benefits in GHG emission reductions are appreciable, but a growth in livestock production is unacceptable given the environmental and public health after-effects of intensive animal farming (not to mention the medical evidence that people should eat less meat).

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[167] *The New York Times*, Kolata G 'A Proposal to Modify Plants Gives G.M.O. Debate New Life' (28 May 2015) <https://www.nytimes.com/2015/05/29/health/a-proposal-to-modify-plants-gives-gmo-debate-new-life.html>

Evidently, the big companies were prepared to take advantage of science, while biological, environmental, social, cultural, and political issues have been largely left out of discussion. More interdisciplinary research and development teams have to be built to effectively counteract the reductionist thinking that characterises current debates and research: social scientists, agronomists, ecologists, evolutionary biologists, biotechnologists, nutritionists, organic farmers, and GMO critics should be included. Public funded research or public-private partnerships should be encouraged and empowered, so that relevant findings and intellectual property are put into public domain. More openness and transparency could help ensure that any potential social and environmental benefits of GE technology are put ahead of immediate profits.

Secondly, a new solution to the health-diet-environment trilemma must be developed, to achieve a net positive impact on biodiversity.[168] Spatial and temporal scales related to food production and consumption are various, ranging from the global environment to the molecular functions involved in health. Most biological studies related to food products are somewhat limited, being shaped in highly controlled laboratory conditions, on a small number of model organisms. There is a serious need for a better management framework, which permits to investigate the relationship with surrounding systems. Building a proper evaluation regime is an essential premise to understand the environmental load of any activity and find viable pathways for its mitigation, building resilient alternatives. Ideally, these alternatives should consider both environmental and health risks to offer effective solutions and the prospective of a net positive impact, compensating for the population increase and social inequality.

These goals are out of reach for conventional food production optimisation techniques, which are based on business-as-usual scenarios and flawed R&D investment policies.

[168] Funabashi M 'Human augmentation of ecosystems objectives for food production by 2045' (2018) *NPJ Science of Food*, 16.

4 ORGANIC FARMING AND THE AGROECOLOGIST PARADIGM

Organic agriculture is a concrete, but controversial farming model for improving the sustainability of agri-food systems. Organic agriculture is focused on promoting biodiversity, soil quality, closed production cycles, and overall enhancing ecological processes based on its main principles – ecology, health, fairness, and care. The benefits of organic agriculture against a range of environmental indicators are beyond dispute. However, when measured against yield performance, organic yields are typically lower than conventional ones.[169] Yields differences are highly contextual and depending on management practices, so much that growing conditions can range from 5 to 34 percent. Given that high productivity is central to sustainable food security policies, organic farming is often deemed as unsatisfactory if implemented on a wide scale. Yield performance is still perceived as more important than a wide array of ecological, social and economic benefits delivered by farming systems.

4.1 The role of organic agriculture

Undoubtedly, far reaching changes in agriculture-based systems are urgently needed if future generations are to have equal or improved preconditions for prosperity. This is particularly true in view of a growing world population. What role could organic agriculture play?

IFOAM - Organics International is the only international umbrella organization for organic farming and global leader in the promotion of the organic principles. It promotes the positive and multi-faceted environmental, social, and economic benefits of truly sustainable agriculture as valid arguments for significantly improving food systems resilience in face of current challenges. At the same time, the organization recognises the need for a radical change. A new holistic vision of the organic sector is developing, thus adding a further stage in the organic movement's timeline, which is characterised by an active engagement with major global issues.

4.1.1 The rise and development of the organic movement

The first phase of the organic movement dates back to the end of the 19th and the beginning of the 20th century. At that time, organic pioneers delivered their opinions in the face of the problematic direction that agriculture was taking. Among the most eminent representatives of this period are Rudolf Steiner, founder of biodynamic agriculture, Sir Albert Howard, and Weston Price in the medical field. Whether it is not certain if their ideas and reflections could already be named a 'movement', they inspired the next generations of ecologists and continue to be leading lights of the organic movement today.

A major contributor to the development of the organic forum is Lady Eve Balfour. She was an environmental activist and member of the Soil Association, the latter aiming at a world membership since the late 1940s. Research activity was high on her list of priorities.

She sponsored and directed, through the Soil Association, the 'Haughley Experiment', a pioneering ecologically-designed agricultural research project on a full farm scale, which main

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[169] Meier M S et al 'Environmental impacts of organic and conventional agricultural products–Are the differences captured by life cycle assessment?' 149 *J. Environ. Manage.* 193–208 (2015); Reganold J P and Wachter J M 'Organic agriculture in the twenty-first century' 2 *Nat. Plants* 1–8 (2016); Seufert V, Ramankutty N and Foley J A 'Comparing the yields of organic and conventional agriculture' 485 *Nature* 229-232 (2012).

aim was filling the gap in the evidence on which the claims for the benefits of organic husbandry were based. The decades-long observation of nutrition cycles of complex food chains involving soil, plants, and animals permitted to draw important conclusions. In particular, deductions concerning interdependences between animal and plants and any cumulative effects. The experiment served as a solid base for the following projects and research teams.

More precisely, two units had been established: on the 'mixed section' chemical fertilisers were used, as well as herbicides, insecticides, and fungicides when thought necessary; on the 'organic section', indeed, no chemicals were used, so that the land was entirely dependent on its own biological fertility. The outcomes of numerous individual analysis had been published in 'The Living Soil and the Haughley Experiment'.[170]

Among the most important results, the author underpinned the fact that in the organic fields the levels of available minerals in the soil fluctuated according to the season, maximum levels coinciding with the time of maximum plant demand. These fluctuations were far more marked on this section than on the other two, where they could be partly related to fertiliser applications.

The different chemical analyses carried out on crops and livestock products, revealed no significant differences between the sections, other than the usually higher water content of the chemically grown fodder. Seasonal variations in chemicals and variations between fields in the same section often exceeded average sectional differences. This lack of difference was in itself significant in that the organic section, showing a nutrient status consistently as high as the others, indicated how little of the minerals applied as fertilisers were recovered in crops.

The mixed section became somewhat 'dependent' on the fertiliser supplements, while the organic fields developed an increasing biological vigour which enabled them to be self-supporting. Though the organic herbal leys were of clearly sparser growth than the much lusher mixed-section leys, the cows on the former gave around 15 percent more milk over a 20-year period.

The disarming wealth of information contained in Lady Balfour's writings were an early warning of the long-term impacts of mainstream conventional agricultural systems. Despite scientific research in the field of organic agriculture was at its beginnings, the ecologist's outcry for a strong engagement was well reasoned and firm. Answering to the most frequently heard argument that intensive chemical farming is the only way of feeding the growing world population, and has therefore to be unconditionally accepted, she argued that

> '[I]t seems probable that the exact opposite could prove to be the case (…) This is because, as is becoming increasingly apparent, the days of the former [conventional agriculture] are numbered. One reason is the enormous demands on the world's non-renewable resources of energy, made by our Western life-style in general, and modern farming techniques in particular. Another is that modern methods are putting strains on the biota which is causing it to collapse. (…) It is not yet, however, generally accepted that the days of our present methods and behaviour are numbered. Even where it is, it is too often regarded as a long-term problem which must not be allowed to obscure the immediate problem, namely the need to increase quantitative food production now. Here it

[170] Balfour E B 'The Living Soil and the Haughley Experiment' (Palgrave Macmillan, 1976).

> is argued that organic farming is less efficient, that it has to rely on re-cycling which is wasteful, so that were it to be adopted, world food production would inevitably be lower, particularly production of protein, at a time when what we need is to produce ever more per acre. To this I would like to point out three things: a common view among nutritionists today is that the amount of protein (especially animal protein) hitherto thought to be required by man has been greatly over-estimated (organic farmers have found this also to be true for livestock); There need be little loss in re-cycling if we did not waste so much; Certainly, we need to produce more per acre. Unfortunately, the yardstick of modern economics is to measure the efficiency by production per man. Labour-intensive small units will always be able to produce spectacularly more per acre than the large mechanised farms, apart from the finding that organically grown food goes further.'[171]

These very lines summarise the position of the organic movement concerning the issue of granting an adequate global food supply. Also, it emphasises some key problems that go beyond a pure productive approach, addressing social and environmental matters as well.

According to Lady Balfour, the utmost quality of sustainable agriculture is 'permanence'. Permanence is exemplified by techniques that maintain soil fertility indefinitely; that use, as far as possible, only renewable resources; that foster biological activity within the soil.

The simple concept of permanence was at the heart of the second phase, dating back to the 1970s. At that time, the results of years of writing and researching on organic agricultural systems were codified. Later on, with the contribution of international and national environmental and organic organizations and movements, these concepts were crystallised in standards and regulations. This process assisted the conversion of the organic pioneers' visions in practical reality.

At the current stage, the standards adopted by state governments and private organizations define in great detail the minimum requirements for organic food production and processing. Official regulation was first introduced in the 1980s in Europe and in the United States. By 2016, 178 countries in the world had organic activities; 87 countries in Africa, the Americas, Asia, Europe, and Oceania had implemented their proper organic regulations.[172]

Through inspection guarantees and certification systems, organic food has gained the trust of consumers and policy makers. Simultaneously, there has been a rapid and continuous growth in the amount of certified organic cultivated land.

4.1.2 Organic food production and trade: state of play

Back in 1999, 11 million ha were cultivated as organic agricultural land, while 4.1 million ha were dedicated to wild collection and further non-agricultural areas. According to the latest data available, organic agricultural land amounts to 57.8 million ha, while 39.9 million ha are

[171] Balfour E B 'Towards a Sustainable Agriculture. The living Soil' (Speech delivered at The First Scientific Conference of IFOAM, Switzerland, 1977).

[172] Research Institute of Organic Agriculture FiBL and IFOAM – Organics International 'The World of Organic Agriculture. Statistics and Emerging Trends 2018' (2018).

devoted to wild collection and further non-agricultural areas – for a total of 97.7 million ha.[173] The organic market monetary value exceeds today €80 billion.

Actually, the share of the organic sector is even greater than that: this data only refers to certified organic production, but many smallholder farmers, particularly in the Southern hemisphere, don't have access to the inputs that characterise the industrial intensive and chemical-based agriculture. Even if they are not certified, their production model follows the organic principles: they are inherently organic and benefit from the agro-ecological improvements that the organic or agro-ecological approach ensures in terms of health and livelihoods.

The ultimate advance of the organic paradigm is to 'contaminate' the mainstream system with the organic principles and connect all organic-like-minded producers and organizations, thus magnifying the impact of sustainable agricultural practices. In other words, it is about 'positioning organic systems as part of the multiple solutions needed to solve the tremendous challenges faced by our planet and species.'[174]

Today, people call for a paradigm shift to make organic 'truly' sustainable. On the one hand, organic provides evidence of improvements on a wide range of paramount issues such as consumer and environmental health, biodiversity, and producers' welfare. Also, the organic market proved to be robust during the economic crisis that recently affected several countries, demonstrating to be more resilient in relation to conventional agriculture farming. On the other hand, though, the share of certified organic production is very limited, accounting for only 1.2 percent of total agricultural land on Earth. The chance to impact on the process of climate change adaptation and mitigation is very limited. Also, being an agricultural model, organic production does not always consider key issues concerning the whole Food Supply Chain (food processing, retailing and consumption).

To become significant, organics require further scaling and mainstreaming, without giving up its fundamental principles and avoiding the trap of short-term market opportunities. Also, according to IFOAM – Organics International the widespread adoption of GM technologies is already threatening the freedom of choice for organic breeders, farmers, and consumers. If the development of the latest breeding techniques is accompanied by deregulation, the organic sector will have to face further challenges, mainly due to contamination risks. The contamination cases would deleteriously affect the reputation and image of organic products. The development of the entire organic market would be put at risk. If genetic engineered products will be excluded from GM legislation in the future, they will be freely released in the environment and marketed without any traceability and labelling requirements. In such circumstances, the costs for economic operators in the organic sector will raise.

4.1.3 The main principles of organic agriculture

There are many definitions and explanations for organic agriculture. All of them agree that organic agriculture relies on ecosystem management, rather than external anthropogenic inputs, but organic agriculture is much more. According to the Codex Alimentarius

[173] Ibid.

[174] Arbenz M, Gould D and Stopes C 'Organic 3.0 for Truly Sustainable Farming & Consumption' (IFOAM and SOAAN, Discussion paper, 2015).

Commission, responsible for all matters regarding the implementation of the joint FAO-WHO Food Standards Programme, organic agriculture is

> '(…) a holistic production management system which promotes and enhances agroecosystem health, including biodiversity, biological cycles, and soil biological activity. It emphasizes the use of management practices in preference to the use of off-farm inputs, taking into account that regional conditions require locally adapted systems. This is accomplished by using, where possible, cultural, biological and mechanical methods, as opposed to using synthetic materials, to fulfil any specific function within the system.'[175]

Organic production combines tradition and innovation to the benefit of the environment, while promoting fair relationships and good quality of life for farmers. It is about sustaining simultaneously the health of soils, ecosystems, and people; relying on ecological processes, animal and plant biodiversity; respecting production cycles tailored on local conditions.

Organic agriculture is built upon four main principles, which also reflect its particular contribution to society: the principle of health, the principle of ecology, the principle of fairness, and the principle of care.[176] Healthy soils, plants, and animals, provide a healthy environment, in which humans can thrive in collaboration with all living things, rather than dominating them. Organic farming and pastoral and wild harvest systems should fit the cycles and ecological balances in nature. These cycles and balances are universal but characterised for site-specific operations. This is why organic management must be adapted to local conditions, ecology, culture, and scale. To attain the *ecological balance*, inputs should be reduced through reuse, recycling and efficient management of materials and energy. A responsible management should ensure both health and well-being of current and future generations and the environment.

To enshrine these fundamental principles in an adequate organic legislation has proved to be a difficult task. The resulting regulatory framework needs on-going maintenance to keep pace with innovation and the multiple effects of climate change on temperatures, precipitation frequency and volume, and soil health. Also, the legislation has to reflect the circumstance that while the organic farmer is always 'ecologically-minded' and shares international values and know-how, its outlook and techniques vary according to the social and cultural background.

For example, among the main concerns of any organic farmer always figures the protection of the local biological balance of the soil. However, the ways to ensure this balance are multiple. An adequate organic regulation should be able to contemplate them all.

Indeed, the conservation of soils is of little importance in modern agriculture, which failed to preserve traditional rural cultures and knowledge. As a consequence, the biological evolution, which is characterised by increasing diversity among species and a progressive enrichment of the environment, is dramatically reversed by the actions of modern man. So much so that scientists are drawing their attention to the current mass extinction process,

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[175] Ibid.

[176] IFOAM 'Principles of organic agriculture' <https://www.ifoam.bio/en/organic-landmarks/principles-organic-agriculture>.

which is said to be human-induced.[177] To counteract this trend, the organic movement is now seeking a new paradigm to express its values and achieve its goals.

Recently, many researchers emphasised that current labelling and certification systems hinder a further development of the organic sector: their questioning seems an inevitable premise of action. More specifically, current certification regulation is said to set minimum requirements, instead of high targets, which are obsolete in face of modern science development. Moreover, certification, third-party verification, and detailed standards are criticised for imposing costly burdens on farmers.

Besides, farmers are not adequately rewarded for the delivery of ecosystem services and common goods (when these occur, which is not always the case). Finally, the current system is prone to fraud and does not directly regulate essential social requirements nor fairness trade aspects.

In addition to these critical issues, an equally impacting (yet still poorly understood) matter is the deplorable influence of Western labelling and certification models on global food systems networks. In fact, the outlook of today's globally recognised standards reflects values and priorities of Northern consumers, policy makers, and governments. Exporting these values in Southern countries undermines their possibility of growing quality products and improving local producers' livelihoods.

4.2 Ecolabelling and certification systems

According to the FiBL survey on organic rules and regulations, 87 countries had already adopted organic standards in 2017, while 18 countries were in the process of drafting legislation.[178] Among them, some countries that recently adopted a regulation were still in the process of finalising its implementation, while some others had adopted a legislation but were not providing the necessary resources to accomplish its purpose. A number of other countries had no organic legislation but National Production Standards, which can be taken as a benchmark for certification activities.

The term 'eco-labelling' refers to the practice of using voluntary or mandatory labelling systems for consumer products as a way of indicating a certain standard of sustainability or environmental responsibility, thus guiding the choices of environmentally-minded consumers.[179] The organic label is comprised in the broader category of ecolabels, which are now widely used in the most diverse fields, ranging from food, to clothes, to buildings and hard-wares.

The Codex Alimentarius, being a collection of internationally recognised food standards, guidelines, and codes of practice, is the best starting point for further analysis of agri-food regulations. Issued for the first time in 1999 within the framework of the Joint Food Standards Programme by FAO and the World Health Organization (WHO), it has been repeatedly revised over time. Today, the Codex Alimentarius provides detailed guidance on

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[177] Gerardo Cabellos et al 'Accelerated modern human-induced species losses: Entering the sixth mass extinction' 1 5 *Science Advances* (2015).

[178] Research Institute of Organic Agriculture FiBL and IFOAM – Organics International 'The World of Organic Agriculture. Statistics and Emerging Trends 2018' (2018).

[179] Schiffman H S 'Green issues and Debates: An A-to-Z Guide' (2011) 167.

food labelling and specific recommendations concerning production, processing, and marketing of organically produced foods.[180] Its features are the result of continuous attempts to internationally harmonise the requirements for organic products in terms of production and marketing standards, inspection arrangements and labelling requirements.

However, different perceptions of the organic production method among consumers, combined with other economic, legal, and technical reasons, hinder the full implementation of a globally recognised regulation. Hence, while the Codex Alimentarius surely remains a useful instrument in assisting member and non-member countries to developing national regimes, the fact remains that more restrictive or permissive arrangements, and more detailed or lax rules are actually implemented.

An organic claim is any claim that describes a product, or the ingredients used to make a product, as organic. For example, '100% organic', 'made using organic ingredients' or 'certified organic'. In order to enable consumers to make a conscious purchase, organic products usually carry such claims in the form of a symbol, logo, or trade mark. Products labelled as organic generally attract a premium price compared to those produced using synthetic fertilisers, chemicals, pesticides, and non-essential food additives or processing aids. The certification is provided by officially recognised inspection systems or certification systems, which have been formally approved or recognised by a government agency having jurisdiction on the matter.

The minimum standards for the concession are listed in the guidelines provided by the Codex Alimentarius, each country defining its own in detail. Undoubtedly, the widespread use of such certifications had a very positive effect on the organic market, safeguarding organic producers from fraudulent practices and permitting sensible consumers to reward the farmers that demonstrate compliance with the organic regulatory framework.

4.2.1 The organic Food Supply Chain

Three major motives are consistently reported for consumers to buy organic foods – health, environment, and food safety and quality.[181] Regardless, consumers are guided in their choice by certification marks, each representing different environmental or ethical attributes, which are thereby reinforced and encouraged to proliferate in the food sector.

A comprehensive legislation should provide guidelines and precise information concerning organic production as well as labelling and trading, to provide adequate and transparent rules to farmers, stakeholders, and consumers. This is especially true in current times, when the close contact between consumers and producers is no longer the norm.

In recent decades, many factors affected the Food Supply Chain. A greater market demand, increasing economic interests, and the growth of urban areas, contributed to a lengthening of the chain itself. As a result, the food we consume often cover long distances before arriving in our plates. At the moment being, only a small portion of agricultural commodities is marketed directly from farms to consumers. Indeed, most products find their way to

[180] Codex Alimentarius Commission 'Guidelines for the production, processing, labelling and marketing of organically produced foods' (FAO and WHO, 2013).

[181] University of New England and Mobium Group 'Australian Organic Market Report. The global organic consumer' (Australian Organic Ltd Research Paper, 2018).

consumers via established trade channels, and the organic market is following this trend: three-quarters of organic farmers are located in low-income countries, while 96 percent of organic food sales take place in European and North American markets.

Being an export-oriented farming system, certified organic agriculture is mainly depending on exporting companies to access the international market. Only in high-income realities organic farmers are part of an alternative, local food network, and are in the position of selling their products directly to consumers.[182] Therefore, off-farm impacts may vary greatly. The relocation of production across countries counteracts mitigation policies and increases the carbon footprint of organics, mainly because of transportation and conservation costs. If organic products from the Southern world are imported in Northern countries by plane or by ship, their environmental footprint is obviously much higher compared to that of local production for local consumption.

Concerning this aspect, current labelling and certification systems are truly deficient. Should organic simply reflect the existing Food Supply Chain, or should the movement aspire to something better? Are not organics supposed to limit the ecological footprint of food consumption as well, to be truly sustainable?

The movement's pioneers set out to create not just an alternative and sustainable mode of production, but a role model for distribution and consumption too. An all-inclusive vision in which growing wholesome foods was the first step to create a *countercuisine,* based on whole grains and unprocessed foods to challenge the conventional industry. Food sovereignty was the ultimate achievement.[183] This concern has not received sufficient attention in current debates. Many philosophical values embedded in the word 'organic' did not survive the rule-making process and the term no longer comes with a 'conscience'.

Europe and the United States, today's organic market protagonists, are promoting further trade agreements, granting equivalency recognition to third countries to facilitate market access. For example, the EU and Chile have signed an agreement on trade in organic products last year. Mutually recognising the equivalence of their organic production rules and control systems, they now allow all organics produced and controlled according to EU standards to be directly placed on the Chilean market – and *vice versa.*[184]

Growing organic trade opportunities further stimulated the already detailed system of external control and certification procedures, to minimise unfair and deceptive practices at all stages of the food chain. An integral component of organic certification are the procedures of inspection of the organic management system. The inspections are designed to protect trade by preventing misleading claims, in view of the growing production and international trade in organically produced foods.

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[182] Seufert V and Ramankutty N 'Many shades of grey – The Context-dependent performance of organic agriculture' 3 3 *Science Advances* (2017).

[183] Gussow J D 'Can an organic Twinkie be certified?' Madden P (ed.) *For All Generations: Making World Agriculture More Sustainable* (WSAA, 1997).

[184] 'Agreement between the European Union and the Republic of Chile on trade in organic products' OJ L331/4.

4.2.2 Insight in the European organic labelling regulatory framework

In recent years, the share of the organic agricultural sector is on the increase in most European Member States. This phenomenon is triggered by a remarkable and continuous growth in consumer demand.

The first European legislative initiative concerning organic production was issued in 1991, to be subsequently repealed and replaced in 2007 by Regulation (EC) 834/2007.[185] The latter fully governed the production and trade of organic products within the European Union until June 2018, when it has been repealed and replaced by Regulation (EU) 2018/848.[186] Nonetheless, this last regulation will only apply from January 2021.

Regulation (EC) 834/2007 underlines that the organic production method and its discipline have a twofold social function. In particular, they provide consumers with an organic market while offering environmental public goods conducive to the protection of the environment, the animal welfare, and the rural development. Evidently, the multiple aims of the European legislator originate from (apparently) remote interests. Firstly, economic and production objectives: above all, the development of a niche market responding to consumers' demand, contributing to the differentiation of products, and assuring an effective functioning of the internal market as well as fair competition; also, support to rural economies. Secondly, to achieve a consumer protection objective and support consumer confidence, offering clear and sufficient information. Lastly, an environmental protection goal: promote the use of natural substances, rather than synthetic ones, protect animals from intensive farming systems, and assure the ecological sustainability of alternative agriculture systems.

In light of this complex pattern, organic regulation can be considered as belonging to the category of quality productions, as such as DOP and IGP. The term organic production is defined in the first recital of Regulation (EC) 834/2007 as

> 'an overall system of farm management and food production that combines best environmental practices, a high level of biodiversity, the preservation of natural resources, the application of high animal welfare standards and a production method in line with the preference of certain consumers for products produced using natural substances and processes.'

The regulation mentions (more explicitly at Article 2) the different steps of production, processing, and retailing, thus highlighting the importance of observing a chain-based approach in order to grant the real organic nature of the products. Each step of the food chain is addressed and regulated by the European legislation. General norms, prohibiting the use of GMOs and ionising radiations, are followed by more specific norms, concerning agricultural plants and livestock production, aquaculture animal production, and processing of organic products, comprised organic feed and food.

The coexistence of organic and conventional production on the same farm is possible, but strictly regulated. Organic farming is meant to respect natural cycles of growth and rest of plants, implementing methods and techniques that safeguard the biodiversity and the fertility

[185] Council Regulation (EC) No 834/2007 of 28 June 2007 on organic production and labelling of organic products and repealing Regulation (EEC) No 2092/91 OJ L 189 (2007).

[186] Regulation (EU) 2018/848 of the European Parliament and of the Council of 30 May 2018 on organic production and labelling of organic products and repealing Council Regulation (EC) No 834/2007 OJ L 150 (2018).

of the soil, using natural fertilisers and biodynamic preparations. Therefore, the use of some chemical fertilisers is permitted exceptionally, in case there is no organic or natural equivalent.

Within the EU, only producers who respect these and further listed dispositions can use terms referring to the organic production method in the labelling, advertising material, and commercial documents. In addition, their choice is restricted to terms referred to in Annex I of the regulation (e.g. in Italy, *biologico*, *bio,* or *eco*). Any misleading terms, including those used in trademarks, or practices used in labelling or advertisement shall not be used by any producer who does not respect the regulatory framework.

Further compulsory indications are the code number of the control authority or control body to which the operator is subject, and the European logo and indication of the place where the agricultural raw materials of which the product is composed have been farmed (on pre-packaged foods). The EU organic production logo may be used in the labelling, presentation, and advertising of products which satisfy the requirements set out under the regulation. National and private logos may be used too, under the same conditions. Specific criteria as regards presentation, composition, size, and design of the logo has been laid down by the European Commission.

According to law, Member States shall set up a solid control system and designate one or more competent authorities responsible for controlling. The competent authority may confer its competences to one or more public authorities offering adequate guarantees of objectivity and impartiality; it can also delegate control tasks to one or more private control bodies, maintaining an effective cooperation. Any operator who produces, prepares, stores, or imports organics from a third country or who places such products on the market, shall - prior to placing them on the market - notify his activity to the competent authorities and submit his undertaking to the control system.

The European Union is among the main import markets for organic products, together with the United States, Canada, and Japan.[187] Organic products can be imported only if the certifying agency has been approved by the respective competent authority of the Member State where the activity is carried out. The process of approval requests compliance or equivalency with the requirements of the importing countries, to achieve through bilateral agreements between the exporting country and the target import country, or through direct acceptance of the certifying agency by the target import country.[188]

4.2.3 Insight in the Australian organic labelling regulatory framework

Australia is among the third countries from which imported products can be sold into Europe as organic, under the National Standard government equivalency or the Australian Certified Organic recognition.[189] The export scene for Australian organic agriculture is

[187] Research Institute of Organic Agriculture FiBL and IFOAM – Organics International 'The World of Organic Agriculture. Statistics and Emerging Trends 2018' (2018).

[188] Winickoff D and Klein K 'Food Labels and Environment: Towards Harmonization of EU and US Organic Regulation' Vogel D and Swinnen J (eds.) *Cooperating in Managing Biosafety and Biodiversity in a Global World: California, the United States and the European Union* (2009).

[189] Today some products categories from 13 countries are deemed to meet these conditions: Argentina, Australia, Canada, Chile, Costa Rica, India, Israel, Japan, Republic of Korea, Switzerland, Tunisia, the United

strong, with exceptional growth in tonnage and value over the last three years (though effected by the dry seasonal conditions of the last two years). Australian grown and manufactured organic products are exported worldwide, for an estimated value of $2.4 billion. That means, an increase close to 88 percent on the total value estimated in 2012. Fruit, vegetables, nuts, meat and eggs account for almost three quarters of the whole.

Today, organic is mainstream among Australians, who are increasingly choosing organic options across a variety of food and durable categories, leading the market demand. As a result, the retail sector now competes with major supermarkets, many of which offer a vast range of organic products, including private label options (e.g. Woolworths). This contributed to the reduction of price premiums in recent years, an increased product availability and easier access to more retail channels.

Every year since 2000, FiBL publishes a yearbook on the state of play of organic agriculture around the world. Australia's organic estate has since then been the largest in the world.[190] The area of land under certified organic management is around 35 million ha (10 percent of all Australian agricultural land) and it is still augmenting. The vast majority of this area is devoted to pastoral operations, especially beef cattle production. Despite the fact that the number of certified organic operations continues to augment every year, producer numbers were slightly down on the previous year, perhaps reflecting a trend of consolidation of farms into bigger units. The largest plant-based sector for number of farms is fruit growing, the largest animal-based sector is beef cattle.

There have been few substantive changes to the Australian regulatory framework for governing organic products over the past year.

Concerning the export-market, Australian products that are labelled as organic and exported must by law be certified by one of the six government-accredited certifying organizations. The certification must comply to the National Standard (NS), which has been last updated in 2016. The NS is maintained by the Organic Industry Standards and Certification Council (OISCC) on behalf of the Australian Government's Department of Agriculture and Water Resources. Further certifications are permitted, if complying to standards that are at least as stringent as the National Standard - granting additional market access or supporting branding purposes.

Certification guarantees compliance with Australian law, but it does not guarantee that products comply with the importing country's law; equivalency negotiations with importing countries are therefore essential. A major review of the regulation of exports is expected in the next years, in order to develop one single standard and a regulatory regime to replace the current regulatory arrangements, which are expiring in 2020. In the meantime, leading businesses of the organic industry founded Organic Industries of Australia, a project to pool efforts for the 'negotiation of policy reforms with governments, to help the industry capitalise on the growing global demand for organic products.'[191]

States and New Zealand. For each country, the regulation specifies which products are accepted, their origin and production standards, as well as the competent authority and recognised control bodies in that country.

[190] Above, n 187.

[191] Organic Industries 'One voice: A unified voice for Australia's organic industries' (Consultation paper, 13 November 2017) <https://organicindustries.com.au/ConsultationPaperA>.

In the domestic Australian market, there is no legislation specifically referencing organic production and marketing requirements. However, the domestic consumer protection legislation prohibits 'misleading or deceptive conduct'.[192] All the major chain retailers also require certification to recognised industry standards for access to their stores, as do some farmers' markets and other independent retailers. As a consequence, the majority of the Australian industry is covered under the National Standard, which is in place since the 1990s. A parallel organic standard, AS6000 - Australian Standard for Organic and Biodynamic Products - has been established in 2009 and further updated in 2015. So far, it has not been used as a certification standard commercially within Australia, but it is a point of reference for the governmental Consumer Protection Agency in cases of domestic disputes over organic claims. In 2017, OISCC released a new national mark, which has yet to be fully adopted by industry. Currently, its adoption is voluntary and available for use by operators that are certified by one of the six government accredited certifiers; it does not exclude the certifier from using its own logo too.

4.3 Impacts of accreditation and certification systems

The organic sector is focused on increasing the quantity of organic foodstuffs marketed under strict rules and agreements. This is its predominant and distinctive character. The organic paradigm, which is born as an alternative system of food provisioning, has been particularly successful in yielding long-term benefits for farmers. However, it is no more characterised for taking distance from productivist and standardised industrial model. Many argue that the organic movement lost its balance and joined the industrial mind-set: quality, origin, and environmental sustainability are no more the solely leading concepts.

4.3.1 Is industrial organic a paradox?

The organic food network is the result of a long process of building an alternative market for organic products, escaping the conventional Food Supply Chain. Standards and certification practices have been of utmost importance for this purpose. Organic's well-rooted certification system has demonstrated the capacity of environmental and ethical certifications to educate consumers, thus assisting the governments in the creation of an international market. At the same time, certifications provide farmers significant incentives to improve their environmental and business management. Organic standards compliance is mandatory for farmers in order to label their products as organic and include farming as well as food processing. Certification through a third-party audit is in place worldwide, thus facilitating the trade of organic products outside the conventional Food Supply Chain, for example in farmers' markets and dedicated stores.

Moreover, certifications enable consumers to recognise organic foods in conventional supermarkets and stores too, hundred miles away from their production site, among thousands of other products. Today, organic foodstuffs can be easily found in common supermarkets and groceries, usually on separated shelves.

On the one hand, the market-oriented approach allowed the organic products' network to evolve. At the beginning, it embodied a 'face-to-face' network, were consumers purchase

[192] *Competition and Consumer Act 2010* (Cth) sch 2 'Australian Consumer Law'.

products directly from the producer and authenticity and trust are mediated through personal interaction with the farmer. It then evolved into a 'proximate' network, characterised by the presence of intermediary actors who sell the product on behalf of the producer, assuring product authenticity. Ultimately, the organic network became an 'extended' one, depending on institutionalised conventions, standards and labelling, that alone enable the consumer to make connections with the place of production and the quality of the product.[193]

Incorporating standards and auditing systems has been key to extend the organic market beyond localities and regions, enabling organic products to be available to consumers all over the world, potentially all year long. Its success is demonstrated by the global massive growth in organic and other environmental and fair-trade markets.

On the other hand, the embeddedness of the organic food production approach in various public and private rules, conventions, and market forms of regulation, has been heavily criticized. Smallholders are likely to have limited access to certification and its correlated benefits, because of high transaction costs, extra work, and resource inputs. Commodities fulfilling the organic standards require further precautions and expenses compared to similar non-organic products. Besides, the dominance by powerful private actors in certification activities erodes the financial benefits of farmers and places on them the full burden of compliance.[194]

In the past two decades, markets grew to accommodate no less than 435 'eco-labels' claiming some aspect of sustainability.[195] However, no matter how thorough or rigorous a sustainability label is, true sustainability is not synonymous with any one existing sustainability standard or label. To meet the expectations of the 'supermarket consumers', many among organic food producers industrialised the whole process of farming, eroding the benefits ensured by the previous alternative supply chain, which directly connected conscious farmers and mindful purchasers.

Today, organic strawberries are available all year long, organic tomatoes can be found in winter, as well as organic cleaned, sliced and bagged fruits from the tropics. A globalised, energy intensive, large-scale Food Supply Chain is needed to afford this luxury. Clearly, as these initiatives penetrate mainstream markets their economic effects are positive. However, the doubt persists: do these initiatives favour the trade-ification of the sustainability concept, rather than smallholders' livelihood and environmental solutions?

The market forces are transforming organic from a reform movement into an industry supporting the ideals of the global supermarket. Organic foodstuff is on the way to become a cheap international commodity just as any other food product.

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[193] Renting H, Mardsen T and Banks J 'Understanding alternative food networks: exploring the role of short supply chains in rural development' (2003) 35 *Environment and Planning A* 399-401.

[194] Higgins V, Dibden J and Cocklin C 'Building alternative agri-food networks: Certification, embeddedness and agri-environmental governance' (2008) 24 *Journal of Rural Studies* 15-27, 18.

[195] Committee On Sustainability Assessment 'The COSA Measuring Sustainability Report: Coffee and Cocoa in 12 Countries' (2013) 9.

4.3.2 The international harmonisation processes

Mutersbaugh deeply explored the remaking of globalised standards through harmonisation and its impact upon certified-organic and fair-trade agri-food networks.[196] The standards language itself has been harmonised, to bring provisions into agreement across national and transnational contexts. This 'globalisation through harmonisation' is not, however, a unitary movement. Transnational institutional codes such as the UN Codex Alimentarius and the International Organisation for Standardization (ISO) Guide 65 are nowadays combined with national and regional initiatives, such as the EU Regulation 2092/91 and the US Department of Agriculture's National Organic Program.

So many parallel initiatives strongly encouraged standard globalisation, but simultaneously internalised conflicting elements of standard language. This is the reason why harmonisation did not reach overall homogeneous standards yet: on the one hand, there are multilateral institutions (such as ISO and WTO) which press for trade liberalisation; on the other hand, agri-food network NGOs (such as IFOAM and the Fairtrade Labelling Organization) emphasise social justice and environmental protection. Both movements contributed to the writing of standards compilation, especially by participating in the process of drafting certification norms.

Certification provisions are distinct from production norms. They are meant to rebuild trust between globally-separated producers and consumers. Nonetheless

> '[c]ertification provisions affect the accumulation of wealth within networks by restricting inter-organizational liaisons, that is to say social relations, in the field. In a sense, certification alters the framework of value production such that farmers and their organizations become consumers of certifications. (…) political and economic impacts cause certification standards to become a locus of social struggle, pitting trade liberalization against socioecological protections, as evidenced by alternative social accountability initiatives.'[197]

Contemporary certification standards codify social practice, setting rules of institutional processes and specifying contractual relations. This is necessary to demonstrate an organic commodity advertised qualities, and to protect that quality (which has also an exchange value). Organic certification norms were developed simultaneously with production norms in the 1970s. At that time, state regulation was limited, and third-party inspections not required. However, through harmonisation, the situation dramatically changed. In the early 1990s, the European standard was crafted, and in a decade-time a series of parallel national standards and harmonisation initiatives were under-way worldwide.

Transnational institutions too, promoted harmonisation: ISO produced the Guide 65 program on third-party certification standards and the ISO 9000 quality standards, inaugurating further steps of the harmonisation process of certification standards. The UN FAO Codex Alimentarius Commission followed soon, introducing the 'Guidelines for the Production, Processing, Labelling and Marketing of Organically Produced Foods'. Later on, several countries adopted food certification standards harmonised to transnational norms.

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[196] Mutersbaugh T 'Fighting standards with standards: harmonization, rents, and social accountability in certified agrofood networks' (2005) 37 *Environment and Planning A* 2033-2051.

[197] Ibid.

The consequences of harmonisation are multiple. The most evident among them are: a shift of standards governance from commodity networks to multilateral institutions; changes in standard texts, now establishing common auditing frameworks and cross-reference. Significant changes occurred also in the manner in which the adoption of globalised standards and their compliance are policed.

Once, ISO was accepted as a negotiated and democratic activity; nowadays, compliance to its standards is enforced via an institutional triangulation with the WTO. This connection is exemplified by ISO enrolment in major trade-related standards initiatives, such as TRIPS (Trade-Related aspects of Intellectual Property Rights), TRIM (Trade- Related Investment Measures), and GATS (General Agreement on Trade in Services).

According to some economists, the shared goal of these initiatives is to set up globalised standards templates that will constrain network standards and national regulation. In doing so, they limit the authority of developing country governments to compel the choices of companies operating or hoping to operate in their territory, while requiring them to enforce rigorous property rights of foreign (generally Western) firms. In the words of W R Hunter, these standards 'are likely to lock in the position of Western countries at the top of the world hierarchy of wealth'.[198]

Another major consequence is the displacement of organic and fair-trade firm-based labels by national or international labels. This phenomenon is due to the unbalanced costs of complying with additional certification paperwork requirements and major impediments to a common understanding of current challenges between producers and consumers. Consumers usually do pay no attention to the distinction between international and individual labels.

Finally, the most disrupting consequence is the loss of *relational* network standards, as they are now substituted by *notional* globalised standards.[199] That means, standards are by now defined by multinational committees, which are placed outside food networks. Consequently, they are non-negotiable, and their compliance is verified by external inspections.

In conclusion, globalised certification standards create barriers for small farmers to entry organic markets by imposing more stringent auditing requirements; they reset the ability of agricultural producers to negotiate exceptions; they eliminate alternative paths to certification. Also, globalised standards-based certifications are hard and costly to implement, and only those firms presenting a strong administrative capacity are likely to obtain them. As a consequence, certification standards are often perceived as a burden by certified farmers. The many expenditures to meet international requirements are causing most of farmers' rent to be consumed by the oligopolistic market structures they depend on.

The *status quo* is protecting the intellectual property rights of the developed world and preserving the privileged economic position of Northern countries by regulating social and environmental standards at distant production sites. Returning to Balfour's prophecies, the organic movement fell into the trap of boxing itself in and is now 'imprisoned in a set of rigid rules.' Transnational organic, fair, and ethical requirements do all potentially provide

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[198] Hunter W R 'What strategies are viable for developing countries today? The World Trade Organization and the shrinking of `development space' (2003) 10 *Review of International Political Economy* 621-644.

[199] Mutersbaugh T 'Fighting standards with standards: harmonization, rents, and social accountability in certified agrofood networks' (2005) 37 *Environment and Planning A* 2033-2051, 2037.

good opportunities for disadvantaged farmers in the South to access Northern markets, while promoting significant values and aspirations. However, the current food networks have been crafted by Northern governments and policy-makers to respond the interests and priorities of Northern consumers. In doing so, they profoundly discouraged the creation of quality infrastructures supporting diverse food products and producers.[200]

While undoubtedly providing benefits, i.e. niche markets of food exports, certification and governance manipulation inevitably drove farming toward high-value horticultural crops and crops destined to the production of agrofuels. These outcomes led to conflicts over the very meaning of sustainability.

The shift towards export markets occurred via the implementation of 'one-size-fits-all' regulations and standards (e.g. GLOBALGAP, ETI), which are today essential for inserting Southern agri-food systems into export markets. Nevertheless, these schemes are excluding smallholder farmers, which do not always belong to cooperatives or labour unions. As a consequence, farmers' livelihood has seen little improvements in recent years, despite the immense potential of local producers to improve local food security and counteract ecosystem degradation. Two further factors encouraged their marginalisation: high accreditation costs to certification and expenses required to comply with complex standards, often borne by producers themselves; and much bureaucracy. Many elaborate requirements (e.g. online recording systems, fire resistant chemical stores to avoid chemical spillages) are financially out of reach for smallholders, who mostly live in poor conditions. These troublesome issues are the obvious consequence of a low level of participation of farmers and breeders in the process of creating standards and requirements, which are actually imposed to them (accreditation is voluntary, but it proves indispensable to access international markets).

Diminishing control over commodity prices, rising costs and falling incomes, are no longer prerogatives of the conventional industrial model of agricultural production. In recent years, the organic movement has flattened into a full-fledged industry. Organic foods are becoming market-driven commodities. The bigger companies adopted industrial methods: raising chicken in factory farms, feeding grain to cattle on feedlots, focusing on monocultures. As Pollan argues, '[i]ndustrial organic might seem an oxymoron, but it is a reality'.[201]

4.3.3 Processes of imitation

The development of the organic movement led to the creation of a highly standardised food production protocol, which enabled the organic food trade to grow worldwide. Industrial agriculture subsumed further 'sustainable' farming systems such as Low Input Agriculture, Precision Farming, Integrated Pest Management, Integrated Production, and Conservation Tillage. However, this process is an indiscriminate strategy led by profit-seeking companies, indifferent to the ultimate goal of the organic movement, to mimic environmental solutions in order to gain *consensus* among consumers.

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[200] Smith K and Lyons K 'Negotiating organic, fair and ethical trade: lessons from smallholders in Uganda and Kenya' in Rosin C, Stock P and Campbell H (eds.) *Food systems failure. The global food system and the future of agriculture* (Routledge, 2012).

[201] Pollan M 'The Omnivore's dilemma. A natural history of four meals' (The Penguin Press, 2016).

The very concept of sustainability is threatened and exploited. Conventional firms pay more and more attention to their 'green reputation', which attracts a growing number of environmentally sensitive consumers. In their attempt to enjoy the benefits of an eco-friendly reputation while reducing the risks of negative publicity, retailers have adopted several strategies, often used in combination. Among these, 'standards dilution' is particularly successful. It consists in lobbying to either alter existing standards created by NGOs, or searching for organizations requiring less stringent standards;[202] Similarly, 'parallel production' occurs when a firm certifies only a small portion of its total product sales to a high standard, using it to greenwash its remaining non-standardised production;[203] finally, the strategy of 'contractual distancing', that means, subcontracting certain aspects of the whole production to non-certified shops.

Moreover, the Southern export-oriented countries that produce many organic foods destined to reach the Northern markets are subject to land grabbing and industrialisation phenomena. The European and US organic standards, which represent the dominant market requirements, are often unaffordable for small farmers, and/or disrespectful of their culture and traditions.

While conventional agriculture is adopting ecological and social elements of sustainability, promoting quality assurance and environmental responsibility, organic agriculture is potentially losing its uniqueness, becoming more and more business-oriented. In this distorting context, a lack of consumers' understanding can lead to negative consequences. As certification schemes are increasingly common in conventional markets, they can be compromised by powerful actors, who shift the costs of environmental management onto farmers and breeders without paying them more. The actors of the conventional Food Supply Chain, retailers in particular, are far more interested in certification standards as a mean for gaining higher profits, rather than a tool to achieve environmental and social purposes. As a consequence, the gains from certification for rural livelihoods are dwindling.

Ensuring the best farm practices and the highest level of ecological, social and economic sustainability is paramount to the future development of organic agriculture. The organic globalised standards accurately prescribed by multinational institutions ended up being a new form of perverse globalisation. The organic movement surely enabled a transition towards more fair and sustainable food systems, but its alternative paradigm failed by concentrating any efforts solely on the regulation of farmers and breeders' activities, while neglecting to analyse the whole Food Supply Chain. The current set of rules and restrictions does not grant shorter distances between producers and consumers, nor small farm size. Indeed, it promotes large-scale agribusinesses, which are more likely to be able to support all the costs and hardships related to the organic certification.

The commitment to the social, economic, and environmental dimensions of sustainable production should be extended to food distribution, to build a concrete alternative to conventional markets. Food retailers play a major role in enabling the sustainable transition

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[202] Mutersbaugh T 'Just-in-space: certified rural products, labour of quality, and regulatory spaces' (2005) 21 *Journal of Rural Studies* 389-402, 398.

[203] Renard M C 'Fair trade: quality, market and conventions' (2003) 19 *Journal of Rural Studies* 87-96, 93.

by negotiating with consumers what is right and desirable in the food system. In this sense, they conduct a 'norm-shaping work'.[204]

The retailers operating in the alternative food chain are effectively supporting minor ecological farming realities by problematising the outcomes of regime practices, challenging the conventional interpretation of the food system. They engage with issues such as rural development and climate change, and they educate consumers by highlighting the food regime's associations with maximised and standardised production, cheap and tasteless food, and market-driven philosophy. These messages are accompanied by the communication of the ideals of transparency and human scale, fair valuation of the food and its producers, health benefits of an aware consumption of 'real and good food'. The pleasure of eating nutritious and fresh food figures among the various benefits of joining an alternative food system.

Various alternative food networks, characterised by efforts to re-spatialising and re-socialising food production, distribution and consumption, have recently spread throughout Europe, the US, and Australia. However, the vagueness and inaccuracy of the notion of 'alternative food network' is a threat for its diffusion and successful implementation. According to the critics, these 'alternative worlds' built on ethics of sustainability, social justice, animal welfare, and the values of local food cultures are no more credible since their products entered mainstream markets.[205]

Productivity improvements in agriculture are still considered key to addressing hunger and malnutrition. However, a narrow focus on growing productivity risks to ignore innumerable variables that should be indeed considered. In fact, the challenge of feeding 9 billion people in 2050 will depend also on *what* people will eat - since inadequate consumption patterns can impact heavily on human environmental footprint – and how *food trade* will be organised - whether it will secure regional food needs and provide local opportunities of wealth creation coupled with environmental regulation, or not.[206]

Food systems have to be reformed to assure a fuller realisation of the right to food: as the former Special Rapporteur on the right to food Olivier De Schutter stated in its final report, 'the food systems we inherited from the twentieth century have failed'.[207] They missed to take distribution issues into account and contributed to severe environmental impacts. Food has been transformed into a commodity. Subjected to 'financialisation', food markets are threatened by growing and volatile prices. Under constant pressure, developing countries are constrained to import the food they are no longer capable to produce. This phenomenon encourages a nutrition transition to a 'western diet' - rich in highly processed foods, less nutritious and healthy than the traditional diets it replaces.

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[204] Forssell S and Lankoski L 'A convention theoretical examination of alternative food retailers as food sustainability transition actors' (2018) 63 *Journal of Rural Studies* 46-56, 54.

[205] Goodman D, Goodman M K and DuPuis E M 'Alternative Food Networks: Knowledge, Practice and Politics' (Taylor and Francis Ltd, 2013).

[206] INRA (French National Institute for Agricultural Research) and CIRAD (French Agricultural Research Centre for International Development) 'Agrimonde: Scenarios and Challenges for Feeding the World in 2050' (2009).

[207] De Schutter O 'Final report: The transformative potential of the right to food' (Report of the Special Rapporteur on the right to food, 2014) 4-5.

The deeper debate concerns not whether productivity should be raised, but how to achieve this.

4.4 Rethinking organic agriculture: agroecology and food sovereignty

The importance of protecting wild and domestic biodiversity, promoting rural livelihoods, and passing on farmers' knowledge can no more be ignored by the organic regulation, if it is to survive. Some political institutions are proving greater awareness and technical competences for environmental issues, probably because civil society is changing its attitude too, being more and more worried about climate change and its effects. It is the right time for the organic movement to push for a more comprehensive legislation, which reflects the core of the organic and agro-ecology movements' approach 'from the farm to the fork'. It should also be a more flexible one, allowing innovation and adaptation to concretely averse climatic variations.

The goal of organic agriculture is that of reaching optimal agro-ecosystems in terms of social, ecological, and economic sustainability. There are many potential policy targets to improve organic performance and match this ultimately objective, including: targeted research programs to develop environmental best practices in organic regulations; enhanced research on crop varieties for conditions specific to organic management; development of domestic organic markets (especially in low-income countries), regional relational certification, and standard systems; establishment of ethical and fair trade practices to couple with organic certification; subsidies for organic farmers to alleviate the costs of the transition period from conventional to organic farming.[208]

However, being primarily a production system, organic agriculture encounters some limits in its capacity to transform the whole food system. In fact, it faces similar challenges as conventional agriculture. There is a crucial shortcoming as far as both agricultural models are concerned: changes to the current food system, such as reducing food waste and change dietary patterns, are not taken into consideration despite their huge potential to contribute to the cause.

According to recent studies, organic agriculture can contribute to improving environmental impacts while providing sufficient food only if it is implemented in an adequately designed food system in which the issues of food production, food consumption, and food waste are simultaneously addressed.[209] None of these matters is to be confronted singularly and fully, but all could be addressed partially, in combination. In this context, agroecology, which is both a scientific discipline and an integrated approach to sustainable farming, is increasingly seen as one of the most favourable ways to shape the future of food production and consumption.

Finally, the proper question is not whether agriculture alone could play a role in creating a sustainable food system. The question is whether organic agriculture, integrated in alternative

[208] Seufert V and Ramankutty N 'Many shades of grey – The Context-dependent performance of organic agriculture' (2017) 3 3 *Science Advances* 1-14, 11.

[209] Muller A et al 'Strategies for feeding the world more sustainably with organic agriculture' 8 1290 Nature Communications (2017).

visions of the food system and conceived as part of the agroecological movement rather than a mere production practice, could promote a more sustainable and just food system.

4.4.1 Implementing agroecology

The word 'agroecology' emerged at the beginning of the 20th century to indicate the application of ecology to agriculture. Since then, both its definition and scope as a scientific discipline evolved significantly. Over the past 80 years, there has been a change of focus on different scales and dimensions, witnessing agroecology's great capacity for adaptation and improvement.[210]

Agroecology changed from the plot or field scale, which was widespread between 1930s and 1960s, to the farm or agroecosystem scale, preferred between 1970s and 2000s (although the smaller scale approaches are still used up to the present time). In some publications, the farm is seen as equivalent to an agroecosystem, in others the agroecosystem is at the larger end of a wider local or regional agricultural landscape. From the 1980s, representatives of the agroecological paradigm such as Altieri and Gliessman started to define it as an approach to protect natural resources and to design and manage sustainable agroecosystems.[211]

Gradually, agroecology started contributing to the promotion of sustainability applied to agriculture: biodiversity and rural development themes emerged, and the words 'soil' and 'landscape' were used more and more often.[212]

In the meantime, agroecology identity changed as well, becoming a movement and a practice. In fact, the term started to be used to define a new way to look at agriculture, considering its deep relationships with society; also, it was recognised as a set of farming and breeding practices aimed at providing solutions for an eco-friendlier agriculture.

Today, agroecology is a scientific paradigm. It is useful to respond to the new sustainability challenges of the agri-food system. According to the IAASTD,

> 'Agro-ecology is the science and practice of applying ecological concepts and principles to the study, design and management of sustainable agroecosystems. It includes social, political, cultural and economic dimensions and integrates state-of-the-art formal science with traditional and community-based knowledge; local food system experiences; and innovations that are low-cost, readily adaptable by small and medium-scale farmers, and likely to advance social equity while conserving biodiversity, natural resources and ecosystem function.'[213]

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[210] Wezel A and Soldat V 'A quantitative and qualitative historical analysis of the scientific discipline of agroecology' 7 1 *International Journal of Agricultural Sustainability* (2009) 3–18.

[211] Altieri M A 'Agroecology: The Science of Sustainable Agriculture' (Westview Press, 1995); Gliessman S R 'Agroecology: Researching the Ecological Basis for Sustainable Agriculture' 78 *Ecological Studies Series* (Springer, 1990).

[212] A Wezel and V Soldat 'A quantitative and qualitative historical analysis of the scientific discipline of agroecology' 7 1 International Journal of Agricultural Sustainability (2009) 3–18.

[213] IAASTD 'Feeding the World, Greening the Planet. Summary of Findings of the International Assessment of Agriculture Knowledge, Science and Technology for Development' (Fact Sheet, Global Report of IAASTD, 2009).

Agroecology, in its many incarnations, focuses on the interaction between plants, animals, humans and the environment. It is today supported by an increasingly part of the scientific community and considered by many global leaders as a successful approach to promote a sustainability revolution in the face of current global climate trends.[214] Fostering sustainable agriculture ensures in turn food security and nutrition, as well as a healthy environment. As argued in the previous chapters, many of the negative outcomes of modern food and farming systems are linked to industrial agriculture: intensive crop monocultures, industrial-scale feedlots, reliance on chemical fertilisers and pesticides, and preventive use of antibiotics. All these factors are triggering devastating effects. Agroecology aims at replacing this uniformity with an innovative approach based on diversifying farms and farming species, as part of holistic strategies to build long-term fertility, maintain healthy rural landscapes and vibrant livelihoods.

There is widespread agreement as to the advantages of enabling environments supportive of agroecology, food sovereignty, and ecologically-based production systems. In the words of the UN Special Rapporteur on the Right to Food Hilal Elver

> 'Agro-ecology will [increasingly] be the only way. When everyone understands this maybe it will be too late. We need to push now to make it an acceptable alternative.'[215]

The microcosms of traditional agriculture, threatened by the growing pressures of industrial agriculture and globalisation, need to be supported by new transitional policies that favours family agriculture and introduce substantial payments for environmental services. For centuries, the agricultural systems were built upon the local resources of land, water, and genetics according to local knowledge. This permitted the nurturing of robust and resilient farms, which held the minimisation of environmental 'bads' as essential principle. Being agrobiodiversity a key component of resilience, it has been the element allowing their long-lasting survival.

Modern agriculture needs to be more 'ecological, biodiverse, local, sustainable, and socially just', in order to reach the goal of sustainable intensification.[216] The productivity and sustainability principles of traditional agroecosystems may become core elements in the process of reaching sustainable, widespread farming systems. Thousands of small traditional farms still existing in most rural landscapes can take part to the 'organic 3.0' movement in many ways.

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[214] *FAO 'Final Report for the International Symposium on Agroecology for Food Security and Nutrition' (2014);* UN Human Rights Council 'Final report: The transformative potential of the right to food' (Report of the Special Rapporteur on the right to food Olivier De Schutter, 2014) 8; IPES-Food 'From uniformity to diversity. A paradigm shift from industrial agriculture to diversified agroecological systems' (Report, 2016); UN Human Rights Council 'Report of the Special Rapporteur on the right to food' (Report of the Special Rapporteur on the right to food Hilal Elver and the Special Rapporteur on Toxics Baskut Tuncak, 2017) 19.

[215] Special Rapporteur on the Right to Food Hilal Elver (Speech delivered at the Civil Society Global Forum Rome 15-19 October 2018).

[216] Altieri M A 'Agroecology, Small Farms, and Food Sovereignty' July-August 2009 *Monthly Review* 102-113.

4.4.2 The international movement for food sovereignty

The concept of food sovereignty has emerged from peasant communities organised at a transnational level as a proposal to rethink how humanity governs food and agricultural production, distribution and trade, and land and aquatic resources.[217] The term, launched in 1996 by La Via Campesina at the Rome Civil Society Organisation Forum, embodies a 'process in action', rather than a set of technical solutions. It is a response to the neoliberal model of corporate globalisation, the lack of accountability of transnational corporations, and the trend of overconsumption spreading in developed and developing countries. Together, these happenings increased world poverty and threatened the capacity of men and women to have access to adequate food.

Supporters of the agroecological paradigm are interested in the concept of food sovereignty, which Altieri describes as

> 'the right of each nation or region to maintain and develop their capacity to produce basic food crops with the corresponding productive and cultural diversity'.[218]

Altieri, as many others, is of the opinion that agroecology is key to its coming. Although the conventional wisdom is that small family farms are backward and unproductive, the author argues, research shows that small farms are much more productive than large farms if total output is considered rather than yield from a single crop. Not only do small- to medium-sized farms exhibit higher yields than conventional larger farms, but they also minimise negative impacts on the environment. As various studies show, small farmers take better care of natural resources, also by reducing soil erosion and protecting biodiversity, and make more efficient use of land, water, and other agricultural resources.[219] According to the last Report of the Special Rapporteur on the Right to Food, comparative studies clearly demonstrate it

> 'Studies using short time frames and focusing on individual crop yields, underestimate the potential long-term productivity of agro-ecological systems. Comparative studies are increasingly showing that diversified systems are advantageous and even more profitable, when looking at total outputs rather than specific crop yields. Agroecology is more likely to produce constant yields in the longer term owing to their greater ability to withstand climate variations and naturally resist pests. Success must be calculated in terms other than economic profitability and take into consideration the costs of pesticides on human health, the economy and the environment. Agro-ecology prevents direct exposure to toxic pesticides and helps improve air, soil, surface water and groundwater quality. Less energy intensive, agro-ecology can also help mitigate the effects of climate change by reducing emissions of greenhouse gasses and by providing carbon sinks.'[220]

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[217] European Coordination Via Campesina 'Food sovereignty now! A guide to food sovereignty' (2018).

[218] Altieri M A 'Agroecology, Small Farms, and Food Sovereignty' July-August 2009 *Monthly Review* 102-113.

[219] *FAO 'Final Report for the International Symposium on Agroecology for Food Security and Nutrition' (2014).*

[220] UN Human Rights Council 'Report of the Special Rapporteur on the right to food' (Report of the Special Rapporteur on the right to food Hilal Elver and the Special Rapporteur on Toxics Baskut Tuncak, 2017) 21.

The principles and characteristics of agroecological and organic farming practices are almost identical, and similar are the challenges they face (e.g. to prove their long-term viability and their capacity to compete head-on with the industrial systems in terms of production and environmental gain). But techniques and requirements are profoundly different.

Agroecological farming is more flexible in many ways: its principles are various and its recommendations, although comparable to organic farming, are not codified; it presents no general bans or inputs, and technologies which improve productivity without causing undue harm to the environment can be applied; there are no mandatory standards, nor inspections or certifications.[221]

Organic farms have become highly differentiated, both in terms of size and mechanisation. Innovative solutions are available but can be implemented only through amendments to the current organic standards and regulations. This has to be done without abandoning the organic key principles, if the whole organic paradigm is to survive and thrive. Incorporating agroecology seems a prerequisite for successful innovation.

A new social, ecological, and technological culture has to be developed. By now, organic settings have a somewhat conservative approach to ecological innovation, meaning innovative techniques that mimic natural mechanisms. Indeed, plants can give huge suggestions for exploring technological solutions to current environmental challenges.[222] Creativity and interdisciplinary research in the field of bionics are likely to engineer feasible applications for solutions that nature has created in the course of evolution.

For example, in the field of robotics several androids or animaloids have been created, but no 'plantoids' - despite the fact that plants are masters in activities such as colonising territories or exploring the soils. This is mainly due to the widely disseminated claim that plants and trees are at the limit between living and non-living organisms, just in a persistent vegetative state. Actually, plants are much more sophisticated in sensing than animals. They are able to move (flowering, re-orienting their sprouts and leaves towards the light, responding to gravity), to sleep, and to communicate with plants of other species as well as with animals by producing chemical volatiles and mimicking animal features.

Innovation in the field of production will not be sufficient to raise organics to the challenges of climate change and a growing and more demanding population. To increase efficiency, sustainability, and equally important transparency and credibility, organic agriculture needs to step back from the inadequate developments of its regulation. Governments and organizations, both at a national and supranational level, are required to review agricultural policies. Expanding the options of conformity assessments and fostering the adoption of innovative farming practices would be a good starting point.

The institution of true cost accounting is paramount in order to acquire a holistic understanding of the impacts of current production and trade frameworks. Evaluating the benefits of organic agriculture in terms of social equity and environmental sustainability will help in the building of sound policies, and in the process of strengthening society awareness about the importance of investing in sustainable farming innovation.

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[221] Niggli U 'Incorporating Agroecology into Organic Research – An Ongoing Challenge' (2015) 4 3 *Sustainable Agriculture Research* 149-157.

[222] Stefano Mancuso 'The roots of plant intelligence' TEDGlobal2010 (July 2010) <https://www.ted.com/talks/stefano_mancuso_the_roots_of_plant_intelligence>.

4.4.3 The Australian proposal: 'Regenerative agriculture'

In 2012, ex-governor general Michael Jeffrey has been appointed Australia's National Soils Advocate. He recently published a report discussing the outcomes of six years of consulting with farmers, Indigenous land managers, policymakers, students, and other interest groups across the country. The report 'Restore the Soil: Prosper the Nation' contains a simple message: Australia's soils, water and vegetation should be declared national strategic assets.

A series of recommendations are provided, aimed at integrating the management of water, soil, and vegetation to maximise agricultural productivity and prosperity in the long term. The author highlights the role of soil security in the world's existential challenges, today resumed in the SDGs: food, water and energy security, climate change abatement, biodiversity protection, and human health.[223] Australian farmers are already greatly affected by climate change and have to address declining levels of soil carbon, increasing soil acidification, and loss of soil and nutrients. These complications are the main legacy of past and ongoing intensive farming and grazing practices, still causing soil depletion.

The author encourages the federal government to support regenerative practices and to cut back on non-organic chemicals and fertilisers. This would be extremely important because healthy soils could neutralise Australia's annual emissions of 600 million tonnes of CO_2, thus allowing a more sustainable transition to renewable energy. Also, it would enhance the capacity of soils to retain water, permitting rainfall to penetrate into the earth rather than be dispersed (currently, around 50 percent of the rainfall flows away).

Regenerative agriculture is defined as 'the application of techniques which seek to restore landscape function and deliver outcomes that include sustainable production'. That means, adopting an approach which is both ecologically and economically viable. In order to implement actions such as using more organic composts and fertilisers, slowing the flow of water, fencing off waterways from livestock, controlling feral animal, direct-drilling crops into pasture, farmers need the support of both the government and the public. In particular, properly funding of agricultural education for farmers, agronomists, and soil and water scientists, is essential to ensure independence from companies with vested interests.

Independent government-funded research and education for farmers should be combined with actions promoted by consumers themselves to constrain major food retailers – such as Coles and Woolworths – to pay farmers a fair price for food. Consumers need to understand that 'driving prices down', usually signifies 'driving farmers to bankruptcy'.[224]

Building knowledge and awareness among farmers and consumers means reconnecting the urban and rural social tissue, which is key to a successful shift towards sustainable farming. Conventional farmers may find the proposed recommendations frightening and controversial, but some practical examples are already in place.

The Mulloon Institute is a research, education, and advocacy non-profit organisation engaged in reconnecting environment, society and farming through practical demonstration. Mulloon Creek Natural Farms is the living sustainable laboratory for the Institute, offering education programs for community groups, land holders, local business owners, Indigenous

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[223] Jeffrey M, Australian National Soil Advocate 'Restore the Soil: Prosper the Nation' (Executive Summary, March 2018).

[224] *The Guardian Weekly*, Chan G 'A security blanket that lies beneath our feet' (Australian ed., 26 October 2018) 199 21 26-27.

groups, schools, and volunteer organisations. The Farming Pilot Project began along 3 kilometres of Mulloon Creek (New South Wales) in 2006. Since the European settlement and the introduction of intensive farming system, the delicate balance between vegetation and water cycle has been dramatically altered by a whole suite of new plant and animal species. For as long as two centuries, the creek experienced soil, nutrient and biodiversity loss, being turned into a flowing channel cutting through the floodplain.

Over ten years of landscaping works later, the creek has become a vibrant ecosystem filtering water through its beds, capturing the flood sediments, and recycling nutrients. Also, it provides shelter for birds, mammals, reptiles, frogs, fish, and invertebrates. By banking water in the floodplain, the Australian farming landscapes is rehydrated, and the original ecosystems rebalanced. The soil's salinity is corrected and the whole ground results enriched with nutrients, rendering it more productive and resilient to droughts, floods, and bushfires. All in all, productivity in the floodplain has increased by 60 percent.[225]

The Institute's research methodologies, which are recognised by the UN Sustainable Development Solutions Network[226], are focused on approaching the environmental impact of rehydrating landscapes and the correlated economic impact on landholders and communities at a large, including social impacts on the community's members. The true potential of water, soil, and vegetation – the crucial elements that ensure regeneration – is exploited.

The recently released Fifth IPCC assessment warns that half a degree Celsius of extra warming will affect hundreds of millions of people. The Mulloon Institute's findings and Jeffrey's report accompany the emergence of an environmental sensibility in Australia, despite the federal government's short-sighted reactions. A debate is raging all over the country on the decision to continue to exploit coal reserves while farmers just suffered a drought that in some areas lasted up to seven years.

4.4.4 The Italian example: 'bio-distretti'

The importance given to the environmental side effects of farming raised the interest for the agroecologist approach everywhere in the world.[227] The experience of the so-called 'bio-distretti' in Italy provides an example of how public authorities, consumers, and farmers can build a resilient local economy, promoting rural livelihoods and environmental care. In the context of these long-term projects, the promotion of organic products is inextricably combined with the promotion of the territories, their biodiversity and their peculiarities.

The Italian Association for Organic Agriculture (Associazione Italiana per l'Agricoltura Biologica, AIAB) launched the first bio-district in 2009, identifying a geographical area where farmers, citizens, tourist operators, associations and public authorities enter into an

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[225] The Mulloon Institute for environment, farming and society 'Projects' <https://themullooninstitute.org/projects/#100projects-section>.

[226] The UN Sustainable Development Solutions Network (SDSN) has been operating since 2012 under the auspices of the UN Secretary-General. SDSN mobilizes global scientific and technological expertise to promote practical solutions for sustainable development, including the implementation of the Sustainable Development Goals (SDGs) and the Paris Climate Agreement. <http://unsdsn.org>.

[227] IPES-Food 'From uniformity to diversity. A paradigm shift from industrial agriculture to diversified agroecological systems' (Report, 2016).

agreement for the sustainable management of local natural resources. Since then, 26 other similar districts have been created among 18 regions, while other 21 are in the process of being formed.

Each bio-district acts according to the principles of organic production and agroecology, and is marked by healthy lifestyle and consumption patterns, vivid human relations, and care for the environment. This participative paradigm represents an innovative, holistic approach towards sustainability, resulting in more valuable and resilient agricultural productions. It is appreciated by well-informed consumers and represents a fulfilment of the economic and social potential of the territories involved.

In November 2017, AIAB created the '*Rete Nazionale dei Biodistretti AIAB'*, a national network sharing a trade mark that symbolises the pact between the productive world of small organic farms, administrations, and civil society. All the actors involved share the responsibility for an effective and sound governance of the territory in the sectors of agriculture, environment, and tourism.[228]

Farmers are the protagonists of this governance model, being the provider of agricultural knowledge, *connoisseurs* of local and traditional foods. The local crops they grow and the traditional breeds they safeguard proved to better protect them against plants' or animals' diseases and to make them more resilient in the face of climate change. At the same time, producers are integrated in a network that ensure them easy access to local markets all year long. Maintaining local biodiversity, they contribute to food and environmental security and provide essential environmental services to their community.

All native or local varieties, breeds, and even yeasts, are the result of years of natural or man-made selections and are characterised for being well adapted to the environmental conditions of the specific area where they have been developed. Being more resilient to climate stress, they need fewer external inputs such as water, fertilisers, or pesticides. Not surprisingly, these same foodstuffs are embedded in the social and cultural heritage of the locals.[229]

A biologically varied system is endowed with the antibodies to counter dangerous organisms and restore its own equilibrium when tried by various sufferings. Indeed, a system that is based on a limited number of varieties is very fragile. The Irish potato famine can be interpreted as the first warning to humankind of the risks connected to genetic uniformity. A single variety of potato was cultivated in Ireland at that time. Being the only one, it was highly vulnerable to virus and fungal blights. When a disease occurred, it caused the starvation and emigration of thousands of people.

The Italian Chamber of Deputies is working on the updating of the current regulatory framework, to effectively support the consolidation of bio-districts throughout the entire

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[228] AIAB 'Nasce ufficialmente la Rete Nazionale dei Biodistretti AIAB: l'unico marchio che garantisce la valorizzazione dal basso' (23 November 2017) <https://aiab.it/nasce-ufficialmente-la-rete-nazionale-dei-biodistretti-aiab-lunico-marchio-garantisce-la-valorizzazione-dal-basso/>

[229] Slow Food Foundation for Biodiversity. Milano S, Ponzio R, Sardo P (eds.) 'Biodiversity. What it is, what does it have to do with our daily food, and what can we do to preserve it?' (Report, Slow Food, last updated January 2018).

country. It has recently published a Dossier presenting two legislative proposals concerning the development of competitive agri-food production systems following organic methods.[230]

These legislative proposals are issued in occasion of the implementation of the new Regulation (EU) 848/2018; both contain the notion of bio-districts (Article 10), described as 'local productive systems, in which the *organic or local cultural methods* are prevailing' [author's trans]. Bio-districts are characterised by the '*interconnectedness* between agricultural activities and other economic activities, and by remarkable rural landscapes' [author's trans]. The major goals of the bio-districts project are individuated by Decree of the Ministry of Agricultural, Food and Forestry (MIPAAF): promoting a sustainable management of local and natural resources, favouring local productions and markets, conserving biodiversity and social agriculture, promoting a broader diffusion of organic products, and 'fostering the *simplification* of the application of organic and environmental certifications' [author's trans]. The legislative proposal suggests the establishment of a National Register of the acknowledged 'Food Districts' [author's trans].

[230] Italian Chamber of the Deputies '*Disposizioni per lo sviluppo e la competitività della produzione agricola e agroalimentare con metodo biologico*' ['Propositions for the development and competitiveness of agricultural and agri-food production using organic methods'] A.C. 290, A.C. 410 Dossier n 21 (6 August 2018).

5 MAPPING THE EVOLUTION OF THE AGRI-FOOD SECTOR

The analysis of possible pathways to reduce agriculture's footprint on Earth's ecosystems made clear that a broader approach is needed if the goal of limiting global warming to 1.5°C is to be reached. Agriculture itself is only the first step of a long and complex food chain, which encompasses all the activities lying between on-farm production and food consumption. The real economic, environmental, and social costs of the food people consume everyday can be identified only through an inquiry that embraces the food system at a large.

No farming system will ever be able to fulfil human needs, if not combined with reasoned food trading, retailing, and consumption patterns. In other words, sustainable intensification does not only refer to food production: the term involves a wide range of further activities, that occur once the agricultural goods leave the farm until the moment the latter goods reach the consumer's plate, anywhere in the world.

According to Paul Hawken, editor of 'Drawdown. The most comprehensive plan ever proposed to reverse global warming', there are 100 actions that, collectively taken, could effectively reverse climate change by 2050. Among the top 20 solutions proposed, 12 are related to land use and the food sector: reducing food waste, adopting plant-rich diets, tropical and temperate forests restoration, silvopasture practices, Regenerative Agriculture, peatlands ecosystems protection, tropical staple trees planting for carbon sequestration, afforestation, Conservation Agriculture, tree intercropping and managed grazing. A rapid intervention in these main areas could reduce the total atmospheric CO_2 concentration up to more than 385 GT from 2020 to 2050.[231]

In light of these considerations, ensuring food and environmental security requires a rethinking of the whole Food Supply Chain, which is currently characterised by a globalised and industrialised asset. The latter is the result of an ongoing transformation, to which various actors - political institutions, private companies, consumers, and farmers – contributed.

The exponential growth in food production has been accompanied by a relevant concentration of power in the hands of a small number of huge transnational firms. These corporations dominate the input, trade, and retail sectors of the Food Supply Chain.[232] Mergers, acquisitions, and management of relevant shareholdings are ongoing in all sectors of the food and agriculture industry. Agri-food markets and their regulatory frameworks are by now shaped through lobbying, marketing, and financial activities carried out by the main actors of the Food Supply Chain. As a result, uneven trade rules and unfair practices typify the global food system, which seems to be benefiting multinational corporations rather than consumers and farmers.

The structural characteristics of agricultural networks and the unfairness of agricultural markets are having relevant environmental and social implications.[233] Not only the

[231] Drawdown 'Summary of Solutions by Overall Rank' <https://www.drawdown.org/solutions-summary-by-rank>

[232] HLPE. "Sustainable agricultural development for food security and nutrition: what roles for livestock?", 2016.

[233] Hendrickson, M. "Power, Fairness and Constrained Choice in Agricultural Markets: A Synthesizing Framework", 2015.

confluence of power in a handful of agribusiness firms has recently raised major concerns about the risk of abuse of dominant market positions; also, it is seriously hindering any appreciable development in terms of sustainability. Being designed to offer year-round provision of large quantities of food at the lowest cost, the global agri-food chain does not consider the negative effects on the human and natural ecosystems.

5.1 A brief history of agriculture and food trade

Agriculture and trade are both paramount components of the Food Supply Chai. Their development over the past centuries needs to be fully understood to obtain a complete picture of the present-day situation, with its multiple and interconnected aspects. Only then, the driving forces contributing to today's food systems asset will be correctly identified.

5.1.1 Agriculture and the rise (?) of civilisations

For about 200,000 years Homo sapiens lived as hunter-gatherers. During this long period, people also began to migrate from Africa to Europe, Asia, the Americas and Australia.

Shortly after the end of the last ice age, people living in the Middle East cultivated wheat and barley for the first time, and domesticated animals. Around 8000 B.C. farmers in what is now known as Mexico began to breed maize (corn) from teosinte, a wild grass indigenous to the region. 2000 years later the first irrigation systems are invented in Egypt and Iran, enabling farmers to double crop yields. Cultivation could then continue through the dry years, thus ensuring greater food security for the population. In the same period the plow was invented in Mesopotamia and the Indus Valley, to harness animal power.

The shift from hunting and gathering to farming was a gradual process, due to differences in indigenous plants and animals, local climate and geography: it happened 10,000 years ago in some parts of the world and 5,000 years ago in others. For centuries, farmers around the world developed new agricultural techniques and domesticated further plants and weeds, choosing seeds from plants with the most desirable characteristics.

It was mainly the farm-related technologies of the Fertile Crescent and China that had the greatest influence on future civilisations.[234] Small domesticated animals and birds, like the chicken in China, provided food, eggs, and feathers. But it was the five mammals found in the Fertile Crescent – sheep, goats, cattle, pigs, and horses – that had an enormous impact on food productivity. Their power was harnessed to pull plows and wagons, grind grain, and build irrigation projects; by grazing, animals also fertilised the fields with their manure. As a result, civilisations with domesticated animals had more food, larger populations, and land transportation, so they were able to move into foreign territories and conquer new land. At the time of Christ's birth, the total number of people has reached some 200 million.

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[234] *Encyclopedia.com*, Lindsey Evans 'Early Agriculture and the Rise of Civilization' *Science and Its Times: Understanding the Social Significance of Scientific Discovery* (21 October 2018) <http://www.encyclopedia.com>.

Although people usually think of agriculture as the first step of a progressive, constant evolution, some archaeologists have recently argued that the shift towards farming has been the worst mistake for human race, or its 'greatest blunder', as Diamond J endorsed.[235]

Studying the rise of agriculture, scholars found that when switching to farming, hunter-gatherers traded quality for quantity. They had to choose between limiting population or increasing food production: the majority opted for embracing agriculture. The evidence suggests that agriculture had negative effects on health: while hunter-gatherers enjoined a healthy diet, early farmers obtained most of their food from one or a few starchy crops, gaining cheap calories at the cost of poor nutrition; in addition, because of dependence on a limited number of crops, they ran the risk of famine if one crop failed. Finally, crowded societies that carried on trade with other crowded societies led to the spread of parasites and infectious diseases.

Besides that, agriculture is also said to be the bearer of other misfortunes upon society: deep class divisions, because some people could store food and concentrate food sources; inequality between the sexes, because farming women were under pressure to have more children that could then work in the fields.

Whether it was a great or a bad choice to embrace agriculture, food, which was once a practical necessity, soon evolved into an indicator of social standing and religious and political identity. With the invention of cooking, food acquired its own language and grew into a complex cultural product – shaped by climate, geography, the pursuit of pleasure and even the desire for health.[236] It is likewise true that since the raise of agriculture food was no more just a means of living or expressing the community's identity – indeed, it kept being at the core of political and economic strategies.

Roman emperors withhold food from people as a form of control, so much that the first recorded famine occurred in 486 B.C. when thousands of starving Romans tried to drown themselves in the Tiber River. In the early 19th century, Ireland's farmers were working to provide cereal crops to the industrious British Empire when they experienced the well-known potato famine. Stalin's collectivisation policies, implemented following the Russian Revolution, left an estimated 7 to 8 million deaths. The Great Chinese famine, the most lethal in human history, dates back to Mao Zedong's 'Great Leap Forward Program'. By collectivising farms, the state triggered a decline in grain production, which exacerbated by a number of natural disasters caused 33 million deaths.

In the second half of the 20th century, Northern wealthy countries adopted agricultural support policies that contributed to the accumulation of huge amounts of crops and dairy products. The US, followed by Canada and by Europe after WWII, was unable to place these products on the market at a reasonable price. Therefore, food aid programs to support humanitarian (as well as economic and geopolitical) goals in foreign countries were initiated. These aid programs, together with the World Food Programme promoted by the UN agency in 1961, were intended to provide food and logistical support in emergency situations such as war and disaster. However, they did not prevent the devastating and frequent famines characterising the recent decades. The US food aid policy was unable to resolve food security issues in the countries interested by its implementation; indeed, it created a dangerous

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[235] *Discover*, Diamond J 'The Worst Mistake in the History of the Human Race' (1 May 1999) <http://discovermagazine.com/1987/may/02-the-worst-mistake-in-the-history-of-the-human-race>.

[236] Massimo Montanari 'Il cibo come cultura' (Laterza, 2005).

dependence on US food provisions. In fact, once the food aid entered the market of developing countries, a new taste for imported foreign grains and foodstuffs emerged. Many of the areas covered by the aid policy, once no more entitled to receive food aid, became commercial importers.[237]

Indeed, national policies and political issues were often responsible for causing or exacerbating the scale of the crisis (e.g. Nigeria between 1967 and 1970, Cambodia between 1975 and 1978, Eritrea and Ethiopia between 1983 and 1985).[238] 'Bread riots' occurred regularly since the mid-1980s in the African Mediterranean regions, following policies by the World Bank and the International Monetary Fund, culminating in the 'Arab Spring'. The food price spikes in 2008, coupled with a global recession, intensified the hunger crisis, and the number of hungry people in the world reached 1 billion by 2009. Food was inaccessible to hundreds of millions worldwide, because of speculation in commodity markets, a rise in oil and fertiliser prices, the rising use of corn in biofuel production, and poor harvests in some places.

In conclusion, agriculture has had both positive and negative outcomes on humanity. As of today, despite the immense quantities of food provided each year by agricultural lands, the 'End Hunger' goal is still to achieve.

5.1.2 Food trade development

Trading food and plants is a centuries-old activity. Asia witnessed thriving trade in tea in ancient times, and spices were traded in the Middle East way back in 2000 B.C. Between 700 and 1300 A.D. the world observed the first important 'contamination' of foreign plants and crops on the Islamic lands, as a result of the intense commerce conducted by Arab and Muslim traders across Africa, Europe, and Asia. Sorghum from Africa, citrus fruits from China, mangoes, rice and sugar cane from India, and many other crops were grown on these lands, contributing to the population's wealth.

However, in the communal memory, European explorers and adventurers are *par excellence* initiators of food trade, importing goods from the Americas and Africa towards Europe. Between the 15th and the 16th century, new plant species and crops were discovered, as such as potatoes, tomatoes, cocoa, coffee, vanilla, avocado, chili pepper, peanuts. During this period of intense trade the most successful crops and plants were even adopted for cultivation by the importing countries, becoming part of European landscapes, cultures, and traditions.

The geographical isolation that enabled the development of genetic variation in cultivated food plants was overcome in the 'age of discovery', also known as 'Columbian Exchange'. Food plants were introduced to colonising countries and in new regions with growing colonial institutions where an export-oriented production was simultaneously stimulated.[239] For some varieties the exchange happened extremely quickly – potatoes, for example, were

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[237] Lappé F M , Collins J and Rossett P 'World Hunger: 12 Myths' (Grove Press, 1998).

[238] World Food Program USA 'A Brief History of Food' 16 October 2015 <https://www.wfpusa.org/a-brief-history-of-food/>.

[239] Nathan N and Qian N 'The Columbian Exchange: A History of Disease, Food, and Ideas.' 24 2 *Journal of Economic Perspectives* (2010) 163-88.

first seen by explorers in 1551 and were already cultivated 15 years later in the Canary Islands. This rapid acceptance is partly due to the need to escape from crop-specific pests and diseases, and partly to complementarity in terms of production season and dietary needs.

Since then, the expansion of human settlement, more efficient transportation, and increases in global trade have magnified the geography of consumption. A different type of 'contamination' followed, entailing the most successful farming techniques developed in Northern rich countries. These techniques were gradually implemented in colonies and all over the Southern hemisphere. The process of agricultural standardisation was mainly an instrument to control foreign production and a way to generate profits, rather than an empowerment tool. First, mechanisation and innovative breeding assured higher yields and incomes to the rich countries, enabling them to free up labour for the Industrial revolution to come. At that point, they were implemented in the poorer countries. Later on, pesticides and fertilisers were developed and subjected to the same process of massive implementation, together with innovative machinery and irrigation systems.

Humankind firstly experienced a breakthrough in plant genetics in the second half of the 19th century, when the Austrian monk Gregor Mendel published the results of his studies on inheritance in pea plants, putting the basis for the modern science of genetics. Since then, breeding technologies continued to evolve. The varieties of basic grains developed in laboratory between the 1950s and 1970s became an essential part of the intensive farming model and were similarly diffused in much of Asia and parts of Latin America.

The latest set of research and development of technology transfer initiatives, beginning in the 1950s and continuing for at least two decades, is known as the 'Green Revolution'. Spearheaded by Norman Borlaug, this initiative resulted in the adoption of high-yielding varieties of cereals, in combination with chemical fertilisers and agro-chemicals, water-supply and new methods of cultivation. The progress in mechanisation was key for this promising agricultural model.

Through a process very much like the latter, genetic engineering techniques were elaborated, tested, and later applied in the Southern countries of the world. However, while the previous research and export of agricultural tools and know-how was a state-controlled process, studies and development concerning GE techniques have been a prerogative of private corporations. As a result, both developed and developing countries became dependent on powerful transnational companies for large shares of the domestic food production.

Today, as opposed to the past, large transnational corporations are the major players in food security issues. The agricultural policies implemented during the 1930s-1980s paved the way for the globalisation of the world food economy and private companies' triumph.[240]

The developments following the Second World War have been decisive for the accomplishment of the process of globalisation that occurred in the food sector. US agricultural and financial strategies were by far the most influential on global outcomes.

[240] Clapp J 'Food' (Polity Resources, 2012) 11.

5.1.3 'Food regimes' shape the global food scenario

Sociologist Harriet Friedmann introduced the notion of 'food regime' to indicate a 'rule-governed structure of production and consumption of food on a world scale'.[241] The term was further developed by Friedmann itself and McMichael P, informing research and teaching in sociology, geography, political science, and anthropology. As McMichael states in a more recent work

> 'The food regime concept historicised the global food system: problematizing linear representations of agricultural modernisation, underlining the pivotal role of food in global-political economy, and conceptualising key historical contradictions in particular food regimes that produce crisis, transformation and transition. In this sense, food regime analysis brings a structured perspective to the understanding of agriculture and food's role in capital accumulation across time and space'.[242]

According to this definition, agriculture and food have to be investigated as key elements of national and international policies, economic relations, and political developments. Two main food regimes are identified by the author for being representative of a certain asset of international trade and investment at a given point in history.

The first food regime is the resulting combination of colonial tropical imports with basic grains and livestock imports from settler colonies.[243] The globally oriented markets for luxury crops to serve European and North American countries were set in the colonial era, under Britain's leading authority. They were followed by trade in temperate agricultural products, such as wheat, involving the first grain trading companies. Commodity exchanges took place in London since the 18th century, and more institutionalized agricultural future trading markets were established in the UK and in the US in the second half of the 19th century.

The second food regime begins with the establishment and development of national agri-food sectors in the US, Canada and Australia, which cost Britain its leading role in the global market politics. After the Second World War, these new agricultural powers led the way for the industrialisation and globalisation of the food market. The US agricultural policies, in particular, became strongly influential on global economies, shaping the new international food order.

In this respect, the great variety of food commodities that is today available anytime, all over the world, is the result of an ongoing economic and agricultural development. In the last fifty years, globalisation has been stimulated and reinforced by agricultural policies that facilitated trade agreements, granted agricultural subsidies, and supported the diffusion of industrial food technologies. Other elements contributed to this phenomenon: the growing consumer purchasing power, the rise of supermarkets and convenience foods, greater consumption of food outside the home, urbanisation, and refrigerated transport.

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[241] Friedmann H 'International regimes of food and agriculture since 1870' Shanin T (ed.) *Peasants and peasant societies* 258-276 (Oxford: Basil Blackwell, 1987).

[242] McMichael P, 'A food regime genealogy' 36 1 The Journal of Peasant Studies 139-169 (2009).

[243] Ibid.

The vicious effects of this progression are manifold, all of them attributable to sequences of standardisation and mechanisation.

First of all, the disconnection between consumers and the food they eat brought to a greater consumption of packed and processed food from industrial cultivation, with no attention for seasonal or local products. This contributed to ignorance and misunderstandings about the derivation of the food that people consume daily, which origins are often mistakenly attributed.

Secondly, an increased and alarming homogeneity in the global food system. A recent research into the origins of food plants analyses the role of specific geographical regions in the progress of agriculture.[244] Most importantly, it studies the extent to which countries use crops from 'regions of diversity' other than their own, revealing that foreign crop usage has significantly increased over the past 50 years. Crops originating from a group of countries identified as primary regions of diversity (or 'centres of origins', pursuing the first definition given by the Russian botanist Vavilov Nikolai) shape today's global food production and trade scenarios.

The study provides a novel perspective on the dangers of globalised food systems. Surely, food supplies are since centuries composed of a variety of crops deriving from several different countries. That means, there is a profoundly interconnected global food system erected upon ancient food plants, with the primary regions of diversity providing many of the crops humanity still depends on today. This is nothing new: food production always depended on agricultural biogenetic resources that have been traditionally developed, conserved, and shared by farmers in their primary regions of diversity. The alarming fact is that, over time, the pool of genetic resources at disposition has been restricted to fewer crops and breeds, to satisfy the needs of 'advanced' industrial agriculture.

Focusing on the production of tradeable commodities rather than food, local knowledge has been sacrificed in the name of progress and mechanisation. The irreplaceable resources developed in the primary regions are today threatened, precisely now, when each country depends on the agricultural biodiversity of other countries more than ever. If the primary regions vanish, also the agricultural biodiversity will be endangered, arising important challenges for food security worldwide. Monocultures and standardisation ensured maximum profits for agribusinesses while promoting the wide adoption of 'western' dietary patterns and a consequent considerable loss of genetic agricultural resources.

5.2 The process of commodification

Food systems governance has been central in the rise and fall of entire nations. Today's asset is the result of decades of unsound political and market strategies that permitted developed countries to thrive by exploiting the natural resources of the Southern hemisphere. Following this first period, the public sector placed the global food governance in the hands of private multinational companies, which then aggravated the situation.

The big food transnational companies (TNCs) operating on a global scale, never demonstrated true commitment in worldwide challenges in the past, nor today. Indeed, they are very likely to distort all efforts to implement a sustainable intensification policy. Their

[244] Khoury C et al 'Origins of food crops connect countries worldwide' B 283 Proc. R. Soc. (2016).

strategies negatively affect food security, access to land, water use, labour standards, and the environment in multiple ways. Perplexities arise concerning the protection of fundamental rights, such as the right to food and farmers' rights to choose what plants' varieties to maintain and exchange. Most importantly, advocates of the right to food condemn the depiction of food as a 'commodity'. This narrative is responsible for many weaknesses of the current global food system.

The commodification of food is a complex process, based upon two major trends. On the one hand, the realisation of (imperfect) international free trade markets, under the pressure of liberalisation advocates such as the World Bank and the WTO. On the other hand, the financialisation of the agri-food sector, due to the success of business models developed by large multinational enterprises, increasingly investing in financial instruments. Both trends pose significant criticalities in terms of environmental, social, and economic sustainability.

5.2.1 The role of national agricultural policies

Domestic policy settings are essential determinants of agricultural productivity because they shape farmers' incentives and capacity to innovate and improve productivity. National agricultural policies laid the groundwork for the massive intensification of international agricultural trade that characterised the second half of the 20th century. The 'scientific-based' agricultural production methods that distinguish the modern industrial farming approach were first developed in the US in the mid-1800s. With the government's encouragement and economical support, research into technical and scientific aspects of farming continued for decades, developing new production techniques. These techniques require heavy capital of inputs, the adoption of hybrid seeds, pesticides, fertilisers, machinery, mono-cropping, and infrastructure for irrigation. Such an energy and water-intensive farming would have not been possible without the supportive agricultural policies implemented in the 1930s.

The US government fought the Great Depression through the adoption of the New Deal economic policies, providing food commodities price support[245], implementing production controls, crop insurance, and farm credit schemes. The US focused on restricting imports while promoting domestic production, exports, and free investments.

Similarly, the European Community moved to increase its own production after recovering from the Second World War, and largely adopted intensive farming. Aiming to increase efficiency and overall profitability of the production chain, the old continent's policies contributed to further environmental depletion.

The new Common Agricultural Policy (CAP) was established in 1962 to support agricultural production and allow farmers to produce abundant and affordable food, while ensuring them a reasonable living. A wide range of programmes have been designed to promote food security and rural livelihood through income support, market measures and rural development plans. Concerning the agricultural market, the main tools to regulate the international trade of food commodities were price supports, high tariffs and quotas on imports, and export subsidies (payments to support exports).

In Australia, different governments have played an active role in encouraging intensive farming practices and farm consolidation, fostering better business management capacities.

[245] This form of support entails the governmental purchase of surplus crops at set prices to protect farmers from the caprices of free markets.

The regulatory framework highly promoted agricultural intensification and encouraged market development by international free-trade agreements, while ecological concerns were put aside. Consequently, weak environmental policies were developed.

Historically, governments have employed a wide range of agricultural policy measures to maintain and stabilise farmer returns, including marketing and price support schemes, as well as subsidies to reduce input costs. Following the Canadian approach, the Australian government instituted a government-run marketing board for the management of a large portion of its agricultural sector. The board acted as a monopolist, buying domestic agricultural products and selling exports abroad. These assistance measures were light if compared with those implemented in North America and Europe. Nevertheless, they distorted resource use across farms and weakened farmers' incentives to find better ways of managing risk and to improve productivity. The government policy offset adjustment pressures, thus impeding structural change.[246]

5.2.2 The Green Revolution

The great turning point in the history of modern agriculture, which in turn marks a watershed in the industrialisation of the Food Supply Chain, can be traced back to 1947. That year, a huge US munitions plant at Muscle Shoals, Alabama, switched over to make chemical fertilisers. After the war, the US government had a surplus of ammonium nitrate, which is the principal ingredient in the making of explosives and also an excellent source of nitrogen for plants. Agronomists in the Department of Agriculture proposed to convert this residual material to give birth to what became the powerful chemical fertiliser industry.

The widespread embracing of large-scale industrial agriculture production models caused food surpluses, which at a certain point became problematic due to their high costs of storage. To solve this structural problem, industrialised countries established international aid programs. Flows of surplus food were redirected towards post-colonial states. The European Community (EC) food aid program began only in 1968, more than a decade later than the US Agricultural Trade Development and Assistance Act, 1954. The European food aid program was also less overtly political: the US, indeed, exported food surplus on strategic perimeters of the Cold War and aided with intensive agricultural development in developing countries. The latter countries became dependent from food aid subsidies and were subsequently targeted as recipients of the industrial agricultural model.

In fact, when the costs related to food aid programs became too high for developed countries, they promoted the so-called Green Revolution. The Green Revolution was a campaign led by Northern wealthier countries with the aid of international agricultural research centres to modernise farming in the developing world through the diffusion of the industrial agricultural model. The provision of hybrid seeds and all agricultural inputs required for intensive farming, has served as basis for a new configuration of international relations. New grounds of governance in the world food economy were established.[247]

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[246] Gray E M, Oss-Emer M and Sheng Y 'Australian agricultural productivity growth. Past reforms and future opportunities' (Research Report, Australian Bureau of Agricultural and Resource Economics and Sciences, 2014).

[247] Clapp J 'Food' (Polity Resources, 2012) 28-29.

According to Green Revolution advocates, the campaign achieved food security and created jobs in many poor countries. Critics, instead, highlighted the fact that gains in national productivity of the targeted nations did not result in a better distribution of food. Hunger is a complex social and economic problem that requires a broader approach to be eradicated, comprising a redistribution of power and resources. The Green Revolution technologies and correlated economic benefits were mostly available to larger-scale farmers, thus promoting consolidation and concentration of power. The phenomenon contributed to exacerbating inequalities. Many smaller farmers had to borrow money to obtain the inputs required and were then unable to pay their debts.

The development of agricultural biotechnology itself has been criticised: mainly promoted by the private sector, the diffusion of GM seeds replaced highly nutritious crops (e.g. lentils and other pulses) by 'cash crops', such as wheat and rice. According to the food activist and ecologist Vandana Shiva, only a reductionist approach that simply counts grain and other crops as if they were just a bunch of commodities can see an improvement when comparing the before and after of food production and nutrition.[248]

5.2.3 The food market crisis of the 1970s

By the early 1970s, the US had become by far the dominant player in the global grain trade, selling half of the grain exported globally. A large share of it was exported to developing countries. The remaining half was provided by Canada, Australia and France. While rich industrialised countries benefited from the new global asset and exported food all over the Southern hemisphere, hunger in the developing world was far from defeated.

However, by the mid-1970s the global food-order had to come to terms with various forms of crisis. At the time, developing countries were highly fragile. After years of dependence on food imports, they needed foreign corporations' inputs to maintain their own production (seeds, fertilisers). In this delicate context, major political changes occurred in the US, with disastrous effects on the global food system: a food market crisis was followed by a broader crisis of industrial agriculture, revealing the very logic of the second food regime.

Between 1972 and 1975, international food markets' prices for basic staples (wheat, corn, and soy) jumped to average three times their levels in 1971. Simultaneously, food stocks reached record lows. The combination of high prices and fading stocks made it very difficult for developing countries to import food, and millions had suddenly no more access to food, which was either too expensive or unavailable.

The reasons for such a sudden shift from surplus to deficit are various. At that time, population growth and bad harvests were targeted as culprits. The oil crisis surely contributed to the situation, being industrialised agriculture dependent on fossil energy. Moreover, although only few analysts pointed to the role of meat-based diet as one of the main causes of the inequitable distribution of food between developed and developing countries, the one billion people in the wealthy countries were eating meat that used as much cereal as the two billion people in the poor countries consumed directly in the form of grain. Finally, the US policy changes had a really negative impact on global food markets - due to the dependency and vulnerability that characterised many countries as a result of the Green Revolution. The

[248] Vandana Shiva 'Response to FSSAI - Food Safety and Standards Authority of India' (Letter, 15 June 2018) <http://www.vandanashiva.com/?p=291>.

US were no longer willing to bear the costs of food storage and decided to no longer accumulate grain stocks. At the same time, they significantly devalued the US dollar, to increase commercial exports, and gradually diminished food aid donations.

Between 1973 and 1977, Earl Butz was the US Secretary of Agriculture in the Nixon and Ford Administration. He shaped the new US farm legislation. In order to ease prices and improve the trade balance, he urged to increase production and export, encouraging the consolidation of smaller 'inefficient' farms into bigger ones and the increase of land under cultivation. The European Community followed a similar path, boosting agricultural subsidies. As a result, food prices fell again in the late 1970s and the food crisis was declared over.

However, a graver ecological and social crisis in the intensive farming system was by then visible. Agricultural intensification and the growing reliance on external inputs, fossil fuels, and hybrid seeds resulted in deep ecological and social aftermaths. Biodiversity and nutritional diversity loss, loss of genetic and habitat diversity, are just some examples of the escalating erosion of natural capital. That means, the provision of fewer ecosystem services, which are various and essential for human survival. There are regulating services (water and soil regulation, local climate regulation and moderation of extreme climate events, pollination, air quality and water regulation), provisioning and supporting services (food, fresh water, raw materials and medicinal resources, nutrient cycling, photosynthesis and soil formation), as well as cultural services (mental and physical health, aesthetic, spiritual and religious values, recreation and ecotourism).[249]

Scientists, academics, and environmentalists argued that the increasing human pressure was diminishing the natural capital at a faster rate than it could be replenished and recognised industrialised agriculture as a major responsible for its depletion. Fossil fuels, pesticides and fertilisers, water and energy-intensive practices, all contributed to environment exhaustion. Healthy ecosystems are vital for human well-being and prosperity, but they were, and still are, seriously compromised by human activities.

These negative environmental effects were combined with social effects, for farmers and consumers alike. In developing countries, as it has happened in the US before, many small farmers were constrained to sell their lands to bigger landowners or to cultivate only certain crops, adapting to the new technologies in order to produce more from the same fields and satisfy international markets' demand. Governments agreed to sell public land to foreign companies and investors to pay their growing debts, thus loosing important sources of revenues and exacerbating food insecurity.

As grain production increased, there was a move to feed grain to animals, which enabled large-scale intensive livestock farms to emerge and meat consumption to climb. Intensive livestock farming has soon been associated with environmental and health problems in many industrialised countries. In addition, more than half of the food supply has ended being made up of three major crops (wheat, rice and maize) standardising consumption patterns all over the world. This trend contributes to further deteriorating public health.

In comparing the 1970s food crisis with today's situation, the similarities are astonishing: despite the enormous progress claimed by the supporters of a globalised world economy, namely, economic growth and scientific and technological development, very little has

[249] WWF 'Living Planet Report 2016. Risk and resilience in a new era' (WWF International, 2016).

changed. Farmers are challenging economic uncertainty and unfair trading practices; developing countries are still needing food aid while rich countries waste large amounts of the food they produce; globally, hunger is on the rise, coexisting in some countries with obesity.

The corroboration of global food markets implies that food is considered, for all purposes, like any other tradable commodity that firms produce, sell and trade, rather than a source of nourishment and a cultural feature of societies. Countries have lost their food sovereignty, being more and more constricted in their production and trade choices. People are considered mere consumers, by now 'distant' from the origin of the food they eat, both in terms of mental and physical distance.[250] The increasing detachment between the production and eating of food is part of the process of 'food commodification'. The network of practices, attitudes, and beliefs around food, as well as the actors surrounding its production, distribution and consumption, are more and more levelled.

5.2.4 The development of international agricultural trade norms

National governments took an active role in managing food production and trade from the time when the industrialisation of agriculture occurred. The resulting food system relies heavily on transnational markets. The current international trade regime is widely recognised as being essential to food security, even if, at a closer look, it is not sure if it encourages or hinders efforts to address global hunger and food security.[251] Besides, the ecological and social impacts of a globalised food market are gaining more and more attention.

For much of the last century, agriculture was exempted from the norm of free trade that was promoted by global economic institutions in other sectors. Agricultural trade was formally covered under the General Agreement on Tariffs and Trade (GATT), within which the norms regulating international trade between US, Europe and other parties has first been discussed and adopted. However, both developing and developed countries continued instituting complex and different systems of agricultural trade policies including various combinations of subsidies, tariffs, quotas, taxes, and marketing boards.

The exemption of agriculture from internationally recognised trade principles and policy frameworks was signalling a meaningful distinction between food and any other commodity on the market. First of all, agriculture and food production are significant for national security, they can be used as a foreign policy lever. Also, they are 'multifunctional', since they provide cultural and environmental services too.[252] Moreover, the dominant political power in the international food system at that time, namely, the US, had no intentions to submit the agricultural sector to free trade. In fact, this would have disturbed its fragile system of supports. Similarly, Europe had its proper complex and indispensable set of policies to support European farmers.

Today, the GATT still exists, shaped by various rounds of negotiations occurred between 1947 and 1994. The Uruguay round is the latest and most ambitious among the negotiations,

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[250] Above, n 191 17.

[251] Clapp J 'Food security and contested agricultural trade norms' 11 2 *Journal of International law and International Relations* (2015) 104-115.

[252] Ibid, 105.

aiming to expand the competence of GATT to new areas. A total of 123 parties took part in the round and developing countries have played an active role in the dialogues for the first time.

One of the most significant changes was the creation of the World Trade Organization (WTO): differently from the GATT, which is an international forum, the WTO is an institutional body.

Another essential innovation was the inclusion of agriculture in the negotiations. Some countries in particular, organised in the 'Cairns Group' (a coalition including small and medium-sized agricultural exporters, including Australia, Canada, Brazil, Indonesia) no more justified the exemption of the farming sector. Many developing countries argued that their industrialised counterparts persisted in distorting agricultural trade practices, outcompeting their own farmers and contributing to their dependence on food aid and imports. Moreover, the US, Europe and Japan itself found it more and more difficult to cover the rising costs of agricultural subsidies and other protections.

The Agreement on Agriculture (AoA) was arranged to liberalise the trade in the sector. However, the goal of improving market access for agricultural products and reduce domestic support in the form of market-distorting subsidies, quotas, and export subsidies was not fully reached. The agreement ended up demanding market-opening measures in developing countries, allowing rich countries to continue adopting a wide range of domestic support measures. The latter countries did it by shifting their main subsidies in blue and green boxes (corresponding to the 'potentially distorting' and 'non-distorting' measures exempted from cuts), thus exempting them from the new trade rules, while demanding further liberalisation of trade in developing countries.

Also, the US and the EU lobbied to obtain a 'Peace Clause' protecting them from challenges on their subsidy cuts for a period of ten years. As a result, only developing countries were forced to cut their own tariffs on imports. The latter were their main agricultural management tool, being complex subsidy programs unaffordable.

The resulting governance framework was unbalanced, unequal, negatively effecting developing countries because of the rise in imported basic foodstuffs from the Northern hemisphere at low prices, and out-competing local farmers. Its nature enabled rich countries to continue with their business-as-usual approach while pushing developing countries toward the praised free trade model.

In addition, the Trade Related Intellectual Property rights (TRIPS) agreement was arranged, setting out rules on trade of intellectual property, such as patents. The Agreement compels countries to provide intellectual property protection for inventions, including both products and processes. In respect of each main areas of intellectual property enclosed by the Treaty, it sets out the minimum standards of protection to be provided by each Member. That means, for instance, that plant varieties, microorganisms, and biological processes should be given safeguard 'either by patents or by *sui generis* system, or any combination thereof'.[253] The second main set of provisions deals with domestic procedures and remedies for the enforcement of Intellectual Property Rights (IPR). Finally, the Agreement provides a dispute settlement system between WTO members concerning the respect of the TRIPS obligations.

[253] Trade Related Intellectual Property rights Agreement, Annex 1C to the Agreement establishing the WTO (entered into force on 1 January 1995) art 27.3.

Being the most comprehensive multilateral agreement on intellectual property, adhered by states in both developed and developing countries and linked to other international trade agreements, it has an enormous influence on plant variety protection. The TRIPS agreement does not mention the UPOV 1978 and 1991 Acts, which represent the first attempt by industrialised governments to provide intellectual property rights protection for plant breeders in their own and overseas markets. Comparing the TRIPS Agreement with the latter Acts, the TRIPS provides more stringent rules and encompasses a wider range of matters. A key aspect is that breeders' exemption for research and experimentation related to the patented invention (which was mandatory in the UPOV first Act and permissive in the second Act) is usually not recognised. Another relevant change relates to farmers' privilege to save and reuse seeds on their own land without the patent owner's permission. The privilege, which was initially implicitly allowed or permitted within reasonable limits, is now generally not recognised under TRIPS provisions.[254]

The new rules on IPR have been criticised for paving the way for transnational corporations' success in the agricultural biotechnology industry. The latter heavily lobbied during the drafting of the Agreement to ensure that patented varieties of seeds would be still legally protected. This guarantees them larger profits. Countries such as India and many African States were against the proposal of imposing intellectual rights on living organisms, arguing that such a practice does not consider the breeding and experimental work conducted by traditional farmers over thousands of years.

The tension between the 'food is different' approach and the full liberalisation of the agri-food sector endured, influencing the next round of trade talks. Non-trade concerns, especially food security and environmental issues, as well as special and different treatment for developing countries, were emerging. Following the 1996 World Food Summit, a greater emphasis was given on the right to food within the UN.

The need to continue reforming the agricultural trade sector was essential for the opening of the Doha AoA negotiations in 2001. Despite the efforts of developing countries to impose their perspective and shape the future regulatory framework, industrialised countries keep considering their current practices to be coherent with the norms of liberalisation; they are not likely to make more generous offer for reducing trade-distorting domestic support practices.

Agriculture has become the most controversial issue. The agricultural sector is particularly important for Southern countries, because large sections of the population live in rural areas and depend on agriculture for their livelihoods. It is essential for developed countries too, in light of the latest forecasts pointing to an increase in population and food consumption. Besides, competition for natural resources is growing: soil and water are more and more precious and end up being disputed.

The ongoing conflicts at the WTO reveal the difficulties arising from the coexistence of contradictory and competing trade norms and interests among the organization's membership. The negotiations are hampered by contrasts between the emerging powers, coming together to form the G33, and the traditional agricultural powers guided by the US and the EU. The first are advocating the creation of an exemption for special products that would allow them to exempt certain commodities from tariff reductions, and a Special

[254] L. R. Helfer 'Intellectual Property Rights in plant varieties. International legal regimes and policy options for national governments' (FAO Legislative Study 85, 2004).

Safeguard Mechanism (SSM), which would permit them tariff increases in response to import surges. The US and the EU, indeed, assumed a hypocritical attitude, averting the attention from their past trade distorting practices and the concessions they obtained in the Uruguay round.

5.3 The process of financialisation

The connection between finance and food markets has become deeper and complex in recent decades. The financial deregulation characterising the last decades' regulatory framework of leading countries in the agri-food sector facilitated the entry into markets for derivatives based on food commodities of large and powerful 'non-commercial' traders and investors. Hedge funds, pensions funds, and investment banks entered the financial agricultural markets, although the majority of these non-commercial traders was unconcerned with agricultural markets fundamental. Commercial traders, traditionally considered ultimately end-users because dealing with the physical commodity as a key part of their business, served as guidance for the novices and provided them financial services and consultancy, reaping immense profits.

In the space of a few years, investors were able to determine ups and downs in the global food market, having enormous impacts on food prices and availability. Commercial traders, in particular, enjoyed exemptions from subsequently implemented regulations designed to curb manipulation of the market by speculators. They gained so much power that they became key actors in the process of shaping the global food system.

5.3.1 Financial deregulation

Commodities trading, whose roots date back to the 16th century, initially occurred in trading platforms. The exchange of physical commodities was soon combined with trading of derivates in stock exchanges, which, since its *debut* in the 17th century, has always been subject to particular rules. Historically, banks were prohibited from the hedging activities permitted to commercial commodities companies. However, a deregulation progression occurring since the 1930s relaxed the conventional rules, allowing many financial actors to sell to investors derivatives that were based on food and agricultural commodities.

At that time, the US was the only major economic power capable of acting at world level to secure its profits: for this reason, the analysis of the US regulatory framework is key to understanding the development of the current situation; it still applies to most agricultural commodity markets in the world (primarily the Chicago Mercantile Exchange Group).

Commodities market was the only major US market where companies were allowed to act on inside information to manage risks others might not know about. Physical traders were often the first to know sensitive data concerning food commodity trends, thus having a role of primary importance in the financial market since its beginnings.[255] Today, every major food trader has financial services divisions. The latter divisions enable traders to manage third-party money through commodity hedge funds and to sell other financial products and services. Food traders (e.g. Cargill, Bunge, and ADM) became influential financial actors by

[255] Murphy S, Burch D and Clapp J 'Cereal secrets. The world's largest grain traders and global agriculture' (Oxfam Research Reports, 2012) 27.

turning their unique and extensive knowledge of agriculture into a marketable tool, gaining more and more power and reaping higher profits.

Financial derivatives can serve two main purposes: they hedge risks, mitigating them by locking prices of food commodities for future purchase or sale; and they enable speculation, an activity which is purely motivated by profit seeking. The impact of speculation on the prices of basic food commodities is exemplified by the food price crisis that occurred a decade ago.[256] Whether commercial traders and other investors are solely hedging their risks or whether they are also speculating to turn a profit from the volatility of food prices, is not easy to understand. Nonetheless, their profits increased significantly due to the sharp rise in commodity prices.

Because commercial traders do not report details of their individual business segments, it is almost impossible to determine in what measure their income is derived from sales of financial products, or speculation on their own account. However, there is wide agreement about their role in the financialisation of food commodity markets and the exacerbating of the recent food price crisis.

While food producers are gradually losing market power, because their role in the food value chain is neglected, food traders, retailers, and inputs providers are gaining the largest share of profits. One reason for this success is that these actors are involved in the financial sector, which by now impacts heavily on food price and food distribution all over the world. The food crisis occurring between 2007 and 2008 revealed the underlying forces shaping the global food system and the power asymmetry characterising the agri-food sector. During the crisis, average global prices for major food commodities rose exponentially: rice by 217 percent, wheat by 136 percent, maize by 125 percent, and soybeans by 107 percent.[257]

Non-governmental organizations and analysts pointed the finger at agri-food transnational corporations' activities and international trade and investment rules. The combination of these factors was held as major cause for the crisis. Issues of direct supply and demand for food were indeed secondary factors in determining food price trends. At that period, financial regulation was meant to prevent market manipulation and distortion by overfull powerful speculators that could cause havoc for farmers and consumers. However, under the pressures of private companies and banks, the regulation had been gradually eroded and relaxed between the 1980s and 1990s.

In the US, for example, banks were granted 'no action letters' from the Commodity Futures Trading Commission (CFTC) and began to sell directly a variety of financial products 'over-the-counter' (OTC, namely trading occurring directly between two parties, without the supervision of an exchange). In addition, the Commodity Futures Modernization Act was passed in 2000, exempting OTC derivatives trade from CFTC oversight. At that time, Europe did not provide any regulation concerning the OTC derivatives, imposing minimal requirements and regulations only to commodity derivatives traded on exchanges.

As a result, commodity future contracts doubled in value all over the world between 2005 and 2008, reaching an estimated $400 billions. Commodity index funds in corn, soy, wheat,

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[256] UN Special Rapporteur on the right to food 'Food Commodities Speculation and Food Price Crisis. Regulation to reduce the risks of price volatility' (Briefing Note, 2 September 2010).

[257] Murphy S, Burch D and Clapp J 'Cereal secrets. The world's largest grain traders and global agriculture' (Oxfam Research Reports, 2012) 5.

cattle, and hogs experienced an exponential growth. Very soon, food commodity prices became highly independent from physical reserves. This phenomenon is known as 'financialisation' of food, referring to the increasingly important role of investors in the food system.

Until recently, the food system involved primarily farmers and a range of commercial interlocutors, who were responsible for trading, processing, distributing and selling food. Recently, due to huge investments of banks and other non-commercial investors, as well as private dedicate funds established as subsidiaries of the big agri-food corporations themselves, commodities prices do not reflect the physical foodstuff prices and availability.

Traders of food commodities invest billions of dollars in financial markets with no intention to take physical possession of the food itself, thus distorting the global food market and consolidating their dominant position. The amount of money involved in commodity trades has augmented exponentially, contributing to food price volatility. The process has been exacerbated by financial speculation, which, especially in the early years, was by no means moderated.

5.3.2 New regulatory frameworks in the US and EU

The first agricultural commodities price shock was followed by another round of high food prices in 2010-2011. This encouraged governmental proposals for more stringent regulation of derivatives markets, including the OTC markets. Calls were made for improved international cooperation among national regulators. Both the US and the EU legislator initiated a process of reform of the financial regulatory structure. However, major investors acted to ensure their role in providing financial products and services in the future, lobbying to maintain their exempt status. Commercial traders, in particular, acted to ensure that the new rules would not change their status while hypocritically supporting more stringent rules on their non-commercial counterparts.

The US reform resulted in the Dodd-Frank Bill, passed to law by the US Congress in July 2010. Soon after, the EU reform process began. Both the CFTC and the European Securities and Markets Authority (EMSA) have been tasked with implementing legislation mandated by the G20 commitments on derivatives agreed in September 2009.[258]

The establishment of a new framework 'to generate a strong, sustainable and balanced global growth' was in itself a complex endeavour.

The Dodd-Frank Act implementation was delayed until late 2012. Subsequently, its mandate to the CFTC imposing stricter position limits[259] was rejected in court, due to financial lobbies arguing that the Commission failed to determine if those limits were 'necessary or appropriate'. On November 2013 the CFTC approved re-proposed position limits rules, posing limits on 28 physical commodity futures contracts and futures and swaps that are economically equivalent to those contracts, including grain and livestock futures. However, they have been set high enough that only a few funds will effectively be affected. In the years following, some of the Act's various provisions have been implemented, but President

[258] G20 'Leaders' Statement' (The Pittsburgh Summit, 24-25 September 2009)

[259] Position limits are supposed to protect futures markets from excessive speculation, which would cause price fluctuations.

Trump recently pledged to repeal the act. On 22 May 2018, the US House of Representatives voted to roll back some of its significant pieces.[260]

In December 2008, the European Commission announced the intention to undertake a regulatory reform of the financial market asset, to increase transparency and curb speculation, giving regulators the power to set position limits and requiring detailed report on derivatives trading activities. Despite various calls denouncing the impact of indiscriminate speculation in the agri-food stuff, and London being the world's largest agricultural commodities market outside the US, the EU regulation of commodities trading remained unsatisfying. The so-called 'Barnier Package', which entered into force in 2012, is the major instrument enabling Europe to deliver the G20 commitments on derivates markets, setting out new rules on clearing, transparency, and trading. Its more relevant element is the European Market Infrastructure Regulation (EMIR), which should outline a regulatory framework for OTC derivative contracts. As its US counterpart, the European regulation has severe limitations, firstly in term of exemptions. Position limits, for instance, do not cover certain types of trading, such as OTC, and exemptions made at a national level could target certain actors, such as commercial traders.[261] Following an extensive assessment of the EMIR, the European Commission proposed a first set of amendments in May 2017, introducing simpler and more proportionate rules on OTC derivatives; a second set of amendments was proposed in June 2017, to enhance the supervision of third country CCPs.[262] Finally, in October 2017, the Commission determined the US to be equivalent to the EMIR in terms of legal, supervisory, and enforcement arrangements for OTC derivatives transactions, thus alleviating the regulatory burden for both EU and US companies. In fact, the EU implementing act allows market actors to comply with just one set of rules, thus avoiding duplicative or conflicting rules.[263]

5.4 Reaping the benefits of the international food trade system

The current asset of global agri-food chains and networks composes a bleak picture. The financial reforms and the development of trade agreements and arrangements proved to be disappointing in providing a safer environment for consumers and smallholder farmers, and a sustainable international food trade framework.

Legislators and policy-makers bear a major responsibility for developing regulations and laws that enable the provision of good and healthy food for all, while protecting Earth's natural

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[260] *The New York Times* 'Congress approves first Dodd-Frank Rollback for smaller banks' (22 May 2018) <https://www.nytimes.com/2018/05/22/business/congress-passes-dodd-frank-rollback-for-smaller-banks.html>.

[261] European Parliament 'Regulating Agricultural Derivatives Markets' (Research Paper, DG for Internal Policies, November 2013).

[262] A central counterparty clearing house (CCP) is an organisation that facilitates trading done in European derivatives and equities markets. These clearing houses are often operated by the major banks in the country. They provide stability and efficiency through bearing most of the risks otherwise passing on buyers and sellers.

[263] Commission Implementing Decision (EU) 2017/1857 of 13 October 2017 on the recognition of the legal, supervisory and enforcement arrangements of the United States of America for derivatives transactions supervised by the Commodity Futures Trading Commission as equivalent to certain requirements of Article 11 of Regulation (EU) No 648/2012 of the European Parliament and Council on OTC derivatives, central counterparties and trade repositories. [2017] OJ L 265.

capital, which is key to provide the environmental services humanity needs to thrive. Indeed, their actions have promoted intense and fast-growing monopolisation. Unsatisfying attempts to structure competition, led to inefficiency and high prices in terms of environmental, economic, social, and human costs.

The basics for the reshaping of the entire Food Supply Chain should entail a combination of food security concerns, built around rights-based approaches, and a sound system of international food trade law. This approach does not completely reject food trade as a tool to provide food security; instead, it contextualises reforms in terms of social and environmental implications. Both monopoly and oligopoly power are inefficient in economic terms: a redistribution of wealth and power is needed to ensure appropriate trade-offs and to guarantee a competitive and sustainable global food market.

5.4.1 Who benefits from global free trade?

The efforts to create a high-level global trade framework have long been justified by the need to ensure the complementarity of international food trade and food security concerns. In the last decades, dozens of treaties and arrangements have been agreed, not only within the context of the GATT/WTO systems but also through Free Trade Agreements such as the North American Free Trade Agreement (NAFTA). However, any debate in food and agricultural trade is still fractured by ruptures of ideology, communities of interests, policy changes, and institutional fragmentations. According to Bill Pritchard, the divergence of opinions concerning the pros and cons of food trade across countries is related to a disconnection between the transnational rule-setting regime for food trade (mainly guided by the WTO) and the main tasks of monitoring and promoting food security (largely spearheaded by the FAO).[264]

As a result, the WTO-based agenda has advanced without paying enough attention to food security issues, while FAO efforts to advance food security and environmental security, which goes hand in hand, are constrained between all-encompassing legal requirements, standards, and obligations. This is exacerbated by a distorted idea of what food security is: abundance of food does not alone provide food security for a countries' people.

According to the 'entitlements approach' proposed by Amartya Sen, the ability of a person to avoid starvation or malnutrition depends on the combination of labour power, resources, and assets that he or she can use to acquire food; and on the rights to resources that can be accessed to transfer an ownership 'bundle' into food.[265] This approach largely informed the 1990s international forums, but the WTO message is still too narrow: according to its officials, if trade is liberalised, the global severity of food security problems will be lessened. However, without appropriate institutions, polices, and infrastructures the liberalisation of food trade policies would likely cause further damage, permitting large-scale importers to outcompete small-scale producers in the Southern domestic markets.

Looking back, the group who most benefited from the reduction of barriers and obstacles to foreign markets is the one of commercial producers, which is expanding at an amazing

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[264] Bill Pritchard 'Trading into hunger? Trading out of hunger? International Food Trade and the debate on Food security' Rosin C, Stock P and Campbell H (eds.) *Food systems failure. The global food system and the future of agriculture* (Routledge, 2012).

[265] Amartya S 'Poverty and Famines: an Essay on Entitlement and Deprivation' (Clarendon Press, 1981).

speed. Indeed, small farmers were unable to directly participate in the growing export-oriented markets and have been constrained either to conclude (often uneven) contracts with major food companies or go out.

Smallholders have seen an increasing competition in accessing resources, experienced marginalisation and loss of independency, were subjected to policies of reallocation of land and other resources away from domestic food production. Paradoxically, developing countries are currently importing huge amounts of food despite their population is largely composed by farmers and breeders. This is due to the fact that their production is export-oriented and responsive to foreign market needs, rather than focused on ensuring domestic food security. The flows of cheap industrialised agricultural products and processed food from the Northern countries played a major role in building such a perverse pattern.

Too often invisible in policy debates involving farmers and consumers, the world's largest commodity traders and retailers shape the world they inhabit, dictating global trends in agriculture and food distribution. Since the 1970s, when governments began to promote private sector management of the food system, agri-food TNCs have grown in size and scope, engaging in many activities. As a result, relatively few global corporations dominate large subsectors of the Food Supply Chain (FSC).

5.4.2 Identifying the Big Food companies

Traditionally, the dominant players of the FSC have been the agricultural commodity trading and food-processing companies. Prior to early 1800s, there was not much trade in temperate zone food and agricultural products, not until Britain and other industrialising countries required more food. Then, transnational agricultural trading firms emerged. As imports grew, protectionist measures were rolled back, enabling the trading firms to develop exponentially. By the end of the Second World War, these same firms were mature to serve US interest in shipping food over Europe and the Southern world.[266]

More recently, the companies dominating the global production of pesticides and seeds and food retailer companies are rapidly gaining influence and power in the agri-food sector. Their emergence is ascribable to mergers and acquisitions resulting in a worrying degree of concentration: the merging of the US corporations DuPont and Dow Chemical; ChemChina acquiring Syngenta; the chemical giant Bayer taking over the US company Monsanto. Meanwhile, major conglomerations have been occurring in the retail sector too, with Wal-Mart alone accounting for 6,1 percent of the global food retail sales.

Between transnational food traders, inputs providers, and food retailers, the first bear major responsibility for the shaping of the current global food system. Food traders are pioneers of the intensive farming paradigm that is now dominating the food production system; they adopted industrial agriculture as the unquestionable model in the past and exported it worldwide. Today, ADM, Bunge, Cargill, and Louis Dreyfus - collectively known as the ABCDs - together with the newcomer Cofco, are the top 5 global commodity traders.[267]

Three main characteristics distinguish the ABCDs from their rival companies.

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[266] Clapp J 'Food' (Polity Resources, 2012) 97.

[267] Heinrich Böll Foundation, Rosa Luxemburg Foundation and Friends of the Earth Europe 'Agrifood Atlas' (Research Report, 2017).

First of all, their centenarian experience: Bunge was founded in 1802 in the Netherlands, Louis Dreyfus in 1851 in Alsace, Cargill and ADM respectively in 1865 and 1902 in the USA.

Secondly, their enormous size: together, they share a significant presence in a range of basic commodities – for instance, a figure between 70 and 90 percent of the global grain trade. In 2015, their annual turnover was respectively around €60.2 billion (ADM), €40.3 billion (Bunge), €111.8 billion (Cargill), and €51.7 billion (Louis Dreyfus).

Finally, their highly diversified and combined businesses, both vertically and horizontally. For instance, Cargill (the biggest of the ABCDs) not only finances soy production in Brazil, but also provides seeds, fertilisers, and agrochemicals to the growers; afterwards, the company buys the soy and stores it in its own facilities, waiting for the best moment to transport them, on its own rail, cars and ships, to where they will be sold.

These figures exemplify the economic power that these companies exercise at various stages of the FSC, and the agri-food system at a large. A great share of their profits derives from input agricultural commodities for feed or biofuel, combined with bulk food commodities and processed foods and beverages. Food commodities are not sold to the open market, they become an internal cost. A large share of the grains bought from the elevators, for example, is processed by the same company and then consumed by its subsidiaries in the form of feed for livestock or biofuels.

It is not hard to see how this far-reaching business can occupy a leading role in the food value chain. It is no coincidence that the 'food-feed-fuel nexus' has been recently identified by the scientific literature as key to understanding how the Big Food companies move large amounts of commodities pending between various sectors.[268] Evidently, traders make profits through a whole series of activities other than grain selling. These activities encircle and relate to the bulk trade: financial speculation, transportation, storage, processing, animal feed, biofuels.

The consolidation of corporate power in the energy and agro-business sectors, combined with the commodification of food and the financialisation of food markets, enabled TNCs to expand their market power. A new form of imperialism emerged, the so-called 'agro-imperialism'. In the name of debt repayment and local patronage networks, Southern governments submitted to massive agro-industrialisation and land grabbing. As foreign corporations sacrifice land and other natural resources to cultivate crops for biofuels and animal feed, the population is deprived of its rights and increasingly suffering from hunger.[269]

The horizontal power of transnational traders is usually depicted as an hourglass: while food production involves thousands of farmers and breeders, their products are collected in hundreds of elevators and bought only by a handful of processers and traders, before being sold to millions of consumers. The ABCDs market power is so prominent in the bulk commodities market, that farmers are likely to grow what companies need them to grow to maximise profits. This is the outcome of their 'origination' strategy (that means, sourcing of the crops and livestock directly from the farms), which enables them to secure the sale of the foodstuffs at harvest time already. Being involved in high-volume bulk trade, major

[268] Murphy S, Burch D and Clapp J 'Cereal secrets. The world's largest grain traders and global agriculture' (Oxfam Research Reports, 2012)

[269] McMichael P 'Biofuels and financialization of the global food system' Rosin C, Stock P and Campbell H (eds.) *Food systems failure. The global food system and the future of agriculture* (Routledge, 2012).

traders can profit regardless of whether prices are rising or falling, as long as they maintain a high volume of trade. For the same reason, they exert enormous leverage in terms of setting the purchase price, especially with those farmers with whom they contract directly.

More recently, ABCDs and their rivals started to directly acquire lands. Traditionally, TNCs avoided to get involved in plantations and the risks of production itself; but access to land is increasingly important to them, as global demand for food is inexorably growing and access to natural resources becomes contested. Various modes of landholding and sourcing of raw materials have been implemented: contract farming, contract or supply agreements with big farmers and breeders, land-leasing, sub-contracting. However, still little is known about the terms and conditions of these arrangements. Acquiring new land, they became an even greater obstacle to entry of newcomers, which has been already compromised through the setting of prohibitive regulations and private standards. In fact, the major companies exert considerable control over regulatory processes worldwide within the agri-food sector, and work with other major industrial operators to define procedures and requirements suiting their own needs. Only like-minded big Asian companies such as Cofco and Olam, relying on the growing Chinese food commodities market, seem to succeed in the break-through.

The enormous market power and knowledge all these companies apply to negotiate prices and achieve high returns from financial transactions are at the core of global environmental and social problems. Agri-food TNCs' policies bear direct or indirect responsibility for deforestation, land and marine pollution, land grabbing in the Southern hemisphere, overexploitation and deterioration of rural areas. Environmentalists are literally removed: 2016 saw a record of 200 killings of people defending their land, forests, and rivers against destructive industries.[270] Farmers lose their independency and bend to the Big Food corporations' will. Energy and water-intensive production of market crops continue, relentless, to the detriment of the environment.

With the exception of lobbying activity and attempts to shape public opinion towards positions that are sympathetic of their business interests, the ABCDs managed to stay widely private to the general consumer. Usually, consumers do not interact with them directly, but with their subsidiaries. Operating in a Business-to-Business profit plan, enable the ABCDs to remain undisturbed behind the scenes, paying little or no taxes at all because of subtle company organization patterns realised in Switzerland, the Netherlands and Singapore.[271]

The Big Food companies remained practically invisible to the eyes of the law too, despite their impressive and complex structure and the detrimental production and trade model they promote. Governmental subsidies and favourable trade and financial policies bear major responsibility for their prospering. Following state-led industrial agriculture and international trade expansion through uneven agricultural trade liberalisation, these companies thrived, their expansion going hand in hand with the financialisation of food and agriculture.

5.4.3 Where to from there?

The privatisation of public sector activities, the liberalisation of trade, and the deregulation of finance have served the food trading companies well, ensuring them a long-lasting

[270] Global witness 'Defenders of the Earth. Global killings and environmental defenders in 2016' (2016).

[271] *Internazionale*, Mulder F and Van de Klundert M (De Groene Amsterdammer) 'Potenze alimentari' (24 March 2017) 52.

dominion on the food market. Their experience, power, and flexibility permit them both to adapt to changes occurring in the markets and to directly shape the process of change.

However, the world is about to change: global trade talks can no more ignore the emerging economies' participation, as new competitors and political tensions are rising. Since the food price crisis of 2007-2008 and the subsequent high and volatile prices on the international food markets, questions and concerns concerning food and agriculture dominate international policy debates. People call for a stand against irrational ecosystems destruction, unfair trading practices, and uneven international trade treaties and agreements. Climate and environmental matters, food security concerns, and critics for the marginalisation of farmers inform the public debate.

According to Clapp J, Canada Research Chair in Global Food Security and Sustainability, the inclusion of agriculture into the WTO can be interpreted as the institutionalisation of an uneven agricultural trade system in which developing countries have a distinct disadvantage. It has promoted vulnerability to the market, creating dependencies based on unbalanced rules. Moreover, it has endorsed an ecological crisis through the encouragement of massive export-oriented industrial farming.[272] To escape the *status quo*, food and environmental security can no more be conceived as mere residual outcomes of a profit-driven market process.

The European Commission has been looking into unfair trading practices (UTPs) in the FSC for several years, editing communications on the subject in the past decade. In January 2016, the Commission announced positive developments, both in the form of national regulations and a voluntary 'Food Supply Chain Initiative' initiated by the private sector. However, a wider EU legislation was not considered necessary at that time. Not until the Agricultural Markets Taskforce presented facts and figures about the state of play of the European FSC, denouncing the inequalities and unfairness characterising widely diffused business-to-business practices.[273] Unfair trading practices have been recognised as being responsible for deviations from good commercial conduct, and are contrary to good faith and fair dealing.

On April 2018 the European Commission proposed a new legislation addressing unfair trading practices in the Food Supply Chain, aiming at alleviating the stark imbalances between small and large operators.[274] Also, the Commission recommended the designation, in each Member State, of a competent authority responsible for enforcement and monitoring of the implementation of the newly proposed rules.

Often farmers and small operators lack bargaining power to counteract improper behaviour that disadvantages the weaker party in a commercial transaction: late payments for perishable products, last minute order cancellations, unilateral or retroactive changes to contracts, the absence of written contracts. As a result, the share of value added distributed to the agricultural sector remains very low, if compared to the whole food chain. This is happening despite the fact that most agri-food businesses are involved in the production phase, facing the largest share of risks and responsibilities that are ascribable to food production.

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[272] Jennifer Clapp 'Food' (Polity Resources, 2012) 89.

[273] Agricultural Market Task Force 'Improving market outcomes: enhancing the position of farmers in the supply chain' (Report, November 2016)

[274] Proposal for a Directive of the European Parliament and of the Council on unfair trading practices in business-to-business relationships in the food supply chain COM/2018/0173.

Finally, a reinforced version of the proposal has been arranged in December 2018. The European Parliament, the Council, and the Commission reached a political agreement on a new set of rules that will ensure protection of the totality of European farmers and of a very large majority of EU agri-food companies against practices contrary to good faith and fair dealing. This initiative should be complemented by campaigns and policies aiming to raise consumers' awareness about their potential to trigger major changes in the way food is produced and traded. If a mounting number of consumers demand greater transparency in the Food Supply Chain, including information about the origin and contents of foodstuffs and their ecological footprint, governments and companies are likely to respond positively.

6 WHAT ROLE FOR CONSUMERS IN THE FOOD SUPPLY CHAIN?

'What should we have for dinner?' is the provocative opening sentence of Michael Pollan's book *The Omnivore's dilemma*.[275] What could have once been a simple question has gotten really complicated today, as the food culture is being replaced by confusion and even anxiety sometimes.

Most people in developed countries do no longer eat what their grandparents did, they seldom grow the vegetables and fruits they consume, and hardly ever breed the animals they eat. Eventually, they do not always know where the food they purchase comes from, to the extent that investigative journalists are sometimes the ones who discover it. Nutritionists are consulted to determine the exact amount of food people should have daily, combining proteins, vitamins and other elements to provide the body with a complete array of nutrients. Food corporations are doing their best to convince the masses about the necessity of consuming certain foods and drinks, sometimes basing their advertisements on governmental-issued dietary goals and sometimes simply working on humans' delight for food. Swings in diet are also related to changes in lifestyle (people are more sedentary, have less time to cook and eat out more) as well as to clever marketing and governmental policies.

The picture of today's relationship between people and food depicts consumers as passive actors in the Food Supply Chain. They seem to merely adapt to the latest discoveries of food scientists and respond to the inputs given them by the big food companies, which ensure that foodstuffs reach supermarkets and discounts at the cheapest price.

Actually, consumers possess enormous powers and could reverse this trend: only, they either are not aware of the disastrous consequences that their behaviour is having on the planet and their own body, or unable to react after having become conscious of it; otherwise, they simply are unwilling to react because of laziness or indifference.

Raising awareness about the environmental costs of food production and food waste, as well as about the negative impacts of the standardised 'western diet' on human health, is insufficient to make people change dietary habits towards more responsible and reasoned consumption patterns. Good eating requires time, which most people do no more devote to food, and good ingredients, which are unaffordable or unavailable for many people. Given this background, reasoned governmental policies become paramount to guide the consumers' choices, but are often perceived as 'paternalistic'. Whether paternalistic food and beverage policies are effective at dealing with the problem they deal with is debated, and there is no understanding on whether alternative ways, which do not involve coercion, are likely to fail.

6.1 Dietary patterns: the connection between food consumption, health, and the environment

As seen in the previous chapters, many of the UN Sustainable Development Goals are relevant to the food system: for example, ending hunger and improving nutrition, and halting land degradation and biodiversity loss. Farming is required to drastically reduce its ecological footprint, while producing food enough to feed in an adequate way the growing population. These issues proved to be confronted not only by developing countries but developed

[275] Pollan M 'The Omnivore's dilemma. A natural history of four meals' (The Penguin Press, 2016).

countries as well, concerning both health and environmental matters. In Europe, for example, where environmental improvements through innovative agricultural systems are on the political agenda, nearly 10 percent of the population is unable to afford a regular quality meal on every second day. Non-communicable diseases, which are the leading cause of disability and death in the European countries, are directly related to the way people eat and drink.[276]

To improve human health and environmental conditions alike, food systems need to undergo a profound transformation and improve their sustainability with respect to planet resources' scarcity. In order to do so, shifting to a resilient and responsible governance of agri-food environments, and sharing ethical values like transparency and accountability, is essential. Diversification is another key component, meaning openness to a wide array of technologies and practices, cultures and experience; inclusiveness too, with respect to the actors of the whole Food Supply Chain and civil society as well, needs to be encouraged. Such a major innovation will be possible only by adopting a 'food system approach', which links food production and consumption, farmers, processers, retailers and consumers.

6.1.1 Food and drink environments

In the last decades, food systems have undergone important changes to provide affordable and safe food to the majority of the people, while increasing the earnings of those who work in the food sector. However, this happened at the expenses of the environment and biodiversity, smallholder farmers and rural communities. Moreover, plenty and affordable food does not necessarily mean nutritious and healthy food, as the global rise of obesity rates and non-communicable diseases testify. Indeed, public health is strongly affected by current dietary patterns, which are more and more standardised throughout the world, levelled on the 'western diet' model. The environment as well is suffering because of the largest share of the global population depending on a few commodities, which are pretended to be available all year round, instead of diversified and locally adapted crops and breeds.

Changing dietary patterns could significantly improve people's livelihood and decrease the costs of public health, while reducing the environmental impact of food systems. In other terms, what is good for the people is good for the environment too: eating more diverse, healthier and unprocessed foods, substituting animal proteins with plant-based ones, and consuming local and seasonal foods, would significantly reduce food production and transportation costs. Reducing food losses and waste would contribute to the same objective. Decreasing pesticides, antibiotics, and fossil fuel usage in agriculture would also be paramount to promote air and soil quality to the benefits of farmers, consumers, and the environment.

However, eating patterns are the result of complex settings, so-called 'food and drink environments', described by the scientific literature as

[276] EC FOOD 2030 Independent Expert Group 'Recipe for change: an Agenda for a climate-smart and sustainable food system for a healthy Europe' (Report, Executive Summary, April 2018).

> 'the physical and socio-economic surroundings that influence what we eat and drink, which shape the availability, accessibility, affordability and acceptability of consumer food items.'[277]

Today's food environments are likely to promote unhealthy consumption practices, exploiting people's biological, psychological, social and economic vulnerabilities. Food preferences are developed in different sets, as such as families, worksites, schools and neighbourhoods. The type and amount of food available in these environments, as well as the way in which it is consumed, are profoundly influencing people's weight and health conditions. For example, the food that a family keeps at home and even how the family members share meals, influence what and how much people eat - resulting in better or worse health conditions.[278]

The so-called 'French paradox' explains this phenomenon: French have been eating more or less the same way for generations, relying on 'archaic' criteria like taste and tradition to guide them in their eating decisions, rather than nutritionist advice (and marketing). As a result, they are demonstrating a lower incidence of diet-related health troubles. Americans, instead, have developed a 'reductionist' and scientific view of food, dividing good and bad foods according to their single components – fats, carbohydrates, proteins, and other macronutrients. While French and Italians focus on the food experience, seldom eating alone and enjoying many foods that are supposed to contain 'unhealthy substances' (cheese and wine, for example), Americans are fixed on nutrients. Moreover, they pay little or no attention at how the food is produced, and consume a lot of processed foods that are supposed to be more nutritious and healthier because low in carbohydrates or fats, high in proteins, gluten free, etc.

The average diet in developed country is too high in processed meat and red meat. The necessity of reducing meat consumption has already been discussed in chapter III, with regard to the pressure of the meat industry on land and water resources, which is too big and expected to rise due to growing population and higher incomes. A growth in meat consumption is to elude if countries are to keep pace with their international commitments concerning mitigation and adaptation to climate change. The water footprint of any animal product is larger than that of crop products with equivalent nutritional value.[279]

Also, the ordinary diet is too low in fruits, vegetables, whole grains and nuts, fibre and Omega-3, causing troublesome effects on people's health and increasing health costs. Of more than 50,000 edible plants on Earth, only a few hundred contribute significantly to food supplies, and just 15 plants provide 90 percent of the global food energy intake; only three crops (maize, rice and wheat) compose two-thirds of the global food intake, which is harmful for people as it is for the environment.

Healthy eating also means eating less, while spending more: low-income families face further barriers to healthy living because vegetables, fruits and whole grains are generally more

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[277] Harvard School of Public Health 'Toxic food environments – How our surroundings influence what we eat' <https://www.hsph.harvard.edu/obesity-prevention-source/obesity-causes/food-environment-and-obesity/>.

[278] Ibid.

[279] Hoekstra A Y and Mekonnen M M 'The water footprint of humanity'109 *Proc. Natl. Acad. Sci. USA* (2012) 3232-3237.

expensive than processed foods, refined grains and sweets. In addition, it takes longer to prepare healthful meals than to buy convenience foods or fast food: people in low-income households, often single parents taking care of children and working full-time, may have less time for meal preparation. Cheaper food - vegetables, fruits and animal products included - is often lower-quality food with inferior nutrition content. For example, there is substantial difference between grass-fed meat and milk and the same products deriving from a corn-fed ruminant confined in a CAFO. Eventually, recent studies indicate that a higher frequency of organic food consumption is related to a significant reduction in the risk of cancer.[280] However, a debate is ongoing on this issue, given that people consuming high quantities of organic products usually conduce healthier lifestyles.

6.1.2 Societal influences: agricultural policies and the food industry

Food and drink environments are, in turn, predisposed by societal influences, as such as food marketing and government food policy and pricing.

Agricultural policies and diets can be linked in different ways. First of all, through the quantity of food supplied. Greater food availability at cheap prices, achieved through highly subsidised agricultural policies, helps explaining the surge in overweight and obesity in high-income countries from the 1970s onwards. Various studies also claim that agricultural policies and support schemes adopted in recent decades in the Western countries (EU and USA in particular) have systematically favoured certain types of agricultural commodities - sugar, cereals, and animal products, most adaptable to further processing - over others, such as fruits and vegetables, legumes and nuts. As a result, vegetable protein intake has been replaced by animal proteins, which were produced in excess; also, the price of fruits and vegetables remained high while that of subsidised products dropped.[281]

As discussed in the previous chapter, agricultural policies are also responsible for promoting a more complex net of interactions, rather than a direct link between producers and consumers. In other terms, the agricultural policies of the last decades endorsed the rise of the multinational companies that now control the majority of food processing and retailing - insisting on maximising their profits instead of consumers' health. Facilitating supply chain models resulted in farm consolidation and specialisation, and globalisation of the Food Supply Chain.

The example of the shift from sugar to high-fructose corn syrup permits to better understand how sensitive changes in agricultural policies can result in big transformations. Prior to the 1980s, the US soft drink industry was the main industrial purchaser of sugar, while its use is very small today for the benefit of high-fructose corn syrup (HFCS), in other words, corn sweetener. There are two main causes for this conversion: public investment in agriculture favoured higher yields and lower prices for corn, while farm price policies have raised the

[280] Baudry J et al 'Association of frequency of organic food consumption with cancer risk. Findings From the NutriNet-Santé Prospective Cohort Study' *JAMA Intern Med.* Published online 22 October 2018.

[281] Elinder S 'Public health aspects of the EU Common Agricultural Policy. Developments and recommendations for change in four sectors: Fruit and vegetables, dairy, wine and tobacco' (National Institute of Public Health Sweden, 2003).

price of sugar relative to that of maize.[282] This strategy allowed the US to induce citizens to consume more corn than they otherwise might, helping in cutting down the national production surplus. Not only soft drinks, but snacks, breads, cereals, crackers, sauces, hot dogs and hams, often contain corn sweetener.

If agricultural policies would have fostered investments in production for local markets, promoting infrastructures for a more direct relationship between producers and consumers, the current situation would be certainly different. Shorter supply chains mean more local economic opportunities and occasions for small-scale farmers to capture the value that is now due to intermediary food industries. More manageable supply chains would also have decreased the need for extensive processing, thus acting as a tool to improve dietary quality.[283]

Another important player in determining food consumption patterns is the food industry, which spends billions of dollars per year marketing food and beverages, targeting adults, children and adolescents alike. Food marketers are specialising in digital marketing techniques, to reach youth across a wide array of platforms – cell phones, video games, social media –, thus arising ethical concerns in the public opinion.

Today, culinary trends can create billion-dollar businesses: novel foods and super foods, which are supposed to have health benefits due to their content in nutritive substances, are granted a growing popularity. A recent research highlights that between 2011 and 2015 there was a globally phenomenal 202 percent increase in the number of new food and drink commodities launched under the name of 'superfood', 'superfruit', or 'supergrain'.[284]

The desire for healthier, nutrient-dense and 'natural' products, and the search for new flavours and textures, is exploited by food companies. Health, environmental and animal welfare concerns are among the main reasons for alternative products purchases.

This is the case for 'plant milk': almond milk, for example, has today overtaken soymilk as the preferred dairy alternative. Almonds are surely a healthy food, but almond milk usually contains a very small percentage of almonds, together with high amounts of sugar, stabilisers and emulsifiers – ingredients that make it much less appealing. In addition, the production of almond milk has a potentially hefty environmental impact: more than 80 percent of the global almond crop is grown in drought-hit California, needing millions of litres of water to grow and reach consumers all over the world. Due to the big profits they make, companies continue to plant almond trees concentrating the production on one area of the globe.[285] Once again, profit-seeking companies found the way to exploit natural resources fuelling their 'green reputation'.

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[282] EC FOOD 2030 Independent Expert Group 'Recipe for change: an Agenda for a climate-smart and sustainable food system for a healthy Europe' (Report, Executive Summary, April 2018).

[283] European Public Health Alliance 'Agriculture and Public Health. Impacts and pathways for better coherence' (Discussion paper, 1 May 2016).

[284] *Mintel*, Mintel Press Team 'Super growth for 'super' foods: new product development shoots up 202% globally over the past five years' (5 May 2016) <http://www.mintel.com/press-centre/food-and-drink/super-growth-for-super-foods-new-product-development-shoots-up-202-globally-over-the-past-five-years>.

[285] *Mother Jones*, Philpott T 'Your almond habit is sucking California dry' (14 July 2014) <https://www.motherjones.com/food/2014/07/your-almond-habit-sucking-califoirnia-dry/>.

According to an interesting study by Quartz, over the past century Americans have dramatically changed their eating habits following three main events – World War II, technology development, and globalisation.[286] These three fundamentals are clearly responsible for shaping the American food economy, as the USDA data on the production of food suggest, while civil society had little or no say in the matter.

During the Second World War, the necessity to feed soldiers fighting far away from home and for long periods meant that shelf-stable protein like dried milk and peanuts became paramount. Peanut butter and oil gained popularity, while the by-product of extracting the oil was turned into flour and soup. The peanut industry continued to be heavily subsidised after the war as well. In the meantime, the milk industry was required to produce record quantities of milk, dried milk, butter and ice cream.

After the war, local shops developed into grocery stores and grocery chains, which made pressures to obtain meat from a single source. Technological development permitted the shipping of processed meat, so that packinghouses could move out of urban areas and build facilities near the farms were animals were raised. Those new facilities were able to process tens of thousands of animals: the fact that they were raised on industrial feedlots and in poor conditions was of no interest for the USDA, which regulations lacked any animal welfare concern. In the industrialisation era animal products as such as meat, rendered more accessible due to on-farm slaughter, cheese, mainly mozzarella to eat on pizzas, and butter, were massively consumed.

Today, big food companies dictate people's dietary habits. The chickpeas market, for example, has seen a gigantic rise driven by hummus consumption, as a result of heavy marketing by Sabra - a company which alone holds 60 percent of the market. Fruits markets are now developing around new seedless and easy-to-peel fruits, as 'Cuties' citrus and 'Mighties' kiwi, the latter sponsored as a 'low-calorie, nutrient-rich superfood', the 'healthiest spoonful on the planet'.

Private and public policies play an important role in shaping people's eating habits, and their impact is often underestimated. Even though the majority of people in the Western world is convinced to buy and consume foods autonomously, the most basic choices are heavily influenced by the major players in the Food Supply Chain. The disconnection between agricultural policy and health considerations is the major obstacle to the amelioration of public health and an ethical development of food systems.

6.1.3 Paternalistic food and beverages policies

Finally, but no less importantly, paternalistic food and beverages policies are also contributing to shape food consumption patterns.

Some food and beverage policies intended to promote public health have been labelled as paternalistic because they restrict the individual's autonomous decision making (or liberty) for his or her own good. Their implementation is usually debated: critics state that such policies are an unwarranted and inefficient limitation on human freedom, while supporters

[286] *Quartz*, Gershgorn D, Kopf D and Shendruk A 'We analyzed 100 years of USDA data and *discovered* three eras that define the US food economy' (22 November 2018) <https://qz.com/1470176/peanuts-ice-cream-and-chickpeas-us-food-trends-charted/>.

defend them on the grounds that they promote values that civil society accepts but has trouble realising, due to cognitive biases.

Paternalistic public health policies involve food and beverages consumption in so far as they attempt to influence citizen's behaviour to prevent disease or injury.

For example, portion size can be considered a cognitive bias that undermines individuals' decision making, because it encourages eating and drinking more of something than people really want. The New York City's 'Sugary Drinks Portion Cap Rule', also known as the 'Soda ban', was an attempt to bar restaurants, fast-food establishments, delis, movie theatres, stadiums and food carts from selling sugar-sweetened drinks in cups larger than 16 ounces (0.5 litre). The ban was intended to educate citizens on the negative health consequences of consuming large quantities of soft drinks, obesity in particular. Strongly supported by Mayor M Bloomberg and his successor Mayor B de Blasio, the regulation was opposed by some citizens and beverage companies claiming that the limit would affect people's freedom and lower income families (which tend to consume more large-size sodas) in a negative way.

The amendment to the article 81 of the New York City Health Code that introduced the Portion Cup Rule was due to take effect six months after passage, but the plans fell through due to its invalidation by the New York Supreme Court, in the person of Justice Milton Tingling, on March 2013. The Appellate Division too ruled against the proposed limit, saying the City violated the principle of separation of powers, the Board failing to 'act within the bounds of its lawfully delegated authority'. Finally, in June 2014, the New York Court of Appeals ruled that the New York City Board of Health, adopting the debated rule, 'exceeded the scope of its regulatory authority'.[287] The amendment was consequently repealed in July 2015.

Two remarks can be made concerning the municipality attempt to introduce the paternalistic regulation on soda: firstly, a remark on the effectiveness of this kind of ban; secondly, a thought on the necessity to find a proper justification for each form of paternalistic policy before proposing it.

Concerning the effectiveness of bans and taxes on certain foods and beverages in the name of public health, the available results of past attempts allowed economists to conclude that the demand for sugary drinks, snacks and fatty foods is extremely inelastic. That means, people tend to be unresponsive to price hikes, and do not significantly change their shopping habits; they are more likely to switch to cheaper brands or cheaper shops, leading to a consumption of even inferior goods, rather than a consumption of fewer calories. In addition, taxes on sugary drinks could lead consumers to simply switch to other high calorie drinks, such as fruit juice, milk or alcohol, thus undermining the aimed impacts on obesity rates. In other words, good intentions do not necessarily involve good policies.

Concerning social acceptance and justification of paternalistic policies, it seems that relatively little attention has been devoted to the question of what particular forms of paternalism may be considered appropriate, and which not. In fact, what is deemed as a sufficient reason for the adoption of a paternalistic measure, is strictly correlated to the culture of the affected

[287] N.Y. Statewide Coalition of Hispanic Chambers of Commerce v N.Y. City Department of Health and Mental Hygiene 110 A.D.3d 1 N.Y. Sup. (2013).

society.[288] Notably, while collectivist cultures are more likely willing to accept limitations on individuals' behaviours in change for a better quality of life, individualist cultures (as Western ones) are very hostile to such policies. Food, in particular, is an important part of everyone's daily life. Eating involves many cultural and societal rules and customs, thus making it really difficult to intervene on dietary patterns without colliding with individual's convictions and habits. Even if freedom to decide what to eat or drink is not essential for democratic debate as freedom of speech could be, it does nonetheless have a close correlation to human dignity and autonomy.

This explains, for instance, the disdain of anti-hunger advocates, democrats, and civil society in face of Trump's administration proposal (as part of the fiscal 2019 budget) to provide a good portion of food stamp benefits via a 'Harvest Box'. The new system would replace a large share of low-income families' food stamp benefits with packages of shelf-stable foods, selected and delivered by the government. The policy is aimed at saving $120 billion over the next years, to funnel towards other projects, and simultaneously provide people with 'healthy food'. However, the plan is viewed as a big restriction on poor people, depriving them of agency on what they eat. Some journalists stated the policy resembles 'the old Protestant work ethic treatise that a person is only as good and worthy as the fruits of their labour'.[289]

In light of these considerations, public health advocates should be fully aware of the justification a particular paternalistic policy has, and how and when the violation of one's autonomy can be held for reasonable in a precise social environment. If it is generally accepted that preventing individuals from harming each other is a good justification for paternalism, the same is not true when it comes to stop a person from voluntarily consuming too many calories, thus becoming overweight or obese. Public health policies aimed at instructing people and influencing their behaviour could be more easily accepted if they improve autonomy, rather than limiting it: for example, interventions that remove financial and physical barriers to healthy diets and exercise, and policies that ameliorate people's ability to use objective nutritional information when purchasing food.[290] In conclusion, addressing toxic food environments as a whole, through comprehensive efforts by governments and industries and local institutions alike, is more likely to be effective than merely tackling one category of products by imposing taxes or bans.

6.2 The food-health nexus: beyond the conventional frames of the debate on nutrition

Certainly, good food is a cornerstone of good health. This basic relationship is widely understood, and people are getting aware of the consequences of unhealthy consumption patterns. However, the profound changes that have occurred in the food supply chain in recent decades have resulted in profoundly negative impacts on the health and well-being of consumers, farmers, and workers. Nonetheless, the destructive impacts on the environment

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[288] Greenacre M 'Defending public health policies from objections of paternalism' 85 *UWOMJ* 2 (Fall 2016) 50-52, 50.

[289] *WBUR*, Howard M 'You can't eat that: Trump's Paternalistic Approach to Food Assistance' (14 February 2018) <http://www.wbur.org/cognoscenti/2018/02/14/food-stamps-miles-howard>.

[290] Greenacre M 'Defending public health policies from objections of paternalism' 85 *UWOMJ* 2 (Fall 2016) 50-52, 51.

and on food cultures and traditions are as alarming as they are underestimated. To make these damaging side effects visible to decision makers and strengthen the role of food systems in health policies, major changes are needed in the way policy-makers act and in the way food consumption and production are perceived by civil society.

Truly healthy food systems can be built only on a more integrated, holistic approach, which includes not only nutrition and health, but also happiness, well-being, and social and cultural indicators, interpreted together and in relation to each other. In the process of decision-making, particular attention has to be directed to empower the most affected by food systems, who are in precarious working conditions and exposed to great health risks.

6.2.1 Unhealthy diets

Existing governance and knowledge structures are the mirror of anachronistic priorities and path dependencies and revealed themselves inadequate to address the systemic risks emerging from food systems. The evidence on food systems impacts is growing, disclosing a disrupting reality, concerning above all its ever-growing economic costs. The extent to which current practices – chemical-intensive agriculture, concentrated livestock agriculture, ultra-processed foods, and deregulated global food supply chains – are impacting human livelihood, is still mostly unspecified.

The major diet-related risks are obesity and non-communicable diseases, as such as diabetes, hypertension, coronary heart disease, metabolic syndrome, respiratory conditions, cancer, osteoarthritis, reproductive diseases, etc. While some precise foods are identified as unhealthy, evidence demonstrates that diets in their entirety are increasingly associated with health problems, rather than single foods. In particular, diets providing an excessive consumption of sugar-sweetened beverages and overconsumption of animal products have been recently linked to the obesity epidemic, heart disease, diabetes, and various cancers.[291] Furthermore, high sodium intake is associated with high blood pressure and hypertension; high consumption of saturated fats with increased risk of coronary heart disease and diabetes; the negative impacts of trans-fatty acids are now subject of broad scientific consensus, and legal limits and bans have been introduced in some states.[292] Generally, the increasing consumption of ultra-processed foods has been identified as one of the main causes of excess energy intake, because of their complex composition and usually large portion sizes.

According to the WHO, non-communicable diseases already count as the leading cause of death globally, with 68 percent of all deaths in 2012 (38 million): almost half of them have occurred prematurely and could have been preventable with lifestyle changes, including

[291] Feskens E J M, Sluik D and Van Woudenbergh G J 'Meat consumption, diabetes, and its complications' (2013) 13 *Curr. Diab. Rep.* 298-306; Green R et al 'Global dietary quality, undernutrition and non-communicable disease: A longitudinal modelling study' (2016) 6 *BMJ Open*; Tilman D and Clark M 'Global diets link environmental sustainability and human health' (2014) 515 *Nature* 518-522.

[292] Stender S, Astrup A and Dyerberg J 'Artificial trans-fat in popular foods in 2012 and 2014: A market basket investigation in six European countries' (2016) 6 *BMJ Open.*

healthier diets.[293] Total healthcare costs attributable to overweight and obesity are predicted to double every decade to account for 16-18 percent of total expenditure by 2030.[294]

Even for wealthy people, excellent diets are nowadays elusive, for many reasons.

First of all, staple foods have altered extremely from those with which our forefathers evolved. There is a growing awareness that the deep changes in diet and lifestyle conditions that began with the introduction of agriculture and animal husbandry, some 10.000 years ago, occurred too recently on an evolutionary time-scale for the human genome to adapt.[295] Before agriculture and husbandry, hominine dietary choices varied by geographic and climate conditions, but still shared universal characteristics: the consumption was limited to minimally processed, wild plants and animals. Through domestication, nutrient components in plants and animals have been subject to changes, subtle at first, more rapid since the Industrial Revolution. Many novel foods were introduced, for which the human genome had no experience, and the process has been recently accelerated by food science, allowing for quantitative and qualitative food and nutrient blends that were completely unknown before.

Dairy products, cereals, refined sugars, refined vegetable oils, and alcohol, which make up almost three quarter of the daily energy intake of US citizens, would have contributed little or none in the typical pre-agricultural hominine diet. Together with processed foods like bakery foods, snacks, soft drinks, candies, condiments, they dominate today's diets.

Secondly, the steady degradation of natural resources and the evolution of industrial agricultural practices caused an erosion of the nutrient qualities of foods. Not only wild plant foods consumed by hunter-gatherers maintain higher micronutrient concentrations than their domesticated counterparts, but also, according to a certain scientific literature, fruits and vegetables grown during the last 50 to 100 years were likely to be richer in vitamins and minerals than the varieties most people consume today, mainly because of soil depletion and breeding.[296] In addition, because of today's lifestyle, previously low-fat protein foods now deliver unnecessary energy. The fat content in intensively farmed animals, whose exercise capacity is very limited, is much higher than that in extensively farmed animals from half a century ago. It is even higher than that of wild animals in their winter peak fat storage.

These main changes have had far-reaching effects on human health and well-being. Many indicators have been altered - glycaemic load, fatty acid composition, macronutrient composition, micronutrient density, acid-base balance, sodium-potassium ratio, and fibre content.[297]

Thirdly, a cultural disposition to feasting is taking place in today's altered food environment. Although survival in most modern societies requires fewer calories than in the environment

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[293] WHO 'Global Status Report on Noncommunicable diseases 2014' (2014).

[294] Wang Y C et al 'Health and economic burden of the projected obesity trends in the USA and the UK' 378 (2011) *The Lancet* 815-825.

[295] Cordain L et al 'Origins and evolution of the Western diet: health implications for the 21st century' (2005) 81 *American Journal of Clinical nutrition* 341-354.

[296] Davis D 'Declining Fruit and Vegetable Nutrient Composition: What is the Evidence?' (2009) 44 1 *HortScience* 15-19.

[297] Cordain L et al 'Origins and evolution of the Western diet: health implications for the 21st century' 81 *American Journal of Clinical nutrition* (2005) 341-354, 346.

in which hominids evolved, fast food promotions of abundant food at low cost boosted the 'supersize me' phenomenon.[298] The food retailing and service sectors are playing an important role in shaping consumer demand, reinforcing the practice of over-eating and making it culturally acceptable.

Finally, the nutritional unfamiliarity that was irrelevant to our ancestors is nowadays a source of vulnerability for people who can afford to purchase the up-to-date processed food diets, often accompanied by questionable health claims based on reductive science. Many of the nutrients these foods, food supplements, or pills are consumed for, have been separated from their evolutionary context, thus diminishing their nutritional value. Giant food processors, supermarkets and fast food chains overlook public health concerns. The latter are capitalizing on the fears of the middle-class, which is increasingly anxious about health protection. Many attempts to defeat diseases through diet involve particular tea blends, chocolate, and exotic fruits and vegetables, which are in turn promoted as the elixir for a long and healthy life. What consumers do not see is how their production often contributes to deterioration of agricultural landscape in developing countries. An exemplar case is that of fish, heavily promoted for the benefits of Omega-3 fatty acid. Fish demand is escalating, although fish stocks will be depleted in few decades. Multinational companies developed a new market, exploiting poor countries' fish reserves and fishermen, who are now reliant on them for their incomes.

6.2.2 Further interconnected pathways in which food systems impact health

The Global Alliance for the Future of Food recently commissioned a report from the International Panel of Experts on Sustainable Food Systems (IPES-Foods) as part of a project to make the impact of food systems on health more visible. Also, it aims at underpinning the essential role that food systems play in generating and supporting health and well-being in all communities.[299]

The report assesses the many negative effects of current food systems. The reasons why and how food systems are making people sick are brought to light, exposing the externalised health costs that policy makers and common people usually do not consider when evaluating costs and benefits of the current food systems.

Different leading channels are identified through which food systems impact health, and unhealthy dietary patterns are only one among them. The concern for healthy eating is gaining much of the public attention, because of the rise of non-communicable diseases, as such as obesity, diabetes, cancers and heart diseases, related to the consumption of specific foods or categories of foods with problematic health profiles. However, four more channels are acknowledged, which impacts are strongly associated with industrial agri-food systems.

First of all, occupational hazards: poor physical and mental conditions of farmers, agricultural workers and other workers involved in the Food Supply Chain are direct consequences of the exposure to risks in the fields, factories, and worksites in general. The risk of occupational injury and death is among the highest in agriculture, fishing, and forestry sectors. The main

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[298] Butler C D and Dixon J 'Plentiful food? Nutritious food?' in Rosin C, Stock P and Campbell H (eds.) *Food systems failure. The global food crisis and the future of Agriculture* (Routledge, 2012) 98-113.

[299] IPES-Food and Global Alliance for the Future of Food 'Unravelling the food-health nexus. Addressing practices, political economy, and power relations to build healthier food systems' (Report, October 2017).

hazards are acute pesticide poisoning, low-dose chemical exposure, airborne substances exposure, zoonotic diseases and antimicrobial resistance (AMR), injury risks and stressful working conditions. Farming has been listed among the ten most stressful professions in the world, the struggles being exacerbated by the liberalisation of agricultural markets, the abolition of price supports in some countries, the exposure to instable international commodity markets, and increased debt loads. The rise of contract farming, in particular, has been associated with an amplified pressure on farmers, who are losing control over input and production, growing their dependency on parent companies. Industrial food processing and factory settings too present highly stressful working conditions, due to the speed of the production line, chronic ambient noise, few work breaks, etc.

While many of the occupational impacts individuated are related to food and farmworkers all around the world, some are prevalent in developing countries and are generally preventable (e.g. through contingent regulations and application of safety norms). However, in both developed and developing countries, many of them are linked to the systemic conditions of industrial production processes.

Estimation of the economic costs are difficult to obtain. In the US, where direct and indirect costs from occupational morbidity and mortality amount to $250 billion, the highest mortality rate have been found to be in agri-food industries.[300] Some reasons why occupational health impacts in food systems aren't fully measurable can be identified. First of all, under-reporting both from small-scale farmers and insecure workforces. Secondly, poor information available due to refusal to grant access to the farms or to provide data and information requested (this happens in particular with CAFOs, which typify livestock production in North America and are increasing in other parts of the world). Finally, poor understanding of the importance of mental well-being and welfare of rural, farming communities, and agricultural workers.

A second major player impacting human health is environmental contamination, which affects food workers in the first place, but civil society too. The exposure of whole populations to contaminated environments resulting from food production is clearly making people sick. Pollution of soil, water, and air and exposure to livestock-based pathogens are directly linked, as already discussed, to current industrial agricultural practices.

Notably, nitrate and phosphorus pollution occurring through chemical fertilizer use and feedlot runoff has been recognised as a key health risk spreading from agricultural to urban areas in the US, Canada, Australia, and Europe. Moreover, the transmission of zoonotic diseases via livestock is more likely to happen in industrial feedlots, mainly because of the high number and density of genetically uniform animals living in close contact with their waste; animal feed composition can also represent an easy channel for disease transmission. The spread of antimicrobial resistance (AMR), linked to an excessive use of antibiotics in intensive livestock farms and aquaculture systems, is alarming. The ability of microorganisms to resist antimicrobial treatments, especially antibiotics, is recognised as a major challenge on a global scale. AMR has a straight impact on human and animal health and carries a substantial economic burden due to higher costs of treatments and reduced efficiency caused

[300] Newman K L et al 'Estimating occupational illness, injury, and mortality in food production in the United States: A farm-to-table analysis' 57 *J. Occup. Environ. Med.* 718-725 (2015).

by sickness. AMR is accountable for an estimated 33,000 deaths per year in the EU, costing approximately EUR 1.5 billion per year in healthcare costs and productivity losses.[301]

Also, exposure to endocrine-disrupting chemicals (EDCs), heavy metal contamination, nitrogen-based air pollution, transport-based air pollution and CO_2 emissions, due to food trucking and shipping around the world, are all contributing to environmental contamination risks on human health worldwide. The annual costs deriving from EDCs exposure alone is $217 billion in Europe and $340 billion in the USA: while some estimates exist regarding EDCs and other types of pollutants, the global burden of sickness due to environmental contamination is still largely undetermined.

A further channel regards food safety: contaminated, unsafe and altered foods cause food-borne diseases, most of them linked to zoonotic bacterial, viral, and parasitic agents.[302] In addition to production-based and environmental paths, food contamination also occurs through unsanitary handling and preparation of food. The trend of out-of-home consumption, the use of semi-prepared and processed foods, and chemical contamination are amplifying the risks. The processing of food and resulting changes in molecular composition are also linked to food allergies and intolerances.[303] The WHO Foodborne Disease Burden Epidemiology Reference Group (FERG) quantified in 600 million illnesses and 420,000 deaths globally the costs of the 31 most common foodborne hazards in 2010.[304]

The last channel concerns food security: the number of people having inadequate or precarious access to nutritious and culturally acceptable food is growing. According to the IPES-Food report, not only progress in historical problems like hunger, malnutrition and foodborne illness is slowing down, but also a range of additional disease, contamination, and diet-related risks are rapidly emerging. While the effects of undernourishment and malnutrition on human health are undiscussed, a debate has risen concerning the concrete dimension of food insecurity, its incidence and causes. Among the latter, international organisations and researchers usually cite poverty, food price shocks, natural disasters and climate change, agricultural problems, population growth and poor governance and policies.

6.2.3 Nutrition-sensitive agriculture

The industrial food and farming models are widely responsible for the current situation: failing to provide viable solutions, they indeed exacerbated the existing complications. Paradoxically, while obesity is expected to cost public health $760 billion by 2025, $3.5 trillion are already spent worldwide for tackling malnutrition.[305]

Policy makers, for their part, promoted unfair power relations that obscured the social, environmental, and economic failure of the present-day food policy. As a result, the complete understanding of its health impacts is jeopardized: the insecure status of hired and migrant

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[301] European Commission 'AMR: a major European and Global challenge' (Factsheet, 2017).

[302] Larsen M H et al 'Persistence of foodborne pathogens and their control in primary and secondary food production chains' (2014) 44 *Food control* 92-109.

[303] Verhoeckx K C M et al 'Food processing and allergenicity' (2015) 80 *Food Chem. Toxicol.* 223-240.

[304] WHO 'Estimates of the Global Burden of Foodborne Diseases' (Report, 2015).

[305] IPES-Food and Global Alliance for the Future of Food 'Unravelling the food-health nexus. Addressing practices, political economy, and power relations to build healthier food systems' (Report, October 2017).

labourers, for example, undermines the reporting of abuses, injuries, and injustices. Not only farmers and farmworkers in developing countries are facing this reality. Similar situations are experienced, for example, by thousands of poor people (mostly migrants) in Italy and in Australia, working in the fields in poor sanitary and health conditions, without proper contracts nor representation.

The overall picture is further blurred by the disconnection of the general public from the process of food production: its detachment and disregard both contribute to reinforce the current *impasse*. Relinking people to the realities of the food they eat, bringing the true cost of food production to light, will be essential in the process of unlocking the health-food bond.

The driving cause of these problematics is the industrial food and farming model: therefore, an urgent case to reform it can be promoted on the grounds of protecting human health. As seen in the previous chapters, further compounding factors such as poverty, inequality, climate change and unsanitary conditions, are themselves largely ascribable to current dominant agri-food systems.

How to bridge the divide between food and agriculture and address the food-health-climate nexus as a whole? The connection between food choices and farming systems (and therefore with specific health, social, and environmental impacts) is not obvious for the majority of the citizenship. This is mainly due to the loss of accountability and the opaqueness of long global food chains. For example, while Europeans may appreciate animal products coming from their own regions for animal welfare concerns, they do not see that 70 percent of the feed used in EU livestock comes from Southern America - causing deforestation, evictions, pesticide poisonings, and human rights violations.[306]

A holistic approach to the nutrition problem goes beyond the concern of 'feeding the world' by providing sufficient net calories at a global level, focusing indeed on the whole nutritional implications of food production models and their environmental interactions too, including the impacts of food processing and transportation. This approach is being deepened by the scientific literature, which crafted the idea of nutrition-sensitive agriculture. The latter is described as

> '[a] concept that aims to narrow the gap between available and accessible food and the food needed for a healthy and balanced diet for all people. It explicitly incorporates nutrition objectives into agriculture and addresses the utilization dimension of food and nutrition security, including health, education, economic, environmental and social aspects.'[307]

Nutrition-sensitive agriculture expands the latitude of the agri-food systems to a dimension encompassing all elements of the food chain, including consumption, with a special consideration of nutrition. In doing so, it links sectors and intervention levels. Firstly, it questions the current global agri-food systems, responsible for fragile agriculture and food economies, and delicate social systems. Then, it proposes multidisciplinary solutions: a more diverse range of food sources, diversification of marketing channels, and more bio-diverse agricultural systems and integrated farming systems. Altogether, they contribute to sound

[306] EIP-AGRI, Schreuder R and De Visser C 'EIP-AGRI Focus Group Protein Crops' (Report, 2014).

[307] Jaenicke H and Virchow D 'Entry points into a nutrition-sensitive agriculture' 5 (2013) *Food Security* 679-692.

market practices, safer working conditions, more balanced and nutritious diets, as well as resilient ecosystems in the face of climate change.

The role of consumers is central if the transition is to be successful: a critical mass of public awareness is required to challenge harmful production and consumption models, as well as a demonstration of willingness to acknowledge that food is a matter of public interest and public health, as well as key for tackling environmental insecurity. Personal food choices are permitting current food policies to thrive: low-cost commodity production, externalization of environmental impacts, immense public health costs, cheap and insecure labour, dangerous conditions for farmers and food workers.

These circumstances are the rule, not the exception, and everyone is responsible for sustaining this global food system. Bringing the sad legacy of the low-cost food model to light is the first step for unlocking the food-health nexus and revealing its deep intertwinement with ecological change and degradation: any effort to address the environmental impacts of agriculture is also an effort to mitigate its negative human health impacts. Different management practices will be insufficient if not accompanied by profoundly different paradigms, based on conciliating agriculture with the environment.

6.3 The global issue of food waste

While there has been an enormous expansion in the production and consumption of food (especially animal products, fats, and carbohydrates), nutritious, healthy and adequate food is still a scarce resource. The big picture is further exacerbated by a shocking truth: according to FAO, one third of the food produced globally is wasted. That means, around 1.3 billion tonnes food is loss or wasted, accounting for approximately $680 billion in industrialised countries and $310 billion in developing countries. Fruits and vegetables, together with roots and tubers, have the highest wastage rate (45 percent), followed by fish (35 percent), cereals (30 percent), and meat, dairy oilseeds and pulses (20 percent). While in developing countries food losses occur mostly at early stages of the food chain and can be linked to financial, managerial, and technical constraints, in medium- and high-income countries food is wasted and lost mainly at later stages in the Food Supply Chain.[308] In other words, the consumers' behaviour plays a central role in developed countries.

6.3.1 Food loss and waste in industrialized countries

Even when focusing on the last stages of the Food Supply Chain, notably food distribution and consumption, there are many channels through which food often ends up being wasted in wealthy countries. This happens although problems as such as poor post-harvest and storage facilities and failure to comply with minimum food safety standards have been largely overcome.[309]

Food retailers and consumers are responsible for this negative trend. Supermarkets habitually impose high 'appearance' quality standards to producers, especially for fresh products such as fruits and vegetables. This practice is leading to serious amounts of food waste: some

[308] FAO 'SAVE FOOD: Global Initiative on Food Loss and Waste Reduction' (last consulted 27 November 2018) <http://www.fao.org/save-food/resources/keyfindings/en/>.

[309] FAO 'SAVE FOOD! Global food losses and food waste. Extent, causes and prevention' (Report, 2011).

produce is rejected when not responding standards concerning weight, size, shape and appearance of crops. The reason why large percentages of foods never arrive on supermarkets' shelves is that consumers would not purchase heterogeneous food, despite its integrity in terms of food safety. For instance, carrots need to be straight, so they can be peeled the full length in one stroke; apples have to be of a certain size and colour and present no aesthetic defects. The problem is exacerbated by the attitude of producers and retailers for disposing rather than using or re-using, because of lower costs. However, products with the wrong weight or shape, or even with damaged packaging, could be distributed in markets as 'sub-standard products' that are still safe to eat.

Consumers have the power to influence these quality standards, so that a broader quality range of products could have access to the retail stores instead of being destructed or classed as animal feed. Or, as an alternative, they could prefer farmers' markets and shops where produces do not have to pass the strict quality standards imposed by the conventional food chain channels.

Also, when large quantities of food are on display and a broad range of products and brands are available in supermarkets and shops, food waste is more likely to happen, because of more products reaching their 'sell-by' date before being purchased. Consumers pretend well-supplied stores and filled shelves, without thinking about the costs that continually replenished supplies entail. Often, people buy large quantities of foodstuffs at a time, rendering it harder to manage storage and consumption, which would minimise waste. Marketing and advertisement promote this behaviour and encourage consumers to buy more food than needed also by proposing larger sizes and bargains.

Finally, one of the major causes for food loss and waste at the consumption level in rich countries is abundance, and consumers' attitude towards it. In other terms, people can afford to waste food and are prone to over-consumption. The amount of available food *per capita* in retail stores and restaurants has increased during recent decades, and food waste is culturally accepted. Indeed, the practice of conserving leftovers in doggy-bags is still encountering resistance in some countries. The only way to prevent this kind of waste is by raising public awareness through education in schools and families, and by promoting political initiatives on the matter.

The last data available relating to the EU shows an estimate of 88 million tonnes food waste in 2012, equating to 173 kilograms *per capita* in the EU-28. The sectors contributing the most are households (53 percent) and processing (19 percent). The remaining share is attributable to food services, production, and wholesale and retail.[310] The costs associated with food waste in the same year are approximately EUR 143 billion, of which two-thirds are associated with food waste from households. Poor data quality and lack of monitoring are major obstacles to a more precise and up-to-date assessment.

According to a study commissioned by the NSW Government, the average NSW household throws out Australian $1,036 of food every year: this equates to 345 kilograms per household, or, one out of every five bags of groceries.[311] A more recent survey conducted for the Australian Environment and Energy Department estimates that food waste costs to

[310] European Commission, Stenmarck Å et al 'Estimates of European food waste levels' (FUSIONS EU Project Report, 2016).

[311] NSW EPA 'Food Waste Avoidance Benchmark Study. At a glance' (Report, 2012).

households are much bigger, varying from Australian $2,200 to $3,800. That means, 3.1 million tonnes of edible food wasted each year.[312]

6.3.2 Food waste legislation

Given that food security is a major concern and food production will face important challenges in the upcoming years, the issue of food loss reduction is gaining importance both in the public and private sectors shaping the global food system. The topic has to be addressed as the first mean to fight imbalances and reduce strains between the increase in food consumption and the necessary but problematical increase in food production. Nonetheless, in a world with limited (and already overexploited) natural resources, cost-effective solutions are to be found if all are to enjoy safe and nutritious food. In fact, food losses embody a waste of precious resources used in production – land, water, energy and inputs – leading to further, unnecessary CO_2 emissions and a loss of economic value of the food produced.

The twelfth SDG adopted by the UN General Assembly in 2015, 'Ensure sustainable consumption and production patterns', include a target to halve *per capita* food waste at the retail and consumer levels and reduce food losses along the whole production and supply chain.

The EU and its Member States are strongly committed to meeting this goal. Since 2015, major improvements have occurred in the European legislation. Notably, a Directive on food waste has been adopted in May 2018, calling on Member States to reduce the quantity of food wasted at each level of the Food Supply Chain and to monitor food losses and waste levels so that progress could be assessed.[313] The monitoring is crucial to the development of further food rescue methodologies. An expert group has been created, with the task of supporting the Commission in the preparation of the common measurement methodology and the minimum requirements each Member State will be asked to assure. European countries are already demonstrating sensibility towards the problematics of food waste, developing legislations that are taken as an example in other regions of the world.

France, for instance, passed an innovative law against food waste in February 2016 *(Loi 2016/138 du 11 février 2016 relative à la lutte contre le gaspillage alimentaire*) constraining bigger supermarkets (more than 400 m^2 large) to donate unsold safe food to charitable associations, with which they are prompted to conclude an agreement. In case of refusal, supermarkets are subject to a fine of EUR 3750 for each infringement of the law. The positive outcomes after a couple of years are remarkable: more than 95 percent of the supermarkets involved are offering their unsold food, which is distributed among poor people. Between 2015 and 2017 the amount of foodstuffs collected by charitable associations has increased by 28

[312] Blue Environment 'Australian National Waste Report' (Prepared for the Department of the Environment and Energy, 2016).

[313] Directive (EU) 2018/851 of the European Parliament and of the Council of 30 May 2018 amending Directive 2008/98/EC on waste OJ L 150 [2018] 109-140.

percent. Moreover, approximately 5000 new associations have been created to efficiently distribute the growing amount of food rescued from waste.[314]

Another positive outcome is the consequently pressure from civil society to ameliorate the legislation in nearby countries, Italy for example. The Italian legislation on food waste has been up-dated in the same year, introducing dispositions concerning food donation and distribution for solidarity and food rescue purposes *(Legge 166/2016 del 19 agosto 2016 'Disposizioni concernenti la donazione e la distribuzione di prodotti alimentari e farmaceutici a fini di solidarietà sociale e per la limitazione degli sprechi')*. The donation of unsold foods is therefore permitted also beyond the date of minimum durability, if the packaging is intact and correct storage conditions have been respected. Donations should be primarily directed to the most deprived people, otherwise to animal feed and composting. Bakeries are included by the law, their products being considered fit for consumption within 24 hours from production. The practice of donation is not mandatory, as it is in France, but promoted through bureaucratic simplification and monetary incentives.

Australia, for its part, is committed to respect the UN Agenda by halving its food waste by 2030 through the implementation of the National Food Waste Strategy, launched in November 2017. The primary legislation involved is the Environment Protection Act 1970, which provides the regulatory framework by imposing restrictions and controls over individuals and corporate bodies. States and territories then establish the legislative background concerning the management of food waste, thus enabling local governments to counteract food waste.

The active role of charitable associations in tackling food waste has been recognized. For example, in NSW[315] and the ACT[316] protection from civil liability is afforded to food donors, where food that was safe to eat at the time it left the possession or control of the donor is offered for a charitable purpose. Similar legislations are in place in other states and territories, thus facilitating 'Good Samaritans' in rescuing food that would otherwise end in the landfill due to the fear to be subject of reprisal from the recipient of the donation.

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[314] *LEFIGARO.fr*, Poingt G 'Loi anti-gaspillage alimentaire: quel bilan après 18 mois?' (16 October 2018) <http://www.lefigaro.fr/economie/le-scan-eco/2018/10/16/29001-20181016ARTFIG00007-loi-anti-gaspillage-alimentaire-quel-bilan-apres-18-mois.php>.

[315] Civil Liability Act, 2002 (NSW) s 58c, after Civil Liability Amendment (Food donations) Act, 2005 (NSW) no 16.

[316] Civil Law (Wrongs) Act, 2002 (ACT) s 11B.

7 REFORMING THE FOOD SYSTEMS

As the analysis conducted in the previous chapters suggests, many of the environmental, social, and health impacts of food systems trace back to a specific industrial food and farming model. Notably, agriculture and food systems at a large are among the main drivers of global warming, land degradation, biodiversity loss, and air, soil and water pollution. Also, they bear responsibility for threatening cultural and social development: not only the livelihood of indigenous tribes and communities, but of rural areas all over the world.

Alternative farming techniques, coupled with local and differentiated markets, have many advantages over chemical farming: they are eco-friendly, protecting and reviving life-support systems and eco-systems services; they enable a reduction in air, water and soil pollution caused by various pesticides and other chemicals; they permit a better control of health hazards in humans and livestock; they promote the conservation and sustainable use of on-farm biodiversity, including traditional cultivated germplasm and natural resources; they have a higher cost-benefit ratio, benefiting farmers and consumers alike.

For these many reasons, reforming the current archetypal is essential. A paradigm shift is needed, towards differentiated agro-ecological systems in which traditional and modern knowledge allow agriculture to step back to its original purpose – nourishing people – while minimising the pressure on Earth's natural resources. An alternative food system should deliver stable yields, health-promoting foods and clean environmental landscapes, succeeding where current systems failed.

The question is *how could the change be triggered*?

Certainly, all the actors of the Food Supply Chain, consumers included, play a major role in investing in and promoting a new paradigm; but good intentions alone and jeopardized actions are very likely to fail, if not accompanied by an all-comprehensive plan. Current power relations are too deeply enrooted in the chain, and self-reinforcing: the path from gaining evidence of the gravity of the situation to act against it, faces huge obstacles. Different problems, all ascribable to the same well, continue to be treated separately by policy makers and in public society debates: health is split from other aspects of sustainability, while industrial farming and dietary patterns are far from each other and are not being addressed as the main cause for environmental detriment. As a consequence, scientific research and policies focuses are on single compartments, losing the advantages of seeing the big picture. Moreover, private interests often drive research and a narrow group of actors is able to exercise ever-greater power over data provision and scientific research priorities.

The outcome is a fragmented approach, which tends to be based on further industrialization, low visibility of global problematics (affecting poor and marginalised groups in the Southern hemisphere as well as farmers and workers in developed countries) and a cultural disconnect between food and agriculture.

The challenge is more complex than recognising the hidden costs of agriculture and food production and addressing the under-reported impacts. The ultimate objective is to influence the way priorities are set and impacts are traded-off. True cost accounting appears paramount both as a means of bringing the various problems and their connections to light, and a basis for counter-acting the perils humanity faces. Only when food, water and health are viewed in their wholeness, on a global scale, there is a chance to succeed.

The concept of Sustainable Development, heavily promoted by the UN since 1980s, could have become the starting point for a progressive change towards environmentally sound economic and social policies all over the world. However, it failed. States did not accept

sustainability as the driver of their development, neither in developed nor in developing countries. In this discouraging context, one more concrete attempt to acquire and diffuse a holistic understanding of the matter could be based on a human rights-approach.

7.1 The Sustainable Development narrative

If the right to a health and balanced ecology was recognised as being a component of the people's fundamental rights pattern, civil society would have a powerful tool to constrain public and private actors to promote policies and business models enabling to produce sustainable foods - free from detrimental environmental, social, and economic impact. In absence of such recognition, the connection between a healthy environment and the protection of human rights is more fragile. However, there are ongoing attempts to raise awareness about the obligation of governments to do everything in their power to protect citizens against the damaging effects of human activities on the environment. These efforts are based on the principle of *Sustainable Development*.

7.1.1 The concept of Sustainable Development

Sustainable Development has become an unavoidable paradigm that should underpin most of human actions: it pervades the environmental discourses, and social, political, economic and cultural discourses alike. From the local through the global level, it is the uniting factor of all attempts to counteract the disastrous effect of global warming on human livelihood and the environment. Although the origins of the deep connection between nature preservation and economic development date back to a couple of centuries ago, the modern understanding of the concept is mainly the result of a large UN-promotion. The operation started with the recognition of the relationship between natural environment and economic progress in the Stockholm Declaration of Principles (1972).

Years of conceptual articulation followed, and the notion of social development was crafted as a third dimension of sustainable development, together with the environmental and economic concerns. Finally, the UN adopted the term as organising principle to meet human development goals while sustaining the capacity of Earth's ecosystems to provide the natural resources upon which humanity depends on. It has been elevated as guiding rule to fulfil 'the needs of the present without compromising the ability of future generations to meet their own needs'.[317]

A plethora of Declarations of states and Resolutions of international organisations, as well as International Treaties, support Sustainable Development. These core documents express it as a combination of two dimensions: *intergenerational* and *intragenerational* equity.[318] The first refers to the fact that states, in their development choices, must preserve the 'natural capital' they hold in trust for future generations, ensuring that it is transmitted in conditions corresponding to those in which it was received. The second one indicates the necessary equity in the distribution of the outcomes of development within one generation, both

[317] World Commission on Environment and Development 'Our Common Future' (Oxford University Press, 1987).

[318] Barral V 'Sustainable Development in International Law: Nature and Operation of an Evolutive Legal Norm' 23 *European Journal of International Law* 2 (2012) 377-400.

internally and internationally. Only through the combination of these two dimensions, Sustainable Development will be achieved.

Beyond these essential components, a vast array of legal standards and principles is further closely associated to its concrete realisation. When employed, they participate in the integration of environmental protection, social and economic development. For instance, the principle of common but differentiated responsibilities, pursuing which, because of their particular contribution to the degradation of the environment, developed countries have a shared but heavier responsibility in working towards Sustainable Development.[319]

The evolutionary nature of the principle is the reason why the standards and principles that need to be respected to achieve its fulfilment can differ substantially. Its content changes *ratione loci, temporis, personae*, *materiae*. Such malleability is source of debate: while some argue that the vagueness of the notion makes it incapable of legal classification, others conclude that, rather than being a weakness, the flexible nature of the concept represents its strength.

The idea of Sustainable Development has a strong legal position as one of the ultimate objectives of the European Union that are stated in the relevant provisions of the Treaties. Even prior to the entering into force of the Treaty of Lisbon, the European Court of Justice already demonstrated its commitment in matter of environmental protection, by employing a dynamic and teleological method.

The EUCJ shaped the all-embracing objective of sustainable development before the environmental integration rule was made legally binding. For example, it stated that the EU legislator is competent to include requirements of criminal penalties in secondary legislation, when necessary to achieve an 'effective environmental protection'. In fact, even if as a general rule neither criminal law nor the rules of criminal procedure fall within the Community's competence,

> '(…) [that finding] does not prevent the Community legislature, when the application of effective, proportionate and dissuasive criminal penalties by the competent national authorities is an essential measure for combating serious environmental offences, from taking measures which relate to the criminal law of the Member States which it considers necessary in order to ensure that the rules which it lays down on environmental protection are fully effective.'[320]

The EUCJ based its conclusion upon the common ground that the protection of the environment already constituted *one of the essential objectives of the Community*. The reasoning was in line with Article 2 EC, stating that the Community has the task to promote a high level of protection and improvement of the quality of the environment; and Article 3 EC, providing for the establishment of a policy in the sphere of the environment. Furthermore, Article 6 EC stated that environmental requirements must be integrated into the definition and implementation of the Community policies and activities, emphasizing the multifaceted nature of that objective.

Through the formal recognition of the environmental integration core of the principle of Sustainable Development in the TFEU, the principle of sustainable development itself has

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[319] The principle of Common But Differentiated Responsibilities (CBDR) is enshrined in the UNFCCC, Article 3 and Article 4, adopted in occasion of the Earth Summit in Rio de Janeiro.

[320] Commission of the European Communities v Council of the European Union, C-176/03 [2005].

become applicable for all the EU's activities, gaining importance. Sustainable Development is since then an overarching objective of European policies and actions. According to Article 11

> 'Environmental protection requirements *must* be integrated into the definition and implementation of the Union policies and activities, in particular with a view to promoting *sustainable development*.'

This statement has legal significance for all European institutions – the European Council, the European legislator, the Commission as a supervisory organ, and the European Court of Justice (EUCJ) alike.

7.1.2 The People's Climate Case

An action has been brought before the EU General Court by a group of families whose livelihood and future are threatened by the impacts of climate change.[321] Many of the plaintiffs are farmers, whose activities are profoundly threatened by the occurring and predicted climatic changes linked to global warming. These families claim that the EU's existing 2030 climate target to reduce domestic GHG emissions by 40 percent by 2030 as compared to 1990 levels is inadequate with respect to the concrete need to prevent dangerous climatic changes. Notably, the European policy is not protecting their fundamental rights to life, health, occupation and property: in fact, the existing target will still allow 60 percent of emissions, instead of 40 percent, to be allocated to industry and EU Member States. Their fundamental rights and the rights of their children are subject to a permanent violation, which is already affecting them and, most importantly, will undermine their livelihood in the imminent future.

The petitioners underpin the inadequacy of the current European regulations in the face of the over-arching objective of *Sustainable Development* enshrined in Article 11 TFEU as a duty to protect the interests of forthcoming generations. In light of these considerations, the plaintiffs asked the European General Court to mandate the European legislator to take stronger measures of climate protection, in order to ensure a better protection of their human rights and the whole global environment. Notably, the application entails two different parts, one related to nullification and one to a claim for an injunction based on non-contractual liability.

The nullification is challenging three EU legal acts: the ETS Regulation, the Climate Action Regulation on emissions from industry, transport, agriculture, etc., and the LULUCF Regulation. The plaintiffs' demand to declare these acts null and void is based on the recognition of their inadequacy in relation to higher ranking law (primary EU law and international law). Moreover, to avoid a *vacuum,* the Court is asked to order that the above-mentioned regulations stay in force until a stronger version of them is enacted. This part of the action is based procedurally on Article 263 TFEU.

The non-contractual liability claim, indeed, underlines that since damage to life, health, property and income, are occurring due to climate change, the EU has the obligation to

[321] Action brought on 23 May 2018 - *Carvalho and Others v Parliament and Council*, T-330/18 [2018].

prevent GHG emissions as much as it can, to prevent additional damage to be caused. This part of the action is based procedurally on Article 340 TFEU.

The EU's higher rank legal obligations to take in consideration are Article 191 TFEU (European primary law), the EU Charter of Rights, as well as the UNFCCC and the Paris Agreement, together with customary international law stating the duty to protect human health and the environment.

The Article 191 TFEU requires the EU to adhere to a standard of a 'high level of protection, prevention and precaution' in developing its environmental and climate policy. According to the plaintiffs, a high level of protection is hardly to be reached given the occurring damage; however, the EU is still obliged to adopt effective and immediate measures to reduce the harmful effects of climate change to the greatest extent possible. Another foremost recognition is embodied in Article 168 of the TFEU, which states that 'a high level of human health protection shall be ensured in the definition and implementation of all Union policies and activities.'[322] Given that a healthy environment is a precondition for a healthy life, Article 168 could serve as leverage for the Sustainable Development objective to be enforced in a court of law as a legal duty.

The EU Charter of Rights protects the rights to life and physical and mental integrity, which are threatened by the increasing incidence of flooding, heat waves, and drought; the rights of children, which are mostly vulnerable to harm and economic and material deprivation due to climate change; the right to pursue an occupation, as it could be the case for farmers and beekeepers who could no more sustain themselves by doing their job; the property guarantee, which extends to physical assets of an agricultural business as such as barns, machinery, and soil; moreover, the right to equal treatment is evoked in relation to discriminations based on age. In fact, unless drastic action is taken now, today's children will face hostile environmental conditions due to climate change that are far worse than those enjoyed by present-day adults.

Reading the People's Climate case in the light of the inter-dependency of all human rights reinforces the petitioners' claim to be protected from the worst global warming scenario through policies that mitigate climate change. Sustainable Development is undeniably a very powerful hermeneutical tool for judges and can be used to weigh on the interpretation of existing norms. Having resort to Sustainable Development in the interpretation process may legitimize a dynamic interpretation of treaty rules, or even lead to a revision of a treaty.[323] However, the quantitative role of the judicial function in the implementation of international law is minimal. Under these circumstances, the capacity of states, as primary enforcers of these norms, to pursue Sustainable Development is still precarious. Combating hunger and malnutrition, ensuring the access to safe and clean water, assuring the right to health and occupation, are more than moral duties or political choices. They are legally binding human rights obligations, and they ought to be treated as such.

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[322] Consolidated versions of the Treaty on European Union and the Treaty on the Functioning of the European Union - Consolidated version of the Treaty on the Functioning of the European Union - Protocols - Annexes - Declarations annexed to the Final Act of the Intergovernmental Conference which adopted the Treaty of Lisbon, signed on 13 December 2007 - Tables of equivalences.' OJ C 326 [2012] 1-390.

[323] See, for example, the ICJ Gabčíkovo-Nagymaros ruling (Gabčíkovo-Nagymaros Project Hungary/Slovakia, Judgment, ICJ Report, 25 September 1997) and the so-called 'Shrimp-Turtle' ruling of the WTO (United States – Import prohibition of certain shrimp and shrimp products' Report of the Panel, WT/DS58/R, 15 May 1998).

7.2 Human rights protection as the case for reforming agri-food systems

The Sustainable Development principle could be interpreted as the precursor of the human right to a healthy environment, which is a *sine qua non* for to the enjoyment of any fundamental human right protected under European and International law. There are multiple reasons to consider environmental protection a human rights issue. First of all, a human rights perspective openly addresses environmental impacts on the life, health, private life and property of individuals rather than on other states or the environment in general. Also, it may be key to ensure higher standards of environmental quality, based on the obligation of governments to take measures to control pollution and contamination affecting people's livelihood. Most importantly, it helps to promote the rule of law in this framework: failures to regulate and control environmental nuisances, including those caused by private actors, such as corporations, are then attributable to States. The latter become directly responsible also for facilitating access to justice and enforcing environmental laws as well as judicial decisions.

The magnitude of environmental caseload of human rights courts and treaty bodies indicates the growing importance of the topic in mainstream human rights law.[324] The international recognition of the right to a healthy environment would finally acknowledge what is already clear – that all people deserve to live in an environment that enables them to enjoy their human rights. Moreover, a useful recognition through codification should also contain significant element of progressive development and reform to be fit for the purpose. The issue is not merely about the recognition of a human right to a healthy environment, but how much more this should add to the existing situation.

According to the Vienna Declaration and Programme Action of 1993, human rights are indivisible, interdependent and interrelated: each individual is entitled to all human rights, without a hierarchy within them. This implies, that the fulfilment of one right is likely to strengthen the fulfilment of other, interconnected rights, and, conversely, that violation of one right is likely to stymie fulfilment of other rights. Looking at the right to food, for example, the Universal Declaration of Human Rights call is not only for food itself, but for an adequate standard of living. It is one amongst several rights (the rights to housing, water, education, and health) that have to be viewed as a cluster of mutually reinforcing socio-economic rights.

The fulfilment of the human rights to food and water is strictly dependent on a healthy and sound environment, thus bearing witness to the interconnectedness of all human rights. That also means, that a true reform of the Food Supply Chain is only possible if each one of these aspects is considered, and if all of them are treated as essential.

7.2.1 The human right to food

The right to food is a substantial part of the founding human rights texts dating back to the post-World War II era, the Declaration of Human Rights (UDHR, 1948) and the International Covenant on Economic, Social, and Cultural Rights (ICESCR, 1976). Although

[324] Boyle A 'Human rights and the Environment: Where Next?' 23 3 The European Journal of International Law 613,642 (2012).

the right to food is by now acknowledged in several instruments under international law, the Covenant deals with it more comprehensively than any other source.

According to Article 11.1 ICESCR, States parties recognise the

> 'right of everyone to an adequate standard of living for himself and his family, including adequate food, clothing and housing, and to the continuous improvement of living conditions'.

Pursuant to Article 11.2, urgent steps are needed to ensure 'the fundamental right to freedom from hunger and malnutrition'.

In September 2000, the UN Millennium Declaration (Resolution 55/2) committed participating countries to halve the proportion of people suffering from hunger between 1990 and 2015. That same year, the Commission on Human Rights appointed a Special Rapporteur on the right to food, who further clarified the content of this right and elaborated on how it should be respected and protected. According to the Special Rapporteur on the right to food Hilal Elver

> 'The right to food is the right to have regular, permanent and unrestricted access, either directly or by means of financial purchases, to quantitatively and qualitatively adequate and sufficient food corresponding to the cultural traditions of the people to which the consumer belongs, and which ensure a physical and mental, individual and collective, fulfilling and dignified life free of fear.'

This statement is in line with the dispositions of the Covenant. It is also compatible with the definition adopted by the Committee in charge of monitoring the implementation of the right to adequate food in those States that are party to the Convention. According to those States

> 'The right to adequate food is realized when every man, woman and child, alone or in community with others, has physical and economic access at all times to adequate food or means for its procurement. The right to adequate food shall therefore not be interpreted in a narrow or restrictive sense which equates it with a minimum package of calories, proteins and other specific nutrients. The right to adequate food will have to be realized progressively. However, States have a core *obligation* to take the necessary action to mitigate and alleviate hunger even in times of natural or other disasters.'[325]

From the perspective that emerges from these statements, States parties have legal obligations to respect, which are fully described in Article 2 of the Covenant. The Committee has exemplified the deriving duties in its General Comment n.12:

> '(…) the right to adequate food is indivisibly linked to the inherent dignity of the human person and is indispensable for the fulfilment of other human rights enshrined in the International Bill of Human Rights. It is also inseparable from social justice, requiring the adoption of *appropriate economic, environmental and social*

[325] General Comment n.12 of the UN Committee on Economic, Social, and Cultural Rights, E/C.12/1999/5 (Twentieth Session, 1999).

> *policies*, at both the national and international levels, oriented to the eradication of poverty and the fulfilment of all human rights for all.'

Evidently, the right to food is about the empowerment of individuals and communities, and not about dependency or state aid, or even charity. Globally, most governments have ratified the Covenant, thus assuming responsibility for the satisfaction of its requirements. Three key obligations have been identified, which can be summed up in three respective duties defining any human rights: the duties to respect, to protect and to fulfil.

The obligation to respect is often called a 'negative obligation', meaning that governments should not indiscriminately take away people's right to adequate food.[326] For instance, they must abstain to arbitrarily dislodge someone from his or her land, if this land represents the main source of income and/or means of livelihood.

The obligation to protect is of growing importance in a globalised world: governments must play an active role by enacting and enforcing laws to prevent third parties from violating the right to food. This duty involves various actions, which together make up a progression: investigation, access to justice and provision of effective remedies.[327] For example, the pollution of a community's water supply or natural habitat by a company should be followed by a government action following the mentioned steps. For this to be possible, appropriate legal means for the protection of the environment ought to be in place.

The obligation to fulfil is traditionally split into two core aspects. The first one is facilitation, that means, governments must take positive action to implement policies that assure people the access to adequate food, by 'facilitating' their ability to feed themselves (agrarian policies should be among the main channels to ensure this facilitation process). The second one is provision, which has to be regarded as delivery of direct assistance in situations in which people's food security is endangered, for reasons beyond their control. This obligation is particularly significant, in so far as it clarifies that starvation is never an option for a government: to let people starve when they do have no means of subsistence is a violation of the right to food; similarly, if a government that is unable to provide food to its citizens does not appeal for external humanitarian aid.

The extension and depth of these obligations show how the current practices of food dumping, speculation in agricultural commodities, subsidiary agricultural policies, land-grabbing, food monopolies and contract farming, agro-fuels production and unsustainable, industrial farming and breeding models, are clearly against the realization of the plethora of governments' responsibilities. Governmental policies must not favour investment that is harmful to the protection and fulfilment of the right to food; instead, they must promote the enhancement of farmers in the value chain, rural development and sustainable farming evolution patterns. More than ever, the international trading system needs to be revised to be conforming with human rights, the human right to food in first place. This is probably one of the earnest areas of systemic change, prompted by the deficiencies demonstrated in occasion of the recent global food crisis. As long as trade and agricultural policies affect

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[326] Mahon C 'The right to food: a right for everyone' Rosin C, Stock P and Campbell H (eds.) *Food systems failure. The global food crisis and the future of Agriculture* (Routledge, 2012).

[327] Ziegler J 'Economic, Social, and Cultural Rights: the Right to Food' (Report of the Special Rapporteur on the right to food, E/CN.4/2006/44, 2006).

human rights and the ability of people to access adequate and sufficient food, they have to be encompassed in the human rights' sphere of law.

7.2.2 The human right to water

More recently, the human right to water and sanitation has been recognised by the international community as a cornerstone of human livelihood and well-being. The UN General Assembly resolution explicitly identifying it as such (Resolution 64/292), calls upon states and international bodies to provide financial resources and help capacity-building and technology transfer to help countries to provide clean, safe, accessible and affordable water to everyone. The same Committee monitoring the realisation of the right to food has adopted a comment on the right to water, stating that

> 'The human right to water is indispensable for leading a life in human dignity. It is a prerequisite for the realization of other human rights (…) the right of everyone to sufficient, safe, acceptable and physically accessible and affordable water for personal and domestic uses.'[328]

Recalling Article 11.1 ICESCR, the right to water falls within the constellation of rights emanating from the realisation of the right to an adequate standard of living, which 'includes adequate food, clothing, and housing'. It is precisely the word 'including' that suggests it is a non-exhaustive catalogue of rights: as the Committee emphasises, the right to water is also intimately related to the right to the highest attainable standard of health and the right to food. Notably, water is necessary to produce and cook food, as well as ensure environmental hygiene. Priority must be given to the protection of water resources to prevent starvation and disease, and to fulfil many other rights embedded in the International Bill of Human Rights; among them, the right to life and human dignity.

In particular, sustainable access to water resources for agriculture is key to ensure the concrete realisation of the right to food: disadvantaged and marginalized farmers, in particular, should be granted equitable access to water and water management systems and technologies.

To promote a better environmental hygiene, pollution of soil, air, and water resources that generate unsafe and toxic conditions of freshwater and oceans, should be targeted. It is a governmental responsibility to protect the natural water resources from contamination by detrimental substances and pathogens. Also, administrations should protect aquatic ecosystems as a whole, for their role in ensuring the sustenance of healthy environments, which provide in turn safe water.

Concerning the normative content of the right to water, both freedoms and entitlements can be identified.[329] Amid the first category, the right to maintain access to existing water supplies and to be free from interference, disconnections or contamination of water supplies. The second category includes the right to a system of water supply and management, which ensures equality of opportunity for people to enjoy their right to water. To each entitlement corresponds a state legal obligation, split into the familiar three-dimensional obligation: to

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[328] General Comment n.15 of the UN Committee on Economic, Social, and Cultural Rights, E/C.12/2002/11 (Twenty-ninth Session, 2003).

[329] Ibid.

respect, so to refrain from interfering directly or indirectly with the enjoyment of the right to water; to protect, namely to prevent third parties from interfering in any way with the satisfaction of the right to water; and to fulfil, which is in turn disaggregated into the two obligations to facilitate the access to water, and to provide water.

Finally, the Commission underpins that all these obligations are to be observed also, if not particularly, during armed conflicts, emergency situations, and natural catastrophes, given that the right to water 'embraces the obligations by which States parties are bound under international humanitarian law'. This statement is of particular importance, given that 'climate conflicts', human conflicts affected by the specific climatic conditions of the area in which they occur, are today a reality. Global warming, which is key to the progression of natural resources degradation, desertification, and augmentation of extreme weather events, is likely to exacerbate climate-related hostilities.

Water surely is indispensable and the most precious resource on Earth, making competition and pressure for its appropriation gradually more aggressive as its supplies are dwindling. In other terms, water scarcity has the potential to affect peace and security, and water-related risks can have grave human and economic costs.

Looking to the roots of the 2007 Sudan's Darfur conflict between farmers and pastoralists, former UN Secretary-General Ban Ki Moon saw the first climate change conflict: a complex dynamic that he described as an 'ecological crisis', rather than an ethnic conflict. Since then, a growing body of research examined the extent to which human conflicts are affected by climatic changes, finding strong causal evidence linking the two phenomena, across all major regions of the world.[330]

The Council of the European Union is giving priority to water diplomacy issues.[331] Member States are aware of the growing tensions and conflicts over access to and use of water, including cross border effect of water-related hostilities within countries, as the availability and quality of the global water resources and ecosystems worsen. All of this can have direct and profound implications for humans' livelihood and international relations. Migration flows from the Southern hemisphere are expected to be prompted by more frequent droughts and extreme weather events; in Bangladesh, researchers found a connection between the continuous flooding, constraining farmers to leave their fields and make a poorly living in the cities' suburbs, and the phenomenon of child brides.

Many other examples could be done, of how climatic changes are turning the Earth in a hostile environment. Therefore, cooperation on water at all levels is ever more important. There is an urgent need to address the water-related consequences of global warming, building synergies between water diplomacy and climate diplomacy, to ensure stability and prevent conflicts.

Water has multiple and crosscutting dimensions, and farming and food industry are one among them. Comprehensive and integrated plans and programmes to guarantee that there is safe and sufficient water for present and future generations must consider the negative impacts on water resources of the current agro-food systems. Their substantial water footprint can no longer be overlooked: farming alone accounts for 70 percent of global water

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[330] *Science,* Hiang S M, Burke M and Miguel E 'Quantifying the influence of climate change on human conflict' (1 August 2013).

[331] Council of the European Union 'Council Conclusions on Water Diplomacy' 13991/18 (19 November 2018).

use and contributes to water pollution from excess nutrients, pesticides and other pollutants commonly used in conventional farming.

The potential of alternative farming practices in conserving freshwater and minimising water pollution is significant and should be promoted as a valuable choice.[332] They represent an optimal, balanced solution, to fulfil both the right to food, which has to be produced sustainably in adequate quantity and quality, and the right to safe and clean water, which has to be guaranteed to all people now and in the forthcoming years.

7.2.3 The right to a healthy environment

All human beings depend on the environment in which they live. A safe, clean and healthy environment is essential for humanity to thrive. In a hostile ambience a full enjoyment of the right to life itself is endangered, and human rights to adequate food and water alike. At the same time, the safeguard of human rights is inextricably linked to environmental protection. The recognition of a deep relationship between environmental protection and human rights is growing, on the back of a wave of international and domestic laws and regulations, judicial decisions, and academic studies that document their *embeddedness*.

Environmental protection claims based on existing human rights, both substantive and procedural, are now regularly deployed in national and international *fora*. Most importantly, 'environmental rights' clamour for acceptance as a new category of human rights *per se*. As the environmental justice landscape evolves, it is paramount to develop new strategies and legal means to ensure the respect of the rights of individual and communities, particularly those dependent on natural resources or gravely affected by environmental degradation. By now, climate change is not only perceived as an environmental issue, but one of the greatest human rights challenge the current generation faces.

Just as climate change has severe impacts on human rights, the responses taken to address climate change have direct and indirect implications for the full and effective enjoyment of all human rights. This connection has been clearly recognised by the UN Human Rights Council (UNHRC) in 2009, with Resolution 10/4, stating, *inter alia*, that

> '[C]limate change-related impacts have a range of implications, both direct and indirect, for the effective enjoyment of human rights including, inter alia, the right to life, *the right to adequate food*, the *right to the highest attainable standard of health*, the right to adequate housing, the right to self-determination and *human rights obligations related to access to safe drinking water* and sanitation (…)'.[333]

After clarifying how human rights, environmental protection and sustainable development are embedded, the UNHRC established a mandate on human rights and the environment, with the task of analysing the human rights obligations as a means to ensure the enjoyment of a clean and healthy environment. The outcomes should then be the basis for best practices in terms of environmental policymaking. John Knox was appointed to serve as first Independent Expert and Special Rapporteur on human rights and the environment. In 2018

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[332] Padmavathy K and Poyyamoli G 'Alternative Farming Systems for Sustainable Food Production' in E Lichtfouse (ed.) '*Genetics, Biofuels and Local Farming Systems'* in *Sustainable Agriculture Review 7* (Springer, 2011).

[333] UNHRC Resolution 10/4 on Human Rights and Climate Change (Tenth Session, 2009).

the mandate has been extended and David R Boyd has since then been appointed as Special Rapporteur.

Mr Knox concluded, after reviewing hundreds of statements of treaty bodies, regional human rights tribunals, and other human rights authorities, that 'the association of human rights norms as applied to the environment is remarkably coherent.' Later on, Mr Boyd expressed his concern for 'unprecedented levels of environmental degradation', calling for states' obligations under human rights law to protect all people against environmental harm to be taken more seriously.[334]

In this context, some framework principles reflecting the already existent human rights obligations in an environmental perspective have been identified. They range from the rights of freedom of expression and peaceful assembly to the duty to protect human rights defenders who are working to protect the environment on which those rights depend, through the prohibition of discrimination in the enjoyment of a safe, clean, healthy and sustainable environment. States have an obligation to establish and maintain concrete environmental standards to protect and fulfil human rights. Most significantly

> '[T]he obligation of international cooperation to address global threats to human rights encompasses environmental threats such as climate change and the loss of biological diversity.'[335]

As of 2012, 177 of the world's UN member nations acknowledged the right to a healthy environment, in different forms: through constitutions, environmental legislations, court decisions, ratification of international agreements, etc. To date, more than one hundred among them conferred it a constitutional status, which is the strongest form of legal protection. This acknowledgement fosters greater environmental laws and permits a better enforcement through landmark court decisions.

The constitutional right to a healthy environment has been incorporated in legislation and has being judicially enforced in Europe, Latin America, Asia, and Africa.

Concerning the European framework, the first samples of constitutional recognition of the Member States' duty to protect the environment occurred in the 1970s. Exemplar provisions can be found, for instance, in the Greek Constitution (Article 24), in the Spanish Constitution (Article 45) and in the Portuguese one (Article 9). The public duty to protect the environment is often accompanied by the recognition of the people's right to enjoy a healthy and safe environment, and the individuals' duty to protect it.

In some other EU countries, the constitutional consecration of the right to a healthy environment occurred at a later date. France amended its Constitution to include the *'Charte constitutionnelle de l'environnement'* in 2005, providing a powerful tool to counteract the harmful consequences that human activities can inflict on the environment. Composed of ten articles, the text identifies rights and duties in matter of environmental protection, based on the precautionary principle that many European countries share as a common heritage. Notably, the first article states that 'everyone has the right to live in a balanced and health-respectful

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[334] Statement by David R. Boyd, Special Rapporteur on human rights and the environment at the 73rd session of the General Assembly (New York, 25 October 2018).

[335] Statement by John Knox, Special Rapporteur on human rights and the environment at the 37th session of the UN General Assembly (5 March 2018).

environment' [author's trans].[336] The Italian Constitution still does not expressively provide any environmental right or duty, which makes it difficult to identify a perfect individual environmental right; nonetheless, the constitutional text requires the protection of the landscape and the cultural heritage (Article 9) and states the right to health protection (Article 32). From these statements, both the Constitutional Court and the Court of Cassation extrapolated the right to a healthy environment as a principle and a precondition for a good quality of life since 1980s.[337] Today, the right to a healthy environment is peacefully defined as a primary and absolute right, therefore inviolable.[338]

Australia is one among only 15 nations, including Canada and the United States, which does not recognise the right to a healthy environment at the federal level. In contrast to the Constitutions of many other countries, which list a range of right and provide legal protection for them, the Australian Constitution includes a few provisions that deal expressly with rights, and no mention of the right to a healthy environment.

Evidence demonstrates that constitutional environmental rights and responsibilities act as a catalyst for stronger environmental laws and enhanced public participation in environmental governance. This has been the case in Argentina, where, in July 2004, a group of residents of the Matanza-Riachuelo Basin filed a suit before the National Supreme Court of Justice against the national government, the Province of Buenos Aires, the City of Buenos Aires and 44 companies, asking for compensation for damages resulting from the heavy contamination of the basin; for the stoppage of the polluting activities; and a remedy for collective environmental damage. The Supreme Court decided in favour of the petitioners, ordering the Government respondents to take affirmative measures to improve the resident's quality of life, remedy to environmental damage, and prevent future damage. [339] The decision was based on Article 41 of the Argentinian constitution, dictating, in its first part, that

> 'All inhabitants enjoy the right to a healthful, balanced environment fit for human development, so that *productive activities* satisfy current needs without compromising those of future generations and have the duty to preserve the environment. Environmental damage shall generate as a priority the obligation to repair it under the terms that the law shall establish.'

The authorities shall provide for the protection of this right, for the rational use of natural resources, for the preservation of the natural and cultural patrimony and of biological diversity, and for information and education on the environment.'

This innovative approach to environmental threats echoes the growing awareness of the interdependence of human rights and the environment. If a state is to fulfil its obligations regarding human rights protection, then it will have to ensure a clean, safe, healthy and sustainable environment. As the Special Rapporteur suggests, the easiest way to appreciate and actualise this deep and mutual association is to formally recognise a *human right to a healthy environment.*

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[336] Loi constitutionnelle 25/2005 du 1er mars 2005 relative à la Charte de l'environnement, Article 1.

[337] See, for example, Italian Constitutional Court, 210/1987, 4.5.

[338] Italian Constitutional Court, 126/2016, 6.2.

[339] Mendoza, Beatriz Silvia and others v the National State and others regarding damages suffered (injuries resulting from the environmental contamination of the Matanza-Riachuelo River) M.1569.XL [2008].

7.2.4 The way forward

Being among the anthropogenic activities which have the largest impact on ecosystems, and therefore responsible for climate change-related outcomes, agriculture and food production at a large should be urgently addressed by regional and international environmental policies. The right to food, water, and health are indissolubly connected to the right to a healthy environment: the way food is produced, distributed, and consumed today is largely responsible for their (dis)satisfaction. The current agro-food systems would be seriously questioned if a human right to a healthy environment would be formally recognised.

Considering the current regulations and laws on the matter, there is no doubt that states have a responsibility to protect human rights from environmental harm caused by business and industry, being irrelevant if the state in question owns or not the company in question.

For example, in the case Fadeyeva v Russia (2005), the European Court of Human Rights (ECtHR) stated that the state's responsibility could arise from 'a failure to regulate private industry', in light of the duty to 'take reasonable and appropriate measures' to secure human rights under human rights convention.[340] A few months earlier, in the case of Öneryildiz v Turkey, the ECtHR recalled the Article 2 of the Convention to specify that the states' positive obligation to take all proper measures to safeguard life for the purpose of the article entails most of all a 'primary duty on the State to put in place a legislative and administrative framework designed to provide effective deterrence against threats to the right of life'.[341] This, according to the Court, covered the 'licensing, setting up, operation, security, and supervision of dangerous activities' and required all those concerned to take practical measures to effectively protect the citizens whose life might be threatened by the correlated dangers.

This narrative is no prerogative of the European view of human rights. The African Court on Human and People's Rights recognised a denial of human rights attributable to the government by international law in the 'Ogoniland case', where unregulated foreign investment contributed little to the livelihood of the resident population while harming its health, well-being, property, and natural resources.[342]

Overall, human rights courts have contributed a lot more than interstate governmental negotiations or UN human rights experts to identify the relationship between human rights obligations and environmental protection, to determine what responsibilities can be attributed to states. They were key in determining what weight should be given to natural resources exploitation over nature protection; to economic development over air, soil, and water quality; to land-use change over conservation of forests, wetlands and all sorts of ecosystems; to agribusiness corporations' profits over rural communities' livelihood; to today's industrial agricultural system over the destructive effects of global warming, and so on.

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[340] *Fadeyeva v Russia* 55723/00 (2005), 89.

[341] *Öneryildiz v Turkey* 48939/99 (2004), 89.

[342] Social and Economic Rights Action Center and the Center for Economic and Social Rights v. Nigeria 155/96 (2002), 52–53.

Currently, different governments and international organisations pursue their own priorities, minimally moderating their actions according to international agreements on matters such as climate change and conservation of natural resources. Environmental protection is considered in the slightest part in policies and interpretations, despite the urgent need to counteract the global warming trend if the human species is to survive. The advantage of looking at environmental protection from a human rights-based perspective, is the focus on what is more valuable to individuals. In doing so, the damage to internationally protected values such as life, food, water, and health through uncontrolled environmental harm becomes unacceptable.

To be meaningful, a right to a decent environment has to address the environment as a public good, rather than in form of a civil or political right. It is best envisioned within the context of economic and social rights, where to some extent it already finds expression through the rights to water, food, and environmental hygiene. Its recognition among existing economic and social rights would add a broader and more explicit focus on environmental quality, which could then be balanced against economic and developmental priorities of the Covenant.[343]

[343] Boyle A 'Human rights and the Environment: Where Next?' (2012) 23 3 *The European Journal of International Law* 613-642, 629.

CONCLUSIONS

The very surfacing of Food Systems Governance as a field of study is to trace back to research results and conclusions about the connection between global environmental change and food security. Ericksen developed the first complete conceptualisation of 'food system', which is still the most comprehensive

> 'Food systems include: (a) the interactions between and within geophysical and human environments, which determine a set of activities; (b) the activities themselves (from production through consumption); (c) outcomes of the activities (contributions to food security, environmental security and social welfare); and (d) other determinants of food security (stemming in part from the interactions in (a);'[344]

Definitions of food systems are relatively scant. Some others can be found in the scientific literature, but none is as all-comprehensive as the above-mentioned, which comprises various essential components.[345] First of all, the interactions among different environment, human and natural ones, in which many differentiated activities take place; the interconnectedness is the reason why action by one group in the system get to affect other groups, as well as other environments. Secondly, because of the activities considered, ranging from production to consumption. Finally, the outcomes of those activities are not only contemplated in terms of food security as the notion has been conventionally interpreted. As seen in various occasions, the significance of food security can no longer be confined to a productionist approach, focused on securing larger quantities of food. The distinction between food production and food safety permitted to evolve the concept, which is by now much more complex, with implications concerning culture, nutrition, health, and the environment. In fact, the natural resources are another key component, also indicated as environmental systems and bio-geophysical environments.

The association between food provision and climate change is the basis for the reasoning conducted in the previous chapters, delineated in interactions between natural and human environments. In contrast to Ericksen's conceptualisation, this work emphasised the role of different actors and governance as both part and drivers of the food system. In fact, there is more and more evidence of the way food systems shape and are being shaped by policies and legislation. Wondering how food systems can cope with global warming and at the same time ensure food security, environmental security, and social welfare, without considering the weight of politics and legislators, would lead to failure.

The ability to provide food security, environmental sustainability, and social welfare can be developed only in the context of a resilient food system, which can absorb disturbances (as such as climate change and extreme weather events) and build and increase its capacity for learning and adaptation. Apart from resilience, other main characteristics have been identified as contributing to the building and survival of a sound food system: for instance, the proximity of producers to consumers, recalling the concept of local foods. Local food implies a new economy as well as a new agriculture, with new social, economic and

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[344] Ericksen P J 'Conceptualizing food systems for global environmental change research' 18 *Global Environmental Change* 234-245.

[345] Hospes O and Brons A 'A systematic literature review' Kennedy A and Liljeblad J (eds.) *Food Systems Governance. Challenges for justice, equality and human rights* (Routledge, 2016) 18.

environmental relationships. Moreover, the space for alternative food activities, namely, food activities that coexists with the commercial and industrial food system, or replace it.

Most importantly, the food system should be 'human rights-proof', reflecting that food security, health, decent livelihoods, safe working conditions, cultural identity, participation in the development of food and agricultural policies, and a healthy environment, are human rights.[346]

Fragmented food policies, dominated by the productionist paradigm and limiting the involvement of civil society, are among the main weaknesses of food systems. Similarly, power imbalances in favour of corporate entities, reluctant to address global environmental, social, and economic crises, are undermining the possibility of a shift towards sustainable food systems. In light of these many considerations, the importance of sound food system governance becomes clear. While most research link global warming and food systems to underpin the impact of climate change on agricultural production, the interactions with these and other aspects of the food chain are most of the time overlooked.[347]

Intervening on agricultural production models is just the first step to build a new food policy. The latter needs to expand beyond food production to include environmental as well as social and health concerns. This integration has to be accompanied by the development of a movement that the literature depicts as 'resistant governance'.[348] Scholars assert that farmers and social movements *in primis* have to challenge the idea of food as a global commodity, emphasising the notion of access to food as a human right (and part of an array of connected socio-economic rights).[349] This resistance is based on the concept of food sovereignty as a means to achieve just and sustainable agri-food systems, and on the certainty that a democratic forum is essential to craft alternative perspectives on food and its value to society. Food sovereignty is central to the progressive evolution of food security. Without denying the global interdependence of various plant genetic resources and biodiverse ecosystems in the global food supply, it seeks a change in the control of food from today's globalised network of transnational corporations to smallholder farmers. Empowering traditional farmers through relocating power and influence in the Food Supply Chain is the prerequisite for the reconnection of consumers with their food.

A new concept of sustainability is the result of such an innovative path, which analyses agricultural production as well as food processing, retailing and consumption as part of a big picture, through the lens of true cost accounting. This method permits to underpin the hidden costs of current food systems, in environmental, social, and economic terms. Solutions are envisageable, notably via the empowerment of a human rights approach, which would ensure that both private and public actors be held as responsible for the impacts of

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[346] Anderson M D 'Rights-based food systems and the goals of food systems reform' (2008) 25 4 *Agriculture and Human Values* 593-608.

[347] Ericksen P J, Ingram J S I and Liverman D I 'Food security and Global Environmental Change' (2010) 12 4 *Environmental Science & Policy* 373-377.

[348] Hospes O and Brons A 'A systematic literature review' Kennedy A and Liljeblad J (eds.) *Food Systems Governance. Challenges for justice, equality and human rights* (Routledge, 2016) 18.

[349] Challies E 'The limits to voluntary private social standards in global agri-food system governance' (2012) 20 *International Journal of Sociology of Agriculture and Food* 175-195.

their policies and actions on people, both in developed and developing countries, with particular emphasis on the harmful effects of climate change.

All actors of the food chain are therefore involved: consumers, farmers and civil society organisations, as opponents of the *status quo* and contributors to a more democratic governance; private and public enterprises, as drivers of the shift towards more responsible and sustainable patterns of production and usage of the natural resources; researchers, as advocates for scientific integrity and the realignment of scientific research with the principles of public interest and public good; policy-makers and legislators, as well as judges and all academics, as pioneers of a new legislative and regulatory framework that encompasses the various and multiple aspects of food systems.

As soon as alternatives come to light, the assumption that an ever-more industrial logic is the only viable solution for addressing environmental, social, and health impacts, can be successfully challenged. Overcoming the traditional biases in sectorial policies and aligning governance with the objective of sustainable food system building is possible where citizens collaborate and take shared ownership in the endeavour.

The 'good, clean and fair' approach promoted by Slow Food summarises the challenge of the *Anthropocene*: the production of good food is the fruit of the competence of the producer, the choice of raw materials and production methods. Consumers have to be educated to be able to recognise the value of good food and appreciate it, as it deserves. As Wendell Berry says, 'eating is an agricultural act': consumers orient markets and production with their choices.[350] Being aware of this process, the consumer becomes a co-producer, rather than a mere recipient.

At the same time, the environment has to be respected: not only via sustainable practices of farming and animal breeding, because processing, marketing and consumption should be taken in consideration too. In fact, every stage of the Food Supply Chain impacts ecosystems and biodiversity, which should be protected for the health and well-being of both human and animal species. In this context, social justice should be pursued through the creation of fair conditions of labour, respectful of man and his fundamental rights, and the pursuit of sustainable development and balanced global economies.

In December 2018, Sir David Attenborough addressed the opening session of UNFCCC (COP24) in Katowice, Poland, urging everyone to take personal action against climate change, the decision makers in particular. Urgent and measurable action is required to counteract the disrupting impacts of climate change, if humanity is to avoid 'the collapse of civilizations and the extinction of much of the natural world'.[351] Reforming current food systems is key to success in this challenging task.

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[350] Berry W *The Pleasures of eating* from 'What are People for? Essays by Wendell Berry' (first published April 1990).

[351] Sir D Attenborough 'The People's Address' (Speech delivered in occasion of the COP24, Katowice, Poland, 3 December 2018).

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