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REPORT ON THE IMPACT OF EUROPEAN GREEN DEAL FROM A SUSTAINABLE GLOBAL FOOD SYSTEM APPROACH

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INTRODUCTION

The Triptolemos Foundation is a private institution that promotes the development of the Sustainable Global Food System and contributes with its actions to the optimization of the global food system, to achieve adequate nutrition for the entire population, to improve citizen confidence and to dignify the sector. Its activities are endorsed by the UNESCO Chair "Science and Innovation for Sustainable Development: Global Food Production and Safety".

The Board of Trustees of the Foundation, meeting on February 9, 2021, approved the drafting of a report on the impact of the European Green Deal from the approach of a global food system in a context of climate change. Experts in their various areas and researchers from the 26 universities and the Spanish Research Council from among the members that make up the board were invited to participate.

This report is aligned with the vision of the food system of the Triptolemos Foundation, with the intention of contributing as a member of civil society, to the development of an integral food policy in the EU following the opinion of the European Economic and Social Committee. Each of the 6 chapters contains a short introduction at the beginning. Given the complexity of the topics covered and the number of researchers, a single event may influence several concepts and there may therefore be some repetition with different approaches.

Content

EXECUTIVE SUMMARY

In December 2019, the European Commission presented the Communication on the Green Deal, which outlined an ambitious set of lines of action that should turn the EU into a neutral climate zone by 2050.

The European Green Deal affects food production above all through the strategies "From Farm to Fork" (Farm to Fork - F2F) and the strategy on Biodiversity (European Commission 2020). Both strategies are closely related, since agroforestry or bioeconomic activity necessarily takes place occupying the natural space.

It should be noted that in principle it is unusual that the Commission has chosen to deal with such an important issue through a Communication, so the planned actions are formulated with the ambiguity and generality inherent in such. However, the effects of its future application may be of great importance for all links in the food chain.

This report analyses the impact of the Green Deal from the approach of a sustainable global food system. It considers not only environmental or economic aspects, but also cultural, nutritional, legislative, etc., and it does so with the help of 30 researchers from different specialities.

According to the description made at COP 21 in Paris (2015), corroborated at COP 22 in Marrakesh (2016), and at COP26 in Glasgow (2021), the agricultural sector is a cause of climate change, but it also suffers from it and can contribute significantly to its reduction. The role of agriculture and livestock is strategic, both for food production and for mitigating the impact of climate change.

In principle, the objectives of the Green Deal are relevant to the current challenges of climate change, population increase, scarcity of resources, etc., but the socio-economic risks of an unconditional application of the announced measures, in some cases just outlined, are neither minor nor negligible. For this reason, a prior systematic evaluation (and also a posterior) of these risks and the impact on economic sectors and consumers themselves is required, especially in the case of the most vulnerable. A complication and a counterproductive difficulty that could possibly have been avoided.

In Chapter 1 this report answers the complex question, “Is the EU self-sufficient from a food perspective?” Answering this question has not been easy, it has required analysing the balance between the food energy produced in the EU and the energy necessary to satisfy the population's demand. The results obtained indicate that the degree of food energy self-sufficiency of EU 27 for the period considered is 105%, in the current form of consumption, result that touches the point of equilibrium. This has implications for the Green Deal strategy that, perhaps, could lead to agricultural production that turns the current low surplus of food energy self-sufficiency in the EU, into a deficit that could therefore increase the need to import food from third countries , which may or may not be guided by the same principles determined by the EU in its Green Deal, which is, that "new sustainable policies carry the risk of unsustainable imports", and on the other hand, some exports could even be questioned.

The Green Deal runs the risk of becoming more of a change in forms than in substance of the European agri-food sector, if only a change in the production system is proposed, without making assessments regarding what it may represent in quantitative and qualitative aspects and, therefore, in farmers and associated sectors, especially taking into account the enormous edaphoclimatic and cultural differences between the various countries and regions of the EU. Europe aspires to become a world leader in sustainability and competitivity and to achieve this, the agri-food sector will have to play a crucial role, but the European Commission seems overly optimistic in its approaches, as explained in Chapter 2.

That is why it is considered more necessary than ever to maintain and increase efforts in research, innovation and technology transfer to generate new basic knowledge about the physiology of plants and animals, with the ultimate aim of generating new agronomic, biotechnological tools, agroecological, production, processing and conservation that improve the productivity and resilience of our food systems, as explained in chapter 3.

The EU is a global player in food security matters, and its decisions substantially affect world food trade and the food policies of the rest of the countries. Among these initiatives, the reform of the CAP, which is expected to be applied as of January 2023, and the Farm to Fork Strategy stand out. The first raises a new instrument, eco-schemes to remunerate farmers for the effective, non-abstract and imaginary provision of environmental services. The second raises quantitative goals to reduce the impact of agrochemicals and increase the area dedicated to organic farming in the EU by 2030. The goal is truly ambitious and needs very important support and multiple tools, which make many sectors doubt its viability, as explained in Chapter 4.

It will also be necessary to take into account the governance systems, which should facilitate the implementation of the new strategies, so that there is a real and effective transfer of the new practices to European farmers and fisher, as well as an impact on the different forms of food processing, consumption and waste. Training and proper communication are essential.

The F2F Strategy has a food chain perspective. It not only establishes goals to reduce fertilizers, pesticides and antibiotics and increase organic production, but also goes into the promotion of healthier diets, reduction of losses and waste, in the application of the principles of circular economy and bioeconomy and in the transfer of knowledge. In this sense, it transcends the traditional scope of implementation of the CAP, focused more on the primary sector than on a global approach to the agri-food system. For this reason, the objectives of the Green Deal will not be achieved only by reinforcing the environmental and climatic character of the CAP, but it is necessary that this be accompanied by an ambitious set of actions that affect the food system, in consumption patterns through modifications in diets, in the reduction of losses and waste from production to households and in the generalization of the principles of the circular economy.

The report warns of the risk of a double food system, of aggravating a situation of imbalance as a result of the impact of the Green Deal on the population, considering that 17% of the European population lives in extreme poverty and 40% is overweight, as

explained in chapter 5.
The COVID-19 pandemic has highlighted the importance of a sustainable, robust and resilient European food system. Some studies warn of the fact that the measures introduced by the Green Deal will have a severe impact on current production structures, significantly reducing production and increasing costs. This will have effects on exports, and in turn will have effects beyond our borders, with repercussions both in terms of competitivity and international trade and in terms of food security at the global level, as explained in Chapter 6.

European foods, which have the reputation of being safe, nutritious and good quality, now also aspire to be the world benchmark for sustainability. Citizen expectations are already evolving and causing significant changes in the food market. However, the environmental ambition of the Green Deal will not be achieved if Europe acts alone. The causes of climate change and biodiversity loss are global in nature and not limited by national borders.

In the different chapters and in the conclusions, the Triptolemos Foundation focuses on the impact of the Green Deal from a vision of a sustainable global food system, and for this it has developed a model for its quantification and analysis (ITRIn Index).

CHAPTER 1

Food: Is the EU self-sufficient?
Balance between the energy produced by food in the EU and the energy necessary to satisfy the current demand of the population

There is an open debate on the autochthonous ability of the EU to feed its entire population. Being able to have this quantified information is very relevant data to analyse the proposals and the possible consequences of the application of the Green Deal.

Self-sufficiency in food energy is linked to the concept of sustainability, both aspects must reach a balance that considers, on the one hand, the costs related to the production and supply of food and, on the other, the costs and environmental consequences associated with said activity.

To determine the result of this balance, this chapter calculates the real energy demand of the European population, taking into account cultural and social factors. This includes diet, food waste or the fact that the consumption of certain food, such as meat from intensive livestock, aquaculture fish, dairy products or eggs, supposes an energy consumption of food resources much higher than that provided by the food itself, as well as the food energy supply. This is understood as the capacity of the territory to generate in that same period and from its own food resources obtained directly or indirectly from the use of photosynthesis, energy suitable to be consumed by the population.

It is not easy to answer this question conclusively, but some reflections can be made. First of all, we must take into account the rate of **growth of the European population**, which, in recent years, has been 0.9 million people per year, that is, a growth rate of 0.2% per year. In addition to taking into account, **the caloric consumption** pattern of the inhabitants of the European Union, which may vary depending on the evolution of income per capita and dietary guidelines, increasing or decreasing as it improves or worsens or the average purchasing power of the European population or modification of diets. An additional factor of uncertainty is related to the impact that future EU agri-environmental policies may have on production per hectare and land use.

The Green Deal established by the EU includes the Farm to Fork strategy, which aims to implement actions for a transition towards more environmentally friendly agricultural systems, capable of adapting to climate change and, as far as possible, contributing to its mitigation. A really ambitious goal, clearly aligned to a more than **necessary green transition**, but which raises a series of **challenges and doubts** that should at least be taken into account. One of the many uncertainties raised by the Green Deal is whether this new strategy will allow the maintenance of the productivity of agricultural systems and ensure the caloric needs of a European population that, despite the health crisis caused by COVID-19, does not stop growing gradually.

Let us remember that, in the Farm to Fork strategy, the **following objectives** are established: 1) Reduce the negative impact of pesticide use by 50%, 2) Reduce the use of fertilizers by 20%, 3) Achieve by 2030, organic cultivation of 25% of the agricultural area and 4) Reduce productive agricultural land by 10%. A study carried out by Beckman et al. (2020) considers that the implementation of the Farm to Fork strategy can lead to a **decrease in production** of between 7 and 12%. In the same line the study of the JRC Joint Research Centre (Barreiro-Hurle, J. et al. 2021), study by the Commission's internal scientific service, which predicts that agricultural production will fall by up to 15%.

However, other authors, with a more systematic approach, take into account that in order to meet the nutritional needs of crops and in particular nitrogen, it is necessary to increase the amount of land used for growing legumes (Connor, 2018). This would cause a decrease in the acreage for cereals and therefore a **greater reduction in global productivity** with respect to that estimated by Beckman et al. (2020). Finally, it would be necessary to take into account what the impacts of the implemented measures may be on the **economic profitability** of agricultural holdings and the potential rate of abandonment of an economic activity that may not become profitable for farmers.

The EU's food self-sufficiency is an issue that to date has not been studied with the necessary rigor. That is why the Triptolemos Foundation has recently supported the realization of a study (Gil et al., In the process of publication) which aims to give an answer to this issue with the maximum precision possible. This means taking into account, among others, the following factors:

- Consider not only the basic average energy consumption (kcal) of a human being to survive, but also add the extra energy consumption due to cultural and social factors.

- Include the percentage of domestic food waste generated in EU countries, as well as the losses produced throughout the value chain from farm to fork.

- Add to the demand the additional photosynthetic calories obtain from all food not only from 100% photosynthetic sources. This implies an additional energy cost of transformation, a feed conversion factor, which has also been considered, since direct energy efficiency has been lost (Gil et al., In the process of publication).

- Subtract from the total food offer the alternative uses of products suitable for human consumption.

One aspect that makes it extremely difficult to carry out this type of study, in addition to the challenge of proposing a reliable and adequate methodology, is not having all the necessary, reliable, comparable information and data from official sources (such as Eurostat) at all stages of the value chain, from Farm to Fork. This forces any researcher to make a considerable effort to estimate unavailable information from reliable alternative sources and contrast them with other related variables to ensure consistency (Clotet et al, 2019). The lack of reliable data to carry out studies extends to the precise measurement of the impact of climate change.

Food energy self-sufficiency is understood as the balance between the population's energy demand and the photosynthetic-based food energy supply of a territory in a given period.

In relation to the **demand for dietary energy**, calculation of real caloric needs of the population, not only the theoretical ones must be taken into account. It is necessary to add both the increase derived from cultural and social factors, such as diet, as well as the one derived from the significant percentage of food waste. In addition, this calculation must consider that the consumption of meat, dairy products and eggs from intensive livestock farming, as well as that of aquaculture products, implies an energy consumption of food resources much higher than that provided by the food itself (Gil et al, in progress publication). As an example, to obtain 1 kcal of farmed beef, the animal must consume slightly more than 31 kcal of feed (FAO 1997).

In relation to the **food energy supply**, it must be considered that the basic energy necessary to feed the population comes from photosynthetic production, that is, from the use of solar energy through the direct consumption of vegetables, as well as the consumption of non-vegetable products, for which production only unprocessed natural resources have been needed, such as grasses, pollen, algae, plankton or terrestrial or marine wild animal species. Among the latter would be products derived from grazing livestock (meat, milk, ...), deep-sea fishing, honey, mushrooms, etc. This supply of photosynthetic energy suitable for consumption is diminished by non-food uses of plant products (production of energy, alcohol, textiles, biodegradable packaging, etc.), (Gil et al, in the process of publication).

In our calculations, the EU 27 (excluding Great Britain) has been taken as the reference territory and the years 2017, 2018 and 2019 as the time interval, as these are the last three years for which complete information is available at the time of preparation of this report. We have worked with the average of these three years to statistically neutralize specific anomalies due to meteorological or market causes. Table 1 presents the summary of the results obtained.

Table 1: Food energy self-sufficiency in the EU 27 (2017-2019)

	kcal/person/day
Theoretical caloric needs	2.200
Increase for social and cultural reasons (diet ...)	440
Household food waste	660
Real caloric intake	**3.300**
Additional kcal for consumption of meat from intensive livestock, aquaculture, dairy products and eggs	5.910
Total supply of kcal / person / day	**9.210**
kcal of photosynthetic production suitable for human consumption	11.644
kcal diverted to non-food uses (energy, alcohol, textiles, etc.)	- 1.940
Total supply of kcal / person / day	**9.704**
% dietary energy self-sufficiency (calorie supply / demand)	**105%**

Source: Triptolemos Foundation (Gil, JC et al, 2021).

The results obtained indicate that the degree of food energy self-sufficiency of EU 27 for the period considered is 105%, **a result that touches the point of equilibrium**. Consequently, will European agriculture be able to continue supplying sufficient food in

a sustainable way for its entire population after the Green Deal, if its production / consumption ratio is not changed?

A very specific aspect in the assessment of this self-sufficiency is the role of animal production in a broad sense (intensive livestock, poultry, aquaculture, etc.).The livestock sector and its associated industries, such as feed production and product processing, have established a population in rural areas and have contributed to territorial balance in many European regions, such as Britain, the Netherlands, Catalonia, Denmark, Northern Germany or Lombardy, areas in which over the years knowledge and specialization have been concentrated allowing innovation in genetics, health, management and nutrition, and producing indices that have made Europe competitive worldwide.

Europe does not produce enough plant protein to feed its livestock, especially in these regions, so it has to turn to imports to keep up with demand. The economic importance represented by this sector in the cited regions and the European trade balance, is in contrast to its environmental sustainability, the more successful this activity is, the more livestock manure remains in the territory of the producing regions.

The **livestock and meat sector** must be rethought, through long-term strategic plans. It is not enough to have certificates of sustainability for imported soybeans. It must be possible to adapt to decreasing demands for animal protein, while its production costs increase to ensure that it contributes to the circular economy, to reduce its polluting emissions and to make efficient fertilization practices, but with the responsibility of offering its products to contribute to alleviating food poverty in the world. It is still a conflict that can become dramatic in geographic areas that depend economically on livestock, but also a challenge for the future. That the meat produced can be labelled with the data of the emissions caused by its production can become an element of competitivity in the world market, if action has been taken to reduce them.

All these reflections make us think that the implementation of the Green Deal strategy could perhaps lead to agricultural production that turns the current low surplus of food energy self-sufficiency in the EU into a deficit that could, therefore, increase the need to import food from non-European countries that may or may not be guided by the same principles determined by the EU in its Green Deal, that is, that **"new sustainable policies carry the risk of unsustainable imports."**

That is why it is considered more than ever necessary to maintain and increase efforts in **research, innovation and technology transfer** to generate new basic knowledge about the physiology of plants and animals, with the ultimate goal of generating new agronomic, biotechnological and agro-ecological systems that allow us to improve the productivity and resilience of our agrarian systems. **Governance systems** will also have to be taken into account, which should facilitate the implementation of new agronomic and land-use strategies, so that there is a real and effective transfer of new practices to European farmers, as well as an impact on the different forms of **consumption and food waste**, as will be seen in the following chapters.

In short, the results obtained in the calculation of the degree of food energy self-sufficiency of the EU 27, in the current form of consumption and based on its photosynthetic production, is 105%, which means that the point of balance is almost reached. This should have implications and considerations in the Green Deal strategy.

CHAPTER 2

The Green Deal and the challenges in agricultural production

Sustainability in agriculture should be promoted, as in other areas, from the environmental, social and economic dimension, ensuring agricultural production to guarantee social well-being and make it compatible with optimal environmental preservation in the present without compromising future generations.

This chapter aims to reflect on the different tools available to farmers from the approach of a sustainable food system. The farmer should have access to a wide range of innovative tools and solutions to meet the many challenges he or she faces and be able to choose the practices that best suit his or her specific needs and agricultural and sociological environments. These tools should cover all the possibilities present in nature and the advances of science, under the legal and technical security of the EU regulations and the rigor of the EFSA.

The need for the Green Deal

One of the main factors of change is the accumulation of evidence on the environmental effects of agricultural activity, having now become one of the main factors responsible for exceeding the limits of the planet (Campbell et al., 2017). At the European level, the contribution to the generation of greenhouse gases or the pollution of inland waters, their role in the loss of biodiversity or the potential effects of improper use on health, derived from the use of antimicrobials are sufficiently accredited (EEA, 2019), and require an ambitious intervention to reverse these effects.

The European Green Deal is **the European Union's response to the challenge posed by the Paris agreements on climate change**. It is a courageous proposal but one that represents a radical change in the productive structures of Europe. The forcefulness of some measures responds to the increasingly evident severity of the climate emergency and the unsustainability of many agricultural practices that continue to cause serious environmental problems in many territories, compromising local populations and future generations.

The European Green Deal affects agri-food production, above all, through the strategies "From farm to fork, F2F", (European Commission 2020) and the strategy on Biodiversity. Both strategies are closely related, since agroforestry or bioeconomic activity necessarily take place occupying the natural space.

The European Green Deal is aimed at **transforming the EU into an equitable and prosperous society**, with a modern, competitive and efficient economy in the use of resources, in which there are no net emissions of greenhouse gases and where economic growth is disassociated from the use of resources, in what is called **"growth without economic growth"**. Societies must rethink what is meant by growth and progress and what it means for global sustainability. Europe aspires to become a world leader in sustainability and competitivity and to achieve this, the agri-food sector will have to play a crucial role. The Farm to Fork strategy is essential to achieve the 17 Sustainable Development Goals (SDGs) of the United Nations and the Paris Agreement or the

agreements reached at the United Nations Conference on Climate Change 2021 in Glasgow **(COP26).**

In general terms, the aim is to reduce the environmental and climate footprint of the EU food system and strengthen its resilience, guarantee food security in the face of climate change and the loss of biodiversity and lead a global transition towards **competitive sustainability** that also allows generating new opportunities. In this sense, all citizens and operators of food value chains, both in the EU and in the rest of the world, should be able to benefit from a just transition, especially after the serious effects and economic recession caused by the pandemic of COVID-19.

Unfortunately, to date there is no impact assessment with a systems approach to goals, even though the assessment is a standard EU procedure for the adoption of policies and regulations. Although **there are no exhaustive reports**, to evaluate the impact of the F2F measure we have the work of the United States Department of Agriculture (USDA) that has prepared the first quantitative study of the impact on the EU and world trade and food security (Beckman et al., 2020) and which analyses the impact of the Green Deal on three scenarios. The report (Barreiro-Hurle et al., 2021) commissioned by the Commission itself has also been considered.

Green Deal and agricultural production

Agriculture in 2030 could potentially be very similar to the current situation with improvements derived from technological progress, which are probably similar to those observed historically in the EU, where a technological improvement has been taking place that implies an increase in factor productivity by 1% per year cumulative (Fuglie 2018). But **this improvement in production efficiency is not enough** in the years until 2030.

The Green Deal, and especially the achievement of the different goals set out in the F2F Strategy and the Biodiversity strategy in terms of reducing chemical inputs and increasing the dedication of the area destined for environmental purposes, will require a substantial change in the way of doing agriculture. Moreover, this must be linked to a transformation of the decision frameworks in which farmers and agricultural companies operate.

Agriculture has reached unforeseen levels of productivity and quality, which make it possible to overcome the continuing demographic challenge. However, this has incurred costs. It has focused on intensive land use, with corresponding pressure on natural systems, and on intensive management of water and other inputs with negative effects on the environment and biodiversity. However, the distribution of global agri-food production has been extremely unfair; While 2 billion people are overweight or obese, 800 million are undernourished.

By its very nature, agriculture uses more natural resource inputs per unit of value added than any other sector of the economy, resulting in very significant greenhouse gas emissions. **It is currently the second sector in greenhouse gas emissions in the European Union**, ahead of the industrial sector. For this reason, the Green Deal aims to implement a gradual and irreversible change in European agri-food production to make it more sustainable, minimizing the environmental footprint and more resilient to

possible future changes or crises. Sustainability does not focus only on environmental aspects; it must necessarily guarantee social and economic sustainability, ensuring the livelihood of farmers and the future of rural communities. For FAO (2014), **sustainable agriculture must necessarily:**

(1) Improve the efficiency of agri-food systems.
(2) Increase the resilience of agricultural systems to adapt to extreme changes and events.
(3) Conserve, protect and enhance natural resources.
(4) Protect and improve rural livelihoods, equity, and social well-being.
(5) Promote responsible and effective governance mechanisms.

Nor can it be ignored that, as Megan Clark, director of the Australian national research agency pointed out, "In the next 50 years we will have to produce as much food as we have done in the previous ten thousand years." The natural right to food transcends borders and requires global action, which European agriculture cannot ignored, so that productivity growth cannot be set aside, also as a central objective.

The challenge of modern agriculture is to achieve sustainability through the conjunction of all available traditional, scientific and technological knowledge, ensuring the necessary production for the well-being of the population with all the modern tools available such as sustainable intensification, which can be combined with others according to the socio-ecological characteristics of the territories. **All production systems must contribute to achieving these objectives, from organic to more industrialized agriculture**. Regarding the first, the European Commission is designing an adequate framework to achieve the goal of 25% of agricultural land with organic farming by 2030. There are serious doubts about whether organic farming can feed the entire population, therefore, it is fundamental to address this conversion by relying on other measures such as changes in diet and reduction of food waste, as well as combining organic agriculture with other sustainable, socially and environmentally responsible intensification agriculture with control of its effects on-site (locally) and off-site (regionally).

The Green Deal and farmers

Farmers, agri-food companies and rural communities are called upon to play a key role:

(1) Building a sustainable food system, through the F2F Strategy.
(2) Actively participating in the new biodiversity strategy.
(3) Contributing to the EU net zero emissions target for 2050.
(4) Contributing to a zero-pollution action plan, safeguarding natural resources.

Agricultural professionals fully coincide with the objectives of the Green Deal, they are the most interested in protecting the ecosystem on which their livelihood depends, but they are concerned about the **availability of instruments** to carry it out and the **costs associated** with its implementation. For this they require the continuous support of research, development and innovation. According to a study by the United States Department of Agriculture, the average increase in **global agricultural productivity** in recent decades (of the order of 2.5% per year) **has gone from being based mainly on the increase in inputs to the improvement of Total Factor Productivity** (TFP), closely related to improving the efficiency of the use of these inputs. In the decade of 1961-

1970, in the middle of the Green Revolution, the TFP factor only contributed 0.2% to the increase in productivity, compared to 1.8% per year due to new varieties and the use (and abuse) of fertilizers and other agrochemicals. The continuous and responsible application of knowledge has allowed these values to change drastically in the current decade, reaching increases in production of 1.7% due to TFP in the last decade and only 0.4% per year for the increase of inputs, which according to the latest OECD reports are declining significantly in the most industrialized countries.

Europe is one of the most food-secure regions in the world, **a quarter of Europe's land area is devoted to arable crops** (compared to a world average of 11%), and livestock densities are among the highest of the world.

A recent study carried out within the Joint Research Centre (Bock et al., 2020) explored, through a prospective analysis, the configuration of **12 profiles of European farmers of the future.** These profiles would reflect the multiplicity and coexistence of agricultural business trajectories in response to the diversity of characteristics of agricultural systems and individual farmers, as well as their way of evolving in the face of technological, economic, social and cultural changes. All these profiles of farmers and agricultural companies, this study points out, will in all probability be much more environmentally sustainable, as a consequence of the producers' own motivations, social demands and a stricter regulatory framework.

Chapter 3 of this report analyses how research efforts should be oriented towards increasing sustainable agricultural production and what instruments are called upon to play a key role. The SARS-CoV-2 pandemic has tragically demonstrated to us the **fragility of our society**, as well as the importance of and need for international action to find a solution to a global problem. However, COVID-19 has also served to recover part of the social recognition of the importance of food production, transformation and distribution, which has not stopped even in the most difficult moments of confinement.

To achieve a resilient post-pandemic society, **the role of agriculture must not be underestimated.** In the coming years, it must focus, regardless of the socio-economic or geographical framework in which it is developed, on sustainable agricultural systems and practices that can ensure sufficient production for social well-being while curbing environmental costs.

Some objectives of the Green Deal

Referring to the 2030 time horizon some of the objectives of the Green Deal that can most affect agri-food or forestry activity are:

- Expand protected areas to 30% of the European space.
- Reforest with three billion trees, restore 25,000 kilometres of rivers and reverse the decline of pollinators.
- 50% reduction in the use and risk posed by pesticides.
- Reduction of at least 20% in the use of fertilizers.
- 50% reduction in sales of antimicrobials used in farm animals and aquaculture.
- An increase in organic farming, reaching a share of 25% of the land for agricultural use by 2030, from the current 8%.
- Reduction of 10% of the agricultural area dedicated to productive uses.

• Review of the regulations on animal welfare.
• Strategy to facilitate and increase carbon sequestration in agricultural soils.

Evaluating, in a preliminary way, some of the objectives set by the Commission and their plausibility, firstly, if we analyse the **objective of reducing fertilizers**, especially nitrogen fertilizers, we can see that the origin of this objective lies in the fact that diffuse contamination by excess fertilizer, especially nitrogen, affects 74% of surface water masses that exceed the 2.5 mg N/L target, which avoids eutrophication of water courses.

Part of this problem is due to the **fertilization of crops and part to the management of slurry and manure.** Obviously, this is a complex problem that has not been solved despite the existence of the Nitrates Directive (1991) or the Water Framework Directive (2000), and which it is intended to tackle without further ado. There has been some improvement with a reduction in gross nitrogen per hectare of agricultural area (the difference between nitrogen applied minus **nitrogen** exported via harvest) that decreased by 10% between 2004 and 2010 for the EU as a whole, although it has stabilized since then. A similar evolution has been observed in the nitrogen use efficiency indicator (NUE), which after improving from 1960 to 2010, has stabilized around 60% since 2010. Much of the improvement in NUE is due to the substantial reduction in global nitrogen application (EU scale) that has been substantially reduced since 1990, maintaining or even increasing crop yields; hence the improvement in balance and NUE (fewer inputs and more outputs).

The **circular economy** offers great possibilities to achieve the objectives of the Green Deal, the management of water, energy and organic matter in such a way that cycles can be closed and fewer resources can be used or resources can be reused as many times as possible to make them more efficient. The aim should be to maximize the efficiency of the entire food complex and to recover nutrients and micronutrients from all waste effluents, as well as energy from them.

In a circular economy context, the aim should be to maximize the efficiency of the entire food complex and to recover the nutrients and micronutrients from all waste effluents, as well as energy from these. In this context, the **waste effluent treatment** sector appears strategic for the sustainability of the system. In the event of significant resource recovery from manure, organic waste and sewage, it would still be necessary to improve fertilization efficiency with these recovered products, through precision agriculture practices. It is no longer useful to apply slurry to the field to assume that the nutrients are recycled, it must be fertilized with slurry, modifying its characteristics and measuring how and when the efficiency of the fertilization is maximum.

Biogas produced from all waste effluents in the food chain, and biomethane for injection into the network, or renewable hydrogen, have the advantage of **reducing greenhouse gas (GHG) emissions**, favouring the application of techniques of recovery of nutrients and the possibility of producing synthetic nitrogen fertilizers to replace natural gas (Feliu and Flotats, 2020), but action must be taken to reduce the demand for these fertilizers so that these renewable energy resources can contribute to increasing their contribution to the food sector, where the penetration of renewable energy is still low (Monforti-Ferrario and Pinedo Pascua, 2015).

The European Commission

The European Commission seems excessively optimistic if it intends to improve the efficiency in the use of nitrogen for example up to 70% (achieve the same production with approximately 10% less fertilizers) if we take into account that this indicator has stabilized since 2010 around 60%, this reduction of 10 points being even higher than the efficiency improvement achieved in the last 30 years 1990-2020.

If this improvement (not very credible) were achieved, the desired **fertilizer reduction of 20%** would be partially absorbed by the improvement in efficiency, but even with this technical improvement the yield drop would be between 5% and 10% since the ratio between fertilization and yield is very linear (Schulte-Uebbing and de Vries, 2021).

Referring to the objective of **reducing 10% of the agricultural area** dedicated to productive uses, the rational behaviour of farmers would be for each one of them to abandon the worst lands, and since there is a diminishing marginal yield, this would imply an impact on production that we could estimate at 5% of agricultural production.

The objective of reducing by 50% the negative impact of the use of agrochemicals on production losses is more difficult to assess since some products (e.g. herbicides) can be compensated with changes in agronomic practices (although they will probably mean an increase in costs of another type for farmer and society) while others have difficult substitution. A reduction in production associated with this measure is unquestionable, so the problem must be addressed. Considering that the danger depends on the amount and repeated exposure.

The objective of going from the **organic agriculture quota of the current 8% to 25%** in 2030 is quite ambitious, it requires a radical reconversion of farmers. Organic farming in the EU has grown remarkably, more or less constantly from 6 million ha (2002) to 13.8 million (2019), that is to say about 450,000 ha / year, really impressive growth. 25% of the EU27 area (175 million ha x 25% = 43.7 million ha) means growing at a rate of 3 million ha / year. Reaching the objective proposed by the EU would mean multiplying by 6 the growth rate of organic farming in the last 10 years, totally changing the inclination of the growth curve. The objective is truly ambitious and needs very important support and multiple tools, which make many sectors doubt its viability.

One of the main **restrictions of organic agriculture** is the limited addition of mineral fertilizers, so the adequate supply of nitrogen is a challenge (Muller et al., 2017), for which nitrogen recovery practices and other nutrients from organic waste and manure should be promoted so that they can be substituted for mineral and synthetic fertilizers.

To compensate, land must be allocated to legumes for biological nitrogen fixation (BNF) to supply nitrogen for the growth of non-legume crops, either in situ or in imported manure. Consequently, this implies a smaller area of land available for cereal crops and more significantly, reduces the overall productivity of organic compared to conventional agriculture. Nitrogen fixation by legumes as proposed by organic agriculture would need 2.6 land units to produce the same yield as conventional agriculture (Connor, 2018).

However, in any case, we can focus on two key issues: a) Organic agriculture also generates problems of diffuse contamination by leachates of excess nutrients since it is difficult to go from 70-80% of NUE (Biernat, T. et al. 2020) and b) The available evidence

shows that **the yields of organic vs. conventional are on average 80% of conventional crops** (Ponti, Rijk et al, 2012), that means a drop of 20% that applied to 17% ,increase in future organic agriculture, 25% compared to the current one, 8%, would mean a drop in production of 3.4%. From a system point of view, this should be compensated with different actions such as diet adjustments, waste, among others.

The combination of the four objectives referred to (20% less fertilizers, 50% less agrochemicals, 10% abandoning of land and 25% organic agriculture) according to the arguments evidenced, justifies the USDA estimate of a 12% drop on average in production in the EU as a whole and the estimates in this line from the JRC (Barreiro-Hurle et al, 2021). If we accept as true, never as good, the projections of **reduction in agricultural productivity** of the MAR 1-MedECC (2021 see reference), it becomes even more difficult to understand how it is intended to get food for the European population and export, if considering the data on the evolution of agricultural land and from the type of agricultural holdings in the European context, we see that functional agricultural area and farmers are lost. The European Union lost 27,139,520 ha of agricultural land between 1990 and 2015, together with a **process of land grabbing or concentration in an increasingly reduced number of agricultural companies**, resulting in a situation in which 3% of all European agricultural holdings control 50% of all farmlands in Europe, while the number of **family-type companies in the sector is progressively decreasing** (23% in the period from 2003 to 2020).

Size of farms

It must be considered that the F2F strategy is a challenge, and the additional costs and investments required may lead to a leap in the concentration of the agri-food sector, since **only farms of sufficient size** will be able to consider the change. In addition, the necessary technological advances often lead to oversizing the efficient minimum size of the agricultural company. In this context, the cooperative alternative or long-term win-win agreements between different participants in the food chain can offer the most balanced responses.

On the other hand, specific policies aimed at small proximity farms with value-added strategies will more than ever be necessary. These **farms are essential for territorial balance and the maintenance of rural vitality**. The realization of the various strategies of the European Green Deal will have to take into account the extraordinary diversity of Europe and, therefore, will have to take into account regional peculiarities, from which conclusions apparently contradictory with the general objectives can be drawn.

Sustainable intensification, is it possible?

The Green Deal proposals are aimed at better production which goes hand in hand with the developments offered by agroecology and the most advanced developments in technology. As, for example, the possible obtention of biological pesticides, varieties resistant to pests or diseases or innovations and agricultural practices that reduce or prevent negative environmental impacts, etc. In this regard, the European Commission seems to want to reopen the debate on **genetic transformation techniques**.

The aim is **to produce more efficiently** by optimizing traditional processes and when possible by the environment through precision agriculture that combines advanced agronomic techniques with the support of ICT (remote sensing, big data, artificial intelligence...), producing more through productivity improvements technology and efficient irrigation, in balance with the sustainability of the system will also be necessary to reduce food losses and waste with action throughout the chain, promoting the circular bioeconomy, providing criteria and relaxing some laws that favour it (marketing requirements, preferred date of consumption, etc.).

Finally, as a relevant observation, if, as we say, science and technology are to play a key role, the promotion of R&D must become a top priority, backed by education and communication.

FAO calls this set of measures **"sustainable intensification",** but as Kenneth G. Cassman et al., (2005) warn us, "while sustainable intensification is necessary to address these challenges, it is not enough because success in conserving natural habitat also requires good governance, legal frameworks appropriate land tenure and international agreements to ensure that progress towards sustainable intensification on existing agricultural lands achieves the desired environmental outcomes".

Agroecology (AE) and Sustainable Intensification (SI) are two pathways proposed for transitioning agriculture towards more sustainable models based on good agricultural practices, both aiming to reduce the need for external inputs and reducing the impacts on the environment and public health. Those two approaches are increasingly discussed and often considered as competing paradigms (Bernard and Lux, 2017). Where the main focus of SI is on optimizing the efficiency of large-scale agriculture production while reducing negative environmental and social impacts, AE takes a more holistic approach by considering practical, social and political aspects of sustainable farming systems in the context of the entire food system, including agricultural supply chains and consumers. Although AE is often associated with smallholder farming, there is increasing interest in testing its viability for larger scale implementation.

Sustainable Intensification and Agroecology aim at achieving, among others, food security and reducing negative impacts on the environment. SI has been widely adopted by international research, policy organizations and the private sector, but it was also received with skepticism criticizing its focus on the production-side. In this context, AE is frequently presented as an environmentally sound counterexample, it is also very often questioned if it can scale up sufficiently to feed a growing population (Bernard and Lux, 2017). How do both systems approach sustainable agriculture?

Sustainable intensification (SI), could be summarized in the lemma "Feed the world sustainably" (Bernard and Lux, 2017). Its main objective is to increase agricultural output levels per area unit while reducing natural (e.g. land and water) and synthetic (e.g. fertilizers, pesticides) inputs by using them more efficiently and thereby reducing the

negative impacts on the environment. It is a relatively open concept that emphasizes ends rather than means, and does not pre-determine technologies, species mix or particular design components (Pretty and Bharucha, 2014).

SI includes also agroecological methods and it is open to the inclusion of different approaches. It is subject to a wide range of interpretations. It involves a broader food system, acknowledging that food security cannot be achieved by food production alone and there is a growing consensus that issues such as waste, responsible consumption and distribution need also be considered. By coupling the terms ‘‘sustainable’’ and ‘‘intensification’’, critics accuse SI of enabling greenwashing of agribusiness companies and business-as-usual large-scale industrial agriculture (Bernard and Lux, 2017).

Drastically **reducing emissions** is a challenge that will require high public investment and a greater effort to direct private capital towards action for the climate and the environment, radically avoiding unsustainable practices. The EU must lead the coordination of international initiatives to build a coherent financial system that supports the development and implementation of sustainable solutions.

Produce more with less and ensure food security, nutrition and public health

The need to produce more with less inputs in a sustainable way poses challenges for European agriculture that only innovation can solve, combining multidisciplinary approaches to obtain sufficient food production from agriculture and livestock, in balance with the environment, adopting all innovations in technological and sociological matters available.

But all this must be achieved without losing sight of the fundamental objective of guaranteeing food safety, nutrition and public health at the European level, without forgetting the repercussions at the international level. To achieve this, the affordability of food must be preserved, while generating fairer economic returns in the supply chain, so that **the most sustainable foods also become the most affordable**, fostering the competitiveness of the EU food supply sector, promoting fair trade and creating new business opportunities.

By shifting the spotlight from compliance to performance, European farmers, ranchers and fishers are critical to managing the transition. They are a fundamental part, cause and effect, but they are also the first link in the food chain, which in many cases is the weakest, and more so under conditions of climate change, as shown in the Food section of MAR 1-MedECC (2021).

In adverse and uncertain environmental conditions and with high economic volatility in the markets (Reguant, F. y Savé, R. 2016), water, energy, soil and biodiversity resources are key.

Following the description made at COP 21 in Paris (2015), which was corroborated at COP 22 in Marrakesh (2016), and at the recent **COP26 in Glasgow** (2021), that the **agricultural sector is the cause of climate change, but they also suffer from it and can contribute significantly to its reduction**. Thus, the role of agriculture and livestock is key, both for food production and for mitigating climate change.

The expected yield losses in most crops can be reduced through adaptation strategies, specific and unique for each moment, place, crop and type of product to be produced. Among these, we can cite the diversification of crops, the adaptation of the cultivation calendar and the use of new varieties / clones / rootstock, adapting the markets and the demand. All of this reinforced by adequate training and information for citizens on the need to optimize available resources.

Public policies, through their different instruments -direct regulations, **financial instruments** or information instruments, or their hybrid forms of design and implementation (Blackstock et., 2020) - can influence farmers' decision margins. And they do so not only through the establishment of limitations and standards, but also by creating new business opportunities, such as through the creation of quality schemes (e.g. organic production) or possibilities of payments for the provision of environmental services (e.g. agri-environmental programs of the CAP or conservation banks).

Some studies warn of the fact that the measures introduced by the Green Deal will have a **severe impact on current production structures**, significantly reducing production and increasing costs. This in turn will have effects beyond our borders, with repercussions both in terms of competitiveness and international trade and in terms of food security at the global level.

The **European Union** will have to incorporate corrective measures and promote sustainable intensification practices and policies, including ecological practices of food production, promoting the use of technologies to achieve a balance between production-needs and developing internationally competitive lines of research and innovation. International agreements will also be necessary to ensure that progress towards sustainable intensification on existing agricultural lands achieves the desired environmental results.

The Green Deal could be a good and caring idea

It could be concluded that the Green Deal is a good and kind idea, which will be unrealizable if it is not accompanied by systemic changes, which irrefutably go through education and training in another vital model, more based on people than on the economy, to which should be replaced by indicators such as GDP by the human development index, or other sustainability indicators. There are limits to economic growth, but there need not be limits to human development.

The Green Deal runs the risk of ending up being **more of a change in forms than in substance of the European agri-food sector**, if only a change in the production system is proposed, without making assessments regarding what it may represent in quantitative and qualitative aspects and, therefore, in farmers and associated sectors, especially taking into account the enormous edaphoclimatic and cultural difference of the different countries and regions of the EU.

The EU must use its intrinsic capacities to mobilize its neighbours and partners to join it in an urgent sustainable development strategy in the short term due to the climate emergency and the urgencies of environmental disasters, but long and sustained over

time, accepting the need to preserve its security of supply and its competitiveness, through quality food, safe and respectful with the environment and social conditions. **Europe must take advantage of this opportunity (perhaps the last one) to position itself globally, leading the development of solutions and clean technologies to combat climate change**, while promoting the generation of an agricultural sector producing food in an economically and socially sustainable way and environmentally and competitive.

All this, without losing sight of the fact that **global agriculture** is facing a new climate reality due to greenhouse gases. **Climate change** could affect in an important way the yield in the production of cereals, a basic source of food.

CHAPTER 3

The role of Science and Technology

Proven science and technology must be an engine to achieve the objectives of the "Green Deal" from Farm to Fork. To make decisions and implement strategies, it is necessary to quantify and analyse the impact that the "Green Deal" will have on European agriculture and on the consumer, both on the volume of production and on its costs. On the other hand, if new technologies are not promoted and their impact on the nutrition of the citizen is valued, it will be difficult for the innovations that require the fulfilment of these objectives to be developed.

Globally, the food production system has been very successful as it allows **feeding more than 7 billion people,** but the procedures used are not sustainable and have a **strong negative environmental impact**.

Agriculture occupies more than a third of the earth's ice-free surface and uses about 70 percent of the water extracted from rivers, lakes and aquifers in which there is significant overexploitation. Pollution caused by excess fertilizers and phytosanitary products is carried to rivers, lakes and finally to the sea by runoff, damaging aquatic and marine ecosystems. Soil degradation is taking place in many areas, causing significant reduction in productivity. It is estimated that at least **25 percent of the greenhouse gases** that are emitted into the atmosphere originate in the process of generating food from the field to final consumption. Furthermore, the continued expansion of agriculture to virgin lands is the **main threat to biodiversity.**

It is clear, that **this situation must be changed urgently** to achieve sustainable food production that causes the least possible environmental damage. This requires a huge scientific and technological effort. In this context, achieving the development of an equitable, healthy European food system that respects the environment, that is sustainable and competitive, will require a great research effort and the development of numerous innovations whose application must be accompanied by the appropriate regulatory framework.

The "**Farm to Fork"** (F2F) strategy included in the EU "Green Deal" is characterized by proposing **very ambitious and short-term objectives** regarding the use of chemical pesticides, fertilizers and antibiotics in livestock. It also proposes that by 2030 it should be possible for 25 per cent of the joint agricultural area of the EU to be dedicated to organic crops, to obtain new crops that provide vegetable proteins or to find food proteins in alternative sources such as insects.

It is obvious that reducing plant protection products requires the development of new products and strategies that farmers can use. The F2F strategy is fundamentally committed to integrated pest control to compensate for the reduction of pesticides, which is a good overall strategy. However, the frequent appearance of new pests as a consequence of the importation of plant products and climate change is producing situations for which there are no control procedures, and even some previously existing ones are deteriorating as a consequence of the biological imbalances produced by the climatic disturbances.

The strategies adopted by the EU to reduce the impact of agriculture on the environment impose a drastic reduction in the use of fertilizers, antimicrobial agents and pesticides, predictably accompanied by a decrease in the total cultivated area. Regardless of the impact that these measures end up having on global sustainability, the truth is that the "**Green Deal" strategy will put great pressure on our agricultural production systems.**

The pressing reality is that, today, **our agriculture is not ready for this change**. To adapt to the new situation, we need crops that produce more with less input. We need to develop new and better comprehensive strategies for pest control, adapt our varieties to climate change and we must learn to acquire and process better the data that is generated from farm to fork to optimize the management of the process as a whole. As has been shown on other occasions throughout history, a transformation of these dimensions can only be brought to fruition if it is accompanied by a **great boost to research, development and innovation.**

The need to produce more with fewer inputs in a sustainable way poses challenges for European agriculture that only innovation can solve. The technological advances available today in aspects such as genetic improvement, the development of varieties that are more resistant to diseases and drought or in soil management and fertilization techniques are evident. But in addition to continuing to advance in technological innovation, it is essential to achieve substantial improvements in the **transfer of knowledge**, making these new technologies accessible to farmers.

How should research efforts be directed towards increasing sustainable agricultural production?

A recent report from the National Academies of Sciences, Engineering and Medicine of the United States proposes **five recommendations for agri-food R&D**, which should be put into practice to ensure that farmers continue to provide in an increasingly sustainable way basic necessities to all of society, not only local but global.

Recommendation 1: Prioritize transdisciplinary approaches.
Recommendation 2: Develop new electronic sensors throughout the agri-food chain.
Recommendation 3: Enhance data science and artificial intelligence.
Recommendation 4: Exploit the use of genomics and genetics.
Recommendation 5: Increase understanding of animal, soil, and plant microbiomes.

In general, we can say that the conclusions of this report apply to European agriculture. We must promote cutting-edge research in the agri-food system, without neglecting the role of agricultural extension in supporting the implementation of innovations. This will require **increasing public and private funding**, as well as looking for new formulas to finance agri-food research, renewing interest in food so that non-agricultural professionals are involved in food production, encouraging students and favouring links between the different sciences that support **new transdisciplinary approaches** to food production.

In this context, what instruments are called to play a key role?

There is a consensus on the potential of new information technologies, data science, artificial intelligence, terrestrial and space sensors, and available molecular

technologies, particularly genomics. **All these technologies in an integrated way should reduce the production costs** of healthier agricultural and livestock products, moderating the expenditure on inputs, as well as limiting the presence of pollutants and residues in the environment and in the final products, translating into **greater food safety.**

Specifically, we should promote:

- **Conservation agriculture** or a set of agronomic practices for the management of agricultural soil that minimizes changes in composition, structure and biodiversity, reducing erosion and degradation.
- **The precision agriculture and livestock** that collects, processes and analyses temporal, spatial and individual data and combines them with other information to support management decisions according to the estimated variability, and thus improve the efficiency in the use of resources, the productivity, quality, profitability and sustainability of agricultural production.
- **Precision plant and animal genetic improvement, including new genomic editing techniques**, which allows the development of more productive and resilient genotypes, of quality and nutritional value and with greater efficiency in the use of inputs.
- **Integrated pest control** capable of keeping traditional and emerging species of pests and diseases below the tolerance threshold, exploiting natural factors and using integrated control methods (biological, physical, chemical, etc.)
- **The sustainable management of irrigation water and the food industry**. The multiplying role of irrigation should be recognized in terms of production per unit area, being the only productive alternative in arid or semi-arid climates. Irrigation is undoubtedly a tool against climate change since it prevents deforestation, brings food closer to the consumer, and is the best rural development tool to the extent that it maintains the population in the territory. At the same time, aquifer management must be improved to ensure the availability of quality water to future generations.
- **The management, treatment and valuation of agricultural, livestock and agro-industrial waste** in tune with the demands of the circular economy.
- **The development of the bioeconomy** that allows expanding the catalogue of crops, incorporating new foods and functional ingredients, new raw materials, with high added value, for medicinal or industrial use, as well as the production of sustainable biomass for energy.
- **The introduction of modern carbon markets** that can fairly reward farmers for sequestering carbon.
- **New food processing technologies** to develop new valuable products for the industry and the consumer.

The necessary multidisciplinary approach

Our scientific system can and must provide solutions, and for this the involvement of practically all scientific disciplines is needed, without renouncing any, from environmental engineering or econometrics to data science, through genetic improvement and biotechnology. The use of scientific advances thus becomes a sine qua non condition to achieve success in the transformations proposed by the "Green Deal".

But this collective effort in innovation will only bear fruit if it is freed from **apriorism and ideological prejudice**. This in no way means giving up supervision of the ethical values associated with R + D + I (Research + Development + Innovation). **Responsible innovation** is that which embarks on transparent projects, with legitimate objectives that respond to properly identified social challenges and whose risk-benefit ratio is duly weighed.

Technologies allied to the "Green Deal"

It is necessary to underline the importance of having increasingly powerful and precise technological tools that facilitate the adaptation of crops, including our traditional varieties, to new production scenarios. For example, such is the case of **CRISPR genetic editing and others,** the highest precision genetic improvement technology that humanity has ever had, and which opens up enormous prospects to provide our plants with new characters to face the challenges of climate change. These new technologies are allies of the "Green Deal", and as such, we must incorporate them into the arsenal of tools with which to face the challenge of sustainability. In addition, we have to do it without more regulatory restrictions than those that are required of other commonly used techniques and which have less precision and safety.

At the **crossroads of climate change**, the decisions we make today on the scientific and technological paths to follow in support of European agriculture, will greatly determine the sustainability and food security of our continent in the future. Scientific evidence has been shown, in many areas, to be the best guide to our supply for making important decisions, and we must not do without it for the design of a sustainable future in Europe.

We have to bear in mind that **we only have agricultural products that have not been devastated by pests**. The F2F strategy also proposes the drastic reduction of food waste. According to the FAO, in the EU a third of this waste is produced once the food has reached our homes. Consumers, producers and distributors must design strategies to avoid this. However, the other **two thirds of food waste** are produced either because we do not have the appropriate varieties, or we do not use them, or because crops are produced under adverse conditions derived from climate change. Harvests also decline due to the action of pests or attack by pathogens such as viruses, fungi and bacteria which, in turn, are also develop emerging diseases due to global change and the mobility of people and goods. Losses occur during post-harvest, food storage or transportation or as a consequence of unintelligent production strategies that lead to the disposal of crops because their marketing value does not compensate for production costs.

Today's agriculture, with its advantages and disadvantages, is capable of feeding a world population of more than **7 billion people**. For this, we have managed to put on the markets harvests of more than 3,000 varieties of plants obtained from about 200 plant species.

The plants we eat have undergone genetic modifications. Genomes are subject to spontaneous mutations inherent in their own nature. During a growing season a soybean plant will spontaneously develop about 16 mutations or a tomato plant, 13. Some of these changes can be useful if they translate into a favourable character and we will select them for future improvement programmes. We have also learned to increase the number of mutations and, therefore, the probability that favourable changes will occur, using chemical or physical agents on the seeds. This way that the variability of the seeds together with sexual hybridization, which makes it possible to try to combine the desired characteristics of the parents in the progeny, has become the main instrument for improvement. As in the sexual crossing the characteristics of the parents are randomly mixed, it is necessary to resort to successive backcrosses which means that the time necessary to obtain a new improved variety is over ten years.

At the end of the last century, techniques for the genetic transformation of plants were developed that allow the introduction of genes regardless of sexual interbreeding. Breeders can introduce genes isolated from other species that do not hybridize to them, or genes isolated from microorganisms, into crop plants. The transgenic and commercialized crops worldwide in 2020 occupy an area greater than **190 million hectares** (about four times the area of Spain). They consist, fundamentally, of corn, soybean, rapeseed and cotton plants that incorporate microbial genes that confer resistance to diseases such as corn borer, since the transformed plants are capable of manufacturing small amounts of their own insecticide, or tolerance to the herbicide action. This allows improvement of the management of crops in a more sustainable way through direct sowing, which reduces soil losses due to erosion and energy consumption from tillage, in addition to avoiding the use of pre-emergence herbicides. When the use of hybrid crop plants is combined with resistance to insect attack, **the desired sustainable production goals are achieved, producing more while using less.**

Since 2014, research works have been carried out that account for the use of genomic editing technologies to obtain new varieties of crop plants with an increase in weight or the number of seeds or fruits (rice, tomato, rapeseed or wheat). Grape, cocoa or wheat varieties resistant to fungi have been obtained, as well as cucumber or potato, resistant to viruses; bacteria resistant oranges, grapefruits or tomatoes or new drought tolerant varieties of soybeans and corn. Soybean, groundnut and rape seed varieties with an improved fatty acid composition or tomato varieties with high lycopene or GABA content or wheat with reduced gliadin content have also been produced.

These scientific advances have **enormous potential to obtain varieties with higher production and better adapted to climate change**, by introducing resistance to high temperatures and drought, improving the efficiency of water use, reducing the consumption of fertilizers and phytosanitary products, resistant to pests and emerging diseases with improved nutritional value.

The **benefits of these technologies could help to achieve the objectives of the "Green Deal".** This has been understood by many countries that have already gone ahead to distinguish from a regulatory point of view the different genomic editing procedures. Beyond the published scientific advances, the United States of America has already approved the marketing of mushrooms that have had a gene for the polyphenoloxidase enzyme edited, mushrooms that do not brown on the sales shelves or in the homes of consumers or a healthier soybean oil that eliminates trans fats by editing its fatty acid desaturase enzymes. Japan has given the green light to the marketing of edited tomatoes with high GABA content with beneficial effects associated with keeping consumers' blood pressure low.

The **European Commission**, in its report of April 29, 2021 **recognizes the limitations of current European legislation to follow the pace of scientific advances in the field of genomic editing**, as well as the fact that the legislation in force could be inadequate to regulate some types of applications based on these technologies. It also recognizes that these technologies could help to achieve the objectives of the EU "Green Deal" and urges a possible modification of the legislation in force. In an international context, it would also be urgent to achieve a conceptual and regulatory harmonization of the definition of transgenic crops and the products obtained through genomic editing.

In addition, we will have to have varieties capable of producing more, using less resources, if we want **to compensate for the foreseeable decrease** in productivity from organic farming. It should also be borne in mind that the agriculture promoted by the "Green Deal" presents doubts regarding the hygienic and sanitary safety of production, for example, the crises of organic food bacterial contamination of fresh spinach from the USA in 2006 and that of the “cucumbers” in Germany in 2011, undoubtedly specific, but not for that reason, less certain.

On the other hand, the **digitalization** of all production processes and particularly their application to precision agriculture should allow the reduction of the application of fertilizers and pesticides without reducing production. However, these procedures are in very early stages of implementation and will be difficult to adapt to Mediterranean agriculture, mainly fruit and vegetable, due to the small size of the farms, although it should not be ruled out that a reduction in costs allows their profitable application on a small scale. To avoid these situations and to produce more food in a sustainable way, we must be able to obtain varieties of crop plants with increased capacities. The strategies that include the digitalization of all the production processes of the food supply chains or the use of precision agriculture, together with the genetic improvement of plants must be the best allies of the "Green Deal".

Loss of agricultural land

If the projections of reduction in agricultural productivity of the MAR1-MedECC (2021), are taken as true, although never as good, it becomes even more **difficult to understand** how it is intended to get food for the European population and export. If the data on the evolution of agricultural land and from the type of agricultural holdings in the European context if considered, we see that functional agricultural area and farmers are lost.

Between 1990 and 2015 the European Union lost 27,139,520 hectares of agricultural land, together with a process of land grabbing or concentration in an increasingly reduced number of agricultural companies, resulting in a situation in which 3% of all European agricultural holdings control 50% of all land cultivation in Europe, while the number of companies in the family-type sector is progressively decreasing (23% in the period from 2003 to 2020).

The role of the food industry

The optimization of the associated agri-food industry has to be considered with new performance indices, due to a lower input of inputs from the field, a greater need to reduce waste, water and energy consumption (water and carbon footprint), a very high level of food safety (chemical and biological controls). Again, science, technology and common sense are the key to producing the functional change in this strategic sector (storage, transformation, processing, transportation, generation of by-products, etc.).

The strong communicative impact on aspects of primary production has left research in food transformation and preparation processes by the food industry in second place. In many cases **agricultural products need to be transformed for consumption**. It is essential to promote research into processing technologies towards safer and more sustainable ways, while maintaining the nutritional and sensory qualities of the products at source. Conservation technologies in any of their forms are essential so that every citizen and, in any circumstance, can have adequate food, considering that the distance between production areas and consumption areas must be reconciled, bearing in mind **the growing trend towards the concentration of the world population in urban areas.**

However, the incentive towards the consumption of "fresh and less processed foods" leaves the food processing industry in a compromised position, and imposes a certain limit to meet the demand for "food à la carte" for food needs, specific population groups, communities, etc. This aspect should be complemented with adequate training and information for citizens on technologies, security and guarantee of supply in urban concentrations.

Much effort and money are being invested in multidisciplinary research in the area of "functional foods" with very promising results, but its role within the framework of this strategy is not clear. Many of these foods, especially those of plant or marine origin, can be obtained profitably through sustainable practices (recovery of by-products and waste, green chemistry, under-used raw materials, etc.), **potentially putting the EU in a very highly competitive position in the international market** for this type of product. In this context, there is also a lot of scientific knowledge to reduce the health risk of excessive consumption of red meat, applying strategies that go from the primary productive sector to the reformulation of healthier meat products.

The review of the legislation and regulations of expiry dates and preferred consumption dates **to avoid food waste is a notable action of this strategy**, although the relaxation of consumption limits may entail a certain risk due to an unforeseen growth of pathogens, augmented by the recommendation to reduce the use of pesticides and antimicrobials.

The investment for the research and application of additives and natural antimicrobial and antioxidant ingredients in food together with clean processing and packaging technologies, as well as the promotion of knowledge of biomarkers and the use of intelligent quality control and packaging systems in the food industry are key pieces to achieve safer sustainable food with a longer shelf life, which can become competitive in long-distance international trade.

From a scientific point of view, the global objectives of the F2F strategy are essential to achieve a sustainable food production system with minimal negative environmental impact. However, **many of the technologies required to achieve them are not yet available.** Consequently, the creation of a new global food production system, in its primary stage of obtaining food energy through photosynthesis, requires great research efforts to achieve novel scientific knowledge and its application for development and implementation of many new technologies. In addition, it is essential that the legal framework allows the use of the new improvement procedures.

The transition to more sustainable models: an opportunity

The transition to sustainable food systems also offers a great economic opportunity for farmers, fishers and stock breeders, as well as for food processors and food services. This transition will allow them to be pioneers integrating sustainability as part of their brand and guarantee of the future. In this environment, science and technology must play a key role and the promotion of R&D must become a top priority in order to achieve the objectives of the “Green Deal”. The EU should maintain its leadership.

CHAPTER 4

Legislation and food safety

The EU has to continue to be an international benchmark for food law. Food security has to consider the nutritional needs of the population and the economic resources of the citizen, ensuring access to safe and healthy food. Community policies on food safety have to safeguard the protection of these rights in an increasingly complex food system.

This chapter aims to analyse, in the Green Deal environment, the role of competent and reference bodies and institutions that regulate and establish limits on the use of ingredients, as well as phytosanitary products and additives, aimed at preserving food safety and the health of the citizen throughout life. The regulation is based on the rigorous analysis of scientific evidence provided by the scientific community. Their work has to be specified in the EU regulations once the risk has been assessed with the participation of all the parties involved and with the prevalence of public interest. Science is not static, it constantly updates its knowledge, and once its hypotheses have been contrasted and verified, they are incorporated into national and international regulations. This correct legislative harmonization is a very important aspect of the success of the Green Deal.

In December 2019, the European Commission presented the Communication on the Green Deal, which outlined an ambitious set of lines of action that should turn the EU into a neutral climate zone by 2050.

In principle, **the objectives of the Green Deal** are relevant to the current challenges of climate change, population increase, scarcity of resources, etc., but the socio-economic risks of an unconditional application of the announced measures, in some cases barely outlined, are not negligible or insignificant. For this reason, a **systematic prior** (and also post) **evaluation** of these risks and the impact on economic sectors and consumers is required, especially in the case of the most vulnerable. This is a complication and a counterproductive difficulty that could possibly have been avoided.

The Green Deal: a unilateral communication from the EU

It should be noted that in principle **it is unusual** that the Commission has chosen to deal with such an important issue through a Communication and not following the usual “Green Paper - White Paper” method that has produced such good results to date.

Using a unilateral Communication, which according to reiterated jurisprudence of the CJUE only obliges the Commission itself, represents a setback in the progressive advance of participatory democracy that allowed the interested parties (stockholders) to intervene and comment on the proposals initially formulated in a "Green Book".

The importance and possible impact that the Commission foresees in the face of these measures, made this ex-ante participation essential.

As it could not be otherwise, **the projected actions are formulated with the ambiguity and generality inherent in a Communication**. However, the effects of its future application may be of great significance for all links in the EU Food System. In this sense, it cannot denied that these effects are not only negative for the economy, but also incompatible with the basic principles of the Treaty, or even in relation to the articles of the Charter of Fundamental Rights of the EU; in which case the intervention of the European Union Agency for Fundamental Rights would be unavoidable.

Likewise, the application of the "Last in- First out" (LIFO) principle, which means that the approval of a new regulation must entail the annulment of a previous one, is expected and recommended in the appearance of new regulations.

The "Farm to Fork" strategy and the CAP

Within this framework of the Green Deal, various initiatives have emerged, including the Farm to Fork strategy (F2F), which transfers to the agri-food sector the guidelines of the Green Deal measured in **quantitative goals to be achieved in 2030**. Previously, in June 2018, the reform process of the Common Agricultural Policy (CAP) for the period 2023/2027 had begun. The objectives and implications of the Green Deal and the F2F strategy, while having effects, go beyond the current CAP and possibly also mark the evolution of future CAPs. However, this does not imply that it is not necessary for it to be climate ambitious and to incorporate elements that make it possible to reverse trends and achieve substantial emission reductions, starting a path that allows meeting the 2050 goals.

The F2F strategy has a **food chain perspective**. It not only establishes goals to reduce fertilizers, pesticides and antibiotics and increase organic production, but also goes into the promotion of healthier diets, reduction of losses and waste, in the application of the principles of circular economy and bioeconomy and in the transfer of knowledge. In this sense, it transcends the traditional field of implementation of the CAP, focused more on the primary sector than on a global approach to the agri-food system. That is why **the objectives of the Green Deal will not be achieved only by reinforcing the environmental and climatic character of the CAP**, but this will have to be accompanied by an ambitious set of actions that will affect the agri-food system, in the habits of consumption through modification in diet, in the reduction of losses and waste from production to households and in the generalization of the principles of the circular economy.

If we focus on the primary sector, the CAP reform introduces some elements that can help start the path towards this neutral climate scenario. They represent an opportunity that must be seized and tackled with ambition. Changes in production systems are required through precision agriculture techniques, making them more efficient in the use of inputs in order to reduce emissions, and modifications of these production systems, with the increase of ecological productions and introduction of principles of agroecology. There is no single solution and these must be adapted to the sector and territory.

It must be born in mind that the ecological transformation of production systems and the adoption of more sustainable practices will not be achieved only by political will, but that **the activity must be profitable**. It is difficult for farmers to assume environmental commitments if the remuneration they obtain is not adequate and if the quality of life in rural areas is not comparable to that in urban areas. For this reason, the environmental and climate action of the CAP cannot be approached without simultaneously considering the **economic and social objectives** that are also included in the strategic plan. The measurements of the CAP that help to strengthen the position and bargaining capacity of farmers in the value chain, to strengthen crisis management mechanisms, to improve living conditions or to facilitate the adaptation of production to non-demand, must not be considered independently of environmental and climate measurements aimed at reducing emissions from the sector.

What instruments of the future CAP can impel these changes?

The legislative proposals of the European Commission on the Common Agricultural Policy (CAP) for the period 2023-2027 aim to continue to provide strong support to European agriculture, promote the prosperity of rural areas and produce quality food, as well as make a significant contribution to the Green Deal. This is especially important within the framework of the from "Farm to fork" and the Biodiversity Strategies, establishing as general goals the equitable treatment of farmers and a stable economic future. This will provide more ambitious protection for the environment and climate change to that established in the 2014-2020 period, as well as maintaining the primary place that agriculture occupies in European society. To achieve these general goals, the Commission has established the specific objectives shown in Table 2.

Table 2. Key objectives on the Common Agricultural Policy (CAP) during the period 2021-2027

Objective 1	Support a viable farming income and the resilience of the sector throughout the EU to improve food security.
Objective 2	Increase agricultural competitivity and productivity in a sustainable way to overcome the challenges arising from increased demand in a world characterized by scarce resources and climate uncertainty.
Objective 3	Improve the position of farmers in the chain of value.
Objective 4	Contribute to the mitigation of climate change and adaptation to its effects, as well as to sustainable energy.
Objective 5	Promote sustainable development and efficient management of natural resources such as water, soil and air.
Objective 6	Contribute to the protection of biodiversity, enhance ecosystem services and conserve habitats and landscapes.
Objective 7	Attract young people and improve their business development to modernize the agricultural sector.
Objective 8	Promote employment, growth, social inclusion and local development in rural areas, including sustainable bioeconomy and forestry.
Objective 9	Improve the response of EU agriculture to social demands for food and health, especially in relation to safe, nutritious and sustainable food, the reduction of food waste and the welfare of animals.

Source: European Comission (2018)

Among the key objectives, the strengthening of organic farming appears as a transversal measure, as was the case in the 2014-2020 CAP, which aims to promote changes in agricultural practices that entail a positive contribution to the production of quality food and food safety, the environment and the climate, sustainable development and efficiency in the use of natural resources, their reuse and the reduction of waste generated, within the framework of the circular economy and the bioeconomy.

The future CAP requires the preparation of strategic plans to achieve 9 objectives, of which three are environmental and climate, action against climate change, protection of the environment and conservation of the landscape and biodiversity. To achieve this, a new environmental structure of **direct payments** is introduced, with the reinforcement of conditionality, new voluntary payments for the climate and the environment (eco-schemes) within Pillar 1 and agri-environmental and climate payments in Pillar 2. Of these the most innovative instruments are **eco-schemes** to the extent that they introduce support for more sustainable practices (such as the introduction of improved species that reduce the need for fertilization or extensive livestock) that are sufficiently general to allow a broad territorial coverage. Along with them, agri-environmental payments allow the introduction of solutions more adapted to local conditions. The success of this new orientation will depend on the budget allocated to these measures, both on the proportion of the global budget that must be allocated to climate and environmental measures and on the proportion of direct payments that must go to eco- schemes. **There are no ambitious policies without adequate budgets.**

The CAP also plays a fundamental role in this regard, because through it, it is planned to establish incentives and bonuses that reward those farmers and producers who meet sustainability requirements, for example by contributing to the capture of carbon in soils, dedicating land to organic farming, investing in the transformation of agricultural waste into biogas or using technological or artificial intelligence systems that promote a more rational use of water or other resources.

These highly ambitious environmental and sustainability objectives undoubtedly pose an enormous challenge to transform the productive, economic and social environment. In addition they cast a doubt as to whether it is possible for the EU to maintain its leading position in world food production and export while meeting the objectives set out in the "Green Deal". For this reason, it is essential that these requirements are accompanied by instruments of technical and financial assistance from the EU, such as cohesion funds and the European Regional Development Fund (ERDF), which will contribute to making this transition fair and competitive and the transformation of the economic fabric of the EU regions that may be most affected by these measures.

The EU 'farm to fork' strategy **is an opportunity** to improve livelihoods, health and the environment, by providing healthy and sustainable diets for consumers. The challenge is the adoption of this policy by the EU between now and 2050 and temporarily, until 2030. The question is whether the transitional period of 8 years will be sufficient or will be extended for a few more years. What does seem to be clear is that the programme is ambitious and that the EU is determined to carry it out.

The Farm to Table strategy and EFSA

It is the responsibility of the **European Commission**, as an executive body within the organizational scheme of the European Union, to guarantee the highest levels of food, animal and plant safety to its citizens through regulation and the establishment of recommendations, as well as the surveillance of the internal market.

In 2000, for the first time the White Paper on Food Safety applied an integrated approach from "Farm to Fork" that involves the main participants of the food chain, such as primary production, the processing industry, the consumer and the administration. In addition, the White Paper served as a catalyst to restore **consumer confidence** in the control systems of the food chain after the food crises of the 1990s, mainly the so-called mad cow crisis (bovine spongiform encephalopathy). Subsequently, this initiative led to **Regulation (EC) 178/2002 of the European Parliament** and of the Council of January 28, 2002, which established the principles and general requirements of food law, creating the European Food Safety Authority (EFSA) and procedures related to food safety were established. It is important to highlight that the agri-food industry is one of the most relevant and work-generating industries in the EU. Citizens have the right to know how their food is produced, processed, packaged, labelled and marketed.

Regulation (EC) 178/2002 establishes a common basis for the measures governing food law both at EU and at national level. Among other things, it establishes that food legislation must be based on a risk analysis, unless it is not considered appropriate due to the circumstances or the nature of the measurement. The Regulation also defines risk analysis as a process made up of three interrelated elements: risk determination, risk management and risk communication. In 2002, the **European Food Safety Authority** (EFSA) was created as an independent and decentralized body responsible for determining risk in terms of food and animal feed safety. The implementation of the Regulation also contemplates the creation of a Standing Committee on Plants, Animals, Food and Feed (CPPAFF) that will be in charge of proposing the regulations, guides and interpretative notes on the matter and can only be executed if they have previously obtained a favourable vote from the qualified majority of the member states meeting in the Committee. The CPPAFF has a multitude of working groups made up of national representatives and experts proposed by the member states to provide independent scientific advice.

The White Paper on food safety served to establish a new vision of food legislation for the 21st century, making it more coherent, complete and updated as regards necessity. From that moment on, it can be considered that the **food sector** became one of the sectors with the **greatest regulatory weight** in the EU. The member states understood that food safety knows no borders and scientific cooperation between parties and countries is crucial at all levels (competent national authorities, industrial organizations and scientific communities).

In very general lines, European food law not only provides legal support to public authorities, such as EFSA, but also requirements to agri-food companies about their products, processes and labelling, as well as integrating the interests of consumers. To carry out this task of integrating food safety in the EU and with the ultimate aim of protecting the health of citizens, the **General Directorate of Health and Food Safety** (DG-SANTE) has structured different actions, which can be summarized as follows:

i) Strengthen the implementation of systems for **monitoring and evaluating** compliance with EU standards in the sectors of food safety and quality, animal health, animal welfare, animal nutrition and plant health within the EU and in non-EU countries. EU in relation to its exports to the EU.

ii) The management of **international relations** with non-EU countries and international organizations in matters of food safety, animal health, animal welfare, animal nutrition and plant health.

iii) Establish a science-based **risk management** system such as that developed by EFSA. The advice that EFSA provides to risk managers enables them to endorse EU laws and regulations, as well as anticipate evolving political priorities and needs, to protect European consumers from food-related risks.

EFSA is the key pillar in EU food safety

EFSA offers scientific advice and scientific-technical support in risk assessment to support risk managers regarding the safety of food and feed marketed in the EU. Since 2002, EFSA has played a relevant role in the latest crises (e.g. dioxins, benzopyrene, acrylamide, melanin, E. Coli outbreaks, etc.). These alerts are well documented and allow **rapid communication between member countries** through the food and feed alert system, called **RASFF** (Rapid Alert System for Food and Feed). Information is shared between competent authorities and companies, in addition to granting enforcement powers to public authorities. RASFF is a network for the exchange of information on direct or indirect risks to human health derived from food or feed. The RASFF system involves the Member States, EFSA and the European Commission, but can be extended to third countries and international organizations, being the EU contact point that participates in the Network of International Food Safety Authorities (INFOSAN) operated by the World Health Organization (WHO).

In short, **the EU has legislative and regulatory instruments** on agriculture, livestock, production and processing of food produced in or imported into the EU **to protect the health of consumers** by acting on food hygiene, animal and plant health, and establishing maximum limits produced in or imported into the EU for contaminants and residues in food and feed. EFSA is supported in its food safety management by national food safety agencies.

It is important to stress that **European food legislation on food safety** provides instruments to deal with incidents and emergencies related to food safety. Information is shared between competent authorities and companies, in addition enforcement powers to public authorities are granted.

The EU, through EFSA, must be prepared to face major social changes related to climate change, migration and the availability of food. FAO already defined food security in a broader way in 1996 that not only encompasses food safety, but also integrates food accessibility. In this way, food security is defined by FAO “as the physical and economic access of all people and at all times to sufficient, safe and nutritious food, in order to satisfy their needs and preferences in terms of food in order to lead an active healthy life” (FAO, World Food Summit, 1996).

In this sense, **EFSA aligns itself with the Green Deal** in its renewed Farm-to-Fork (F2F) strategy for a fair, healthy and environmentally friendly food system in terms of guaranteeing food safety, nutrition and public health. However, the objectives of the European Green Deal in terms of preserving affordability and access to food, promoting the competitivity of the agri-food sector and sustainability of production and consumption by reducing waste, reducing emissions that generate environmental impact, promoting fair trade or reversing the loss of biodiversity, **are not direct responsibility of the EFSA**, although their actions may directly influence this. The COVID-19 pandemic has highlighted the importance of a sustainable, robust and resilient European food system.

Although EFSA's main mission in the safety of the food chain has remained unchanged since its creation in 2002, it has been adapting to the needs and changes in the European regulatory environment where it operates, so it cannot escape the challenges presented by the roadmap of the European Green Deal to provide the EU with a sustainable economy.

One of EFSA's vital activities is the use and exchange of resources, data and experiences in assessing current risks and identifying emerging ones. As such, EFSA does not have scientific laboratories and its task is **to compile existing scientific knowledge and provide the risk manager with sufficient scientific evidence** to support a risk management decision such as regulation. For this purpose, it is nourished by an extensive network of participants in scientific cooperation, which includes the Advisory Committee, the national focal points that engage the collection and transfer of information, scientific networks, collaborating organizations included in the article 36, the EFSA expert bases and the EFSA scientific committee panels. The result of the scientific report on the evaluation of the consultation is approved by the Panel of experts in one of its plenary sessions and will normally be classified as scientific opinion, but it can also be a declaration, a guidance document or another type of document that will be published in the EFSA Journal for public access.

In general terms, the **10 EFSA thematic panels** cover its areas of action and are: animal health and welfare panel (AHAW), biological risks panel (BIOAHZ), food chain contaminants panel (CONTAM), food additives and flavourings panel (ANS), food contact materials panel, enzymes and technological aids (CEF), genetically modified organisms (GMO) panel, dietary products, novel foods and food allergens panel (NDA), plant health panel (PLH), plant protection products and their residues panel (PPR), additives and products or substances used in animal feed panel (FEEDAP).

Recently, Regulation 178/2002 has had a new impulse with Regulation (EU) 1381/2019 of the European Parliament and of the Council of June 20, 2019, on the transparency and sustainability of the **determination or evaluation of risk in the EU in the food chain.** The standard expressly mentions that it is necessary to guarantee that risk communication is transparent, continuous and inclusive throughout the risk analysis, involving the Union and national risk assessors and managers.

Risk communication should reassure public confidence that the fundamental objective of all risk analysis is to ensure a high level of protection of human health and the interests of consumers. Risk communication must also be able to contribute to a participatory and open dialogue between all stakeholders, to ensure that the prevalence

of the public interest and the accuracy, completeness, transparency, consistency and accountability are taken into consideration in the process of risk analysis.
Specifically, the **EFSA in its 2020 strategic plan** "Trusted science for safe food Protecting consumers' health with independent scientific advice on the food chain "**has identified a series of potential regulatory gaps** where more collaboration is needed, being; i) relationship between pesticides and pollinators, ii) effect of climate change, iii) substitution of experimental animals for predictive models, iv) human data, v) microplastics, vi) transmission vectors, vii) management of big data and artificial intelligence, and viii) exposure to multiple chemical agents.

In EFSA's strategic plan, **action is proposed in specific areas**. Firstly, to continue advancing in the improvement of food security but together with alternative and sustainable production of food systems, in this way maintaining **EFSA's proactive vision** in risk assessment, anticipating the impacts that innovation may have on food production and food systems and also considering the benefits (risk / benefit and risk / risk assessment). A final area of action is to continue innovating in risk assessment where there is less dependence on animal experimentation, which presents problems of ethics and reproducibility, to take better advantage of artificial intelligence and the construction of predictive mathematical models.

European legislation on food safety should be based on the work of the European Food Safety Agency (EFSA). The permitted doses or limits (**Admitted Daily Intake-ADI**) are calculated and reviewed based on an average European diet. This results in prestige and international recognition in terms of safety of the food produced in Europe.

An example of lack of coordination between scientific and legislative evidence in the EU

The regulatory issue of new genomic editing technologies is an example of lack of coordination between scientific and legislative evidence in the EU. In practice, breeders need to have technologies that allow them to achieve the proposed objectives, for example, those of the "Green Deal", and they also need the use of these technologies to be regulated in a way that makes them accessible and viable.

The regulation of transgenic crops is subject to the European Directive 2001/18 / EC (Directive 2001/18 / EC, Regulation (EC) 1829/2003, Directive 2009/41 / EC and Regulation (EC) 1830/2003) which was approved in accordance with a so-called precautionary principle that addressed some supposed dangers that its consumption could have for the health of consumers and for the environment. **These dangers have not materialized** in more than twenty years since this Directive has been in force. However, the restrictions it imposes have hampered scientific research and entrepreneurship in the European agro-biotechnology sector. **This Directive hinders transgenic crops in the EU but does not prevent huge quantities of their products,** which are essential today, to feed European livestock **from being imported.**

In July 2018, the High Court of Justice of the EU (Case C-528/16), ruled that the use of plant varieties obtained through genomic editing must be regulated in accordance with the Directive that regulates transgenic crops. The use of genetic engineering techniques in genome editing procedures was probably decisive in this ruling, and although it is true that such editing technologies can also be used to introduce genes into specific places

in the genomes, in which case we would speak of new transgenic crops, it is also true that mutagenesis directed by genomic editing does not involve the introduction of foreign genes into plants, while at the same time it is a very valuable tool for improvement.

New varieties must be evaluated for what they are, not how they have been obtained. It does not seem reasonable that two varieties with an identical mutation are regulated differently. The mutations of the new varieties are subject to traceability procedures through the sequencing of their genome, but not regarding the technology used to obtain them. From all this the convenience of separating the use of directed mutagenesis techniques by genomic editing from regulation by Directive 2001/18 / EC is deduced. Incidentally, this was approved many years before the development of genomic editing techniques.

The scientific community of the EU under the initiative called EU-SAGE has requested the European authorities to make an urgent change in the regulation of genomic editing techniques. The European Commission in its report of April 29, 2021 recognizes limitations in European legislation to keep pace with scientific advances in this area and that the legislation in force could be inadequate to regulate some types of applications based on genome editing technologies (NGTs). Likewise, it recognizes that among the benefits of these technologies could be that of helping to achieve the objectives of the Green Deal and urges intensifying the studies that could lead to a modification of the current legislation.

A holistic approach to a sustainable global food system

At the same time, the need for a holistic and integrative approach, such as for example that posed by the OneHealth paradigm, to face the challenges posed by the new food system is becoming more and more important. One of this challenges is globalization as a result of the greater integration of world economies, societies and cultures that will have repercussions in new free trade agreements, and especially with the so-called emerging economies.

This will lead to **an even more complex food system** to control throughout the production chain and anticipate new risks. Not only will trade and the control of possible regulatory fraud have to be contemplated, but also special attention will have to be paid to the introduction of new foods and ingredients in formulations, new processes for food production such as the growing demand for minimally processed or ready-to-eat foods which may increase known risks or reintroduce risks already controlled.

In this process, the EU will need to ensure that the existing high standards of food safety are universally adopted. For this, cooperation with organizations with which EFSA has already been working, such as WHO, FAO, World Organization for Animal Health (OIE), Codex Alimentarius or the Organization for Economic Cooperation and Development (OECD), among others, should be strengthened, to promote high standards in risk assessment in a harmonized approach to provide global solutions to global challenges.

Finally, the new food safety strategy must understand and integrate the perceptions and expectations of citizens regarding food safety. Moreover an additional task of communication and education is necessary.

CHAPTER 5

Economy, training and nutrition in the EU: Are we moving towards a double feeding system?

17% of the European population lives in extreme poverty and 40% is overweight, these data predate the impact of the pandemic.

This chapter will analyse the impact of the Green Deal on the population from different angles, bearing in mind that in the current circumstances we can reach a situation of imbalance that leads to a double food system in the EU. The different realities in the EU related to food accessibility, nutritional status and economic availability are analysed from a system approach, considering that there can be no sustainable and socially balanced development if a balance is not maintained between all of them. Do we save the planet or do we save humanity? The chapter also addresses the topic of organic food.

The "Farm to Fork" strategy is an essential element of the Green Deal, and aims to integrate the links between healthy people, healthy societies and a healthy planet to achieve a fair, healthy and environmentally friendly food system. These premises are indisputable, but they must all be considered, integrated as a whole and from a vision of a sustainable global food system.

Feed the world. A challenge of the 21st century

Vaclav Smil, in "Feeding the world. A challenge for the 21st century", states: "The only way to feed **10,000 million people** (which is a plausible prospect in the medium term) with a traditional farming system based exclusively on recycling organic matter and legume rotations, would **represent doubling, or even tribling the amount of land** that is cultivated today".

This would require a complete removal of all rainforests, the transformation of a large part of the tropical and subtropical pastures into cropland, and the return of a substantial proportion of the energy from labour to agriculture ... which makes this option a mere theoretical conception, and he adds: "**In a world without synthetic nitrogen** fertilizers, the number of inhabitants of the planet should be **2,000 to 3,000 million less** than the current one, depending on the quality of the diet that we are willing to accept". This perspective does not seem to have changed much, despite the advances in food production techniques called biological, ecological or organic.

Climate change has and will have influence on food production and health. The question is whether there is a shortage of food or if there will be in the near future (Reguant, F. 2009) since, despite the fact that hunger and malnutrition affect some 900 million people, there has been food availability at all times in order, on paper, to supply the total demand. In any case, it is indicated that the "solvent demand" is considered, which is that of the population with sufficient purchasing power to buy food, since the "real demand", which includes that of those who lack economic resources, goes further.

Today, the problem is more the lack of economic resources, than of food and the destabilization of prices are the gateway to new legions of the hungry. It has been estimated that if there is a **20% rise in real food prices in 2025, the world's undernourished population would increase by 440 million people** (Senauer et al, 2001).

The **groups most exposed to malnutrition** are those that have moved away from the classic agrarian systems based on diversity and self-sufficiency and, for this reason, urban areas are the most sensitive population centres, but also the environments and areas dependent on monoculture agriculture for export. Obviously, it is not about idealizing primitive agriculture, but it must be considered that some models of unbridled development involve weaknesses if forms of regulation and guarantee of supply are not foreseen for impoverished countries and populations. The key concepts to understand malnutrition in our world are, poverty, food dependency, urban population and price instability (Reguant F., 2009).

A **very widespread current today**, especially among people who can choose what, when and how much they eat, is the desire to consume food “like before” and, if possible, without added technology. This trend is manifested, for example, in the consumption of chicken. The "before" lived more or less in freedom, ate grain, took a few months to develop, were expensive and were out of reach of the classes with low resources. Today's chickens reach adulthood in a month and a half in living inside and fed on fodder, but the price is lower and the nutritional value practically the same.

If these procedures are properly modulated, and the standards of animal welfare and quality of rearing methods are respected, we have a good source of economically affordable proteins, that is, we have **"socialized" proteins of high biological value**. Fortunately, for example, the prejudice against eggs seems to have been considerably overcome, which, due to their economic price and their nutritional value, can contribute to a correct diet at a low cost.

Besides production, the distribution and access to food are key aspects to feed the world population. This broader understanding of solutions to prevent hunger, although widely recognized, is not included in the dominant framing of food security (Barreiro-Hurle et al., 2021) focussing on production aspects, (Tomlinson, 2013). Beckman et al. (2020) predict an **increased food insecurity** (22 million people more compared to no adoption scenarios) following the adoption of agricultural input reductions proposed in the F2F strategy due to higher commodity prices and a reduction in income (reduction of trade), particularly in Africa. However, this analysis shows various limitations because it only takes into account reductions in agricultural input.

Taking all of these considerations into account can help feed the most vulnerable part of the food system better. History shows us that the barely achievable goal is that there be no double food system. Present and future problems are inequality (Therbon G., 2015) and need to be solved not only in North America, Europe or Australia, but especially in Asia, Latin America and Africa.

Is organic food more nutritious?

Organic or biological foods, which the European Union promotes, are consistently considered better and healthier than conventional ones, but **there is no scientific evidence** that this is always the case. They are inevitably more expensive than their conventional counterparts and their consumption is associated with a better quality of life and social level. Analytical studies on the nutritional value of these foods, compared with conventional ones of correct nutritional quality, do not indicate great differences which, if there are, depend on many variables basically on **sensory perception**.

It cannot be said that consumers of organic products are better nourished than those who consume conventional foods if both follow an adequate and balanced diet. The allegations or advertisements that suggest that if you do not consume organic food you do not have a healthy diet, meaning if you cannot pay for these foods you are condemned to an incorrect diet, are **ethically highly arguable**.

It is positive to promote organic food, but the available data indicate that today **it is not possible to feed the entire population** with products of this type. Also, it is not easy to change eating habits in one generation. Integrated production, an intermediate between organic or biological and conventional food is an area to promote.

Regarding the possible **increase in the price** of organic food as opposed to conventional food, during the transitional period (2021-2030) legislative changes must be made to ensure organic production under the CAP and in accordance with the commitments of the Union with the Paris Agreement. To do this, the CAP should **establish a system of aid** that favours the productivity of organic food, with the aim of increasing the supply and lowering the price to consumers. Favouring the supply of organic food can create an incentive for Union farmers to put farmland into production in certain areas, which could indirectly help to keep the population in rural areas, avoid depopulation, and generate employment and wealth.

Environmental pollution, to which pesticides (also designated as phytosanitary) contribute, especially if they are not used with prudent and restrictive criteria, is a problem that must be considered and combated. It is evident that the use of phytosanitary products must be **restricted as much as possible** and that biological or ecological agriculture should be promoted, but always **with the perspective of producing** sufficient, safe and affordable food for the entire population, considering that the danger depends on the amount and repetition of exposition.

It must be remembered that all **foods** properly marketed in the EU, in accordance with current legislation, are **safe**. It is also necessary to show that it is **diet** as a whole (variety, sufficiency and balance), and not a product considered in isolation, that influences health, as well as keeping in mind the different economic, social, cultural, training realities ... of EU citizens.

The Green Deal not only requires the availability of healthy food, but also **active information and training policies** for citizens on food and nutrition and the scientific criteria on which they are based.

EU food legislation is very strict and, although there can always be some flaw or fraud, the quality and safety of practically all conventional food produced or consumed in the EU is guaranteed.

Ultimately, a balance must be struck between sustainable Farm-to-Fork production and a sufficient global supply of affordable food for the entire population, from a sustainable global food system approach, avoiding simplifications, schematics and reductionist approaches.

In this sense, for example, genetically modified foods obtained with innovative tools, without being the panacea, can contribute to sufficient availability of safe and healthy food, but the emotional vision of many consumers, especially in Europe, generates resistance based on certain misunderstood forms of environmentalism.

Healthy and sustainable diets

According to the global sustainability standard, European food is characterized by being statistically safe, nutritious and of excellent quality. Moreover, access to resources is considered a fundamental question of strategic security, for Europe's ambition to carry out the Green Deal. Despite the polarization in the food industry market, it seems that more and more people are going to demand **food which is less processed and from sustainable sources**, so innovation in this field will be the main challenge for the food industry. The strategies to ensure the health of the population must be based on guaranteeing sufficient, quality, safe and healthy nutrition and educating individuals in healthy nutritional habits.

In 2019, before the COVID 19 pandemic, 17% of the population was at risk from poverty or social exclusion. After the pandemic, the poverty of those already facing hardship and exclusion has increased, and **new kinds of poverty have emerged in Europe**. These circumstances can generate a greater situation of imbalance and inequality that lead the population to a **double food system**, with citizens who can afford the consumption of certain types of more expensive foods, and those who have been forced to reduce spending on feeding. The lack of economic resources determines the choice of food.

The concept of “nutritional security” contemplates “the constant access, availability and affordability of foods that promote well-being, while preventing and, if necessary, treating ill-health”. Policies from food, agricultural and trade were originally designed to guarantee the quantity rather than the quality of food. A **radical transformation of food systems** is necessary for all consumers to have access a nutritious, safe, affordable and sustainable diet.

The **European Green Deal Strategy** projected in "Farm to Fork" **faces challenges of transforming the way of producing and consuming food in Europe**, as well as the reduction of the environmental footprint of food systems, strengthening resilience to shocks and guaranteeing the availability of healthy and affordable food for the current population and future generations. This strategy can also afford an opportunity to eliminate the current scenario of double feeding, and to meet this objective it aims to:

1. **Create a food environment so that the healthy and sustainable choice is the easiest.** A healthy diet based on plant products, including alternative protein sources to meat, reduces the risk of ill-health and the environmental impact of the food system.
2. **Label foods so that consumers choose healthy and sustainable diets.** The purpose of food labels is to inform consumers of their nutritional content and values. With the new strategy, the Commission wants to improve information to consumers about the nutrition and environmental impact of the food they buy.
3. **Intensify the fight against food waste.** 50% reduction in food waste per capita by 2030.
4. **Invest in research and innovation** in food, bioeconomy, natural resources, agriculture, fisheries, aquaculture and the environment. The transmission of knowledge will be essential.
5. **Promote the global transition**. The sustainability of European food can provide a competitive advantage that creates new business opportunities for European farmers.

Other initiatives for optimal nutrition security and reducing the "double feeding" gap include:

1. Education in nutrition and health for the general population, involving all population groups from children to adults.
2. Education of health professionals on the impact of nutrition and sustainability in health.
3. Improvement of the exploitation of natural resources. For example, through the adoption of food from third countries in European populations, as has happened recently with the coffee husk.
4. Application of the strategy of co-creation of new foods with the participation of industry, scientists, nutrition and health professionals and consumers.

The policies framed in the **European Green Deal**, the roadmap with which the EU aims to achieve a sustainable and neutral climate economy by the year 2050, **respond to the demands of Europe's upper-middle-income population, but pose the problem of economic accessibility to those foods of low-income consumers**, especially sensitive to price in their purchasing choices, this being the segment of the population that **suffers the most from ill-health associated with an inadequate diet.**

A drastic reduction in the use of agrochemical must be sought as well as a reversion in the loss of biodiversity, improvement of animal welfare and promotion of organic farming, but another important objective is "preserving the affordability of food […] so that the most sustainable food is also, ultimately, the most affordable". **Making hitherto opposing objectives compatible is a formidable challenge.**

In the Communication on this strategy, the Commission goes further and presents the possibility of **acting on the tax system**, so that food internalizes the environmental costs of its production and encourages the consumption of fruit and vegetables, proposals supported by numerous studies (Recanati et al., 2019).

Other opinions, however, argue that achieving a healthy diet for everyone is only possible **if food policies are framed within broader economic and social policies** that address the basic problems, poverty and social inequality in European countries (Penne and Goedemé, 2021). Surely **this is the approach** that can facilitate the development of all the objectives of the EU F2F project and eliminate the existing real double food system described at the beginning of this report. This challenge is not without its difficulties, but it is the key.

The mentality of consumers has changed, since variables predominate among their **selection criteria**, such as environmental, health, social or ethical issues. In addition, there is a risk that the challenge of food insecurity and food affordability will continue to grow. All this is due to the fragility and the economic crisis that we have been going through in recent times. Therefore, it is essential to **adopt measures that promote a change in consumption patterns and the waste of resources**.

Reducing the average global demand for animal products and their participation in human diet is a strategy for more sustainable food systems based on the rationalised use of natural resources, reduced environmental impact, and protection of human health (Muller et al., 2017). Organic agriculture combined with a reduced number of animals in livestock production and a reduction in competition between food and feed products, can provide a promising part of the solution for more sustainable agricultural production, food supply and consumption, if relatively **modest diets are adopted**. Besides, there is also a relation between production and diet, "agriculture needs to be nutrition sensitive, not focussing only on a few species, and attend to deficits in nutrition to overcome hunger and obesity" (Pretty and Bharucha, 2014).

For all this, the European Union has decided to opt for the introduction of **tax incentives** that permit society to incline towards a sustainable food system. Consumers should be encouraged to adopt a diet based on sustainable and healthy products, regardless of the economic situation of each individual, as well as to support the transition towards an equitable and prosperous society that responds to the challenges of climate change and environmental degradation. Thus, the quality of life of current and future generations would be improved.

European food, which has the prestige of being safe, nutritious and of good quality, **must now also be the global benchmark for sustainability**. In this sense, the transition to sustainable food systems is also a great economic opportunity. Citizen expectations are evolving and causing significant changes in the food market. This is an opportunity for farmers, fishers and aquaculture producers, as well as for food processors and food services. This transition will allow them to be pioneers, making sustainability part of their brand to guarantee the future of food in Europe.

At the same time, this strategy considers essential the creation of a favourable food environment that **facilitates the choice of healthier and more sustainable diets** for the benefit of the health and quality of life of the population, which also contributes to reducing health costs. Consumers must be able to choose sustainable food and all those active in the food chain must see this as their responsibility as well as a great opportunity.

Consumers, whose education should begin at **school**, can help make the transition less traumatic by showing an early predisposition to purchase sustainable products. The **dissemination campaigns** have to be continuous, but at the same time, the products offered, in addition to being affordable, have to be attractive. **The food industry can find an opportunity** for the development and commercialization of innovative products under sustainable production, promoting local consumption and including attractive biodegradable packaging systems (obtained without competing with the production of food for human consumption). However, this transition will be difficult to achieve without a **radical transformation of the economy and a cultural change**, producing and consuming less in a responsible way.

Consumption of meat and greenhouse gases

The consumption of meat contributes approximately 50% of the protein in the European diet, with a downward trend, but worldwide growth is expected until 2050, especially of poultry and pork products (Peyraud and MacLeod, 2020).

The 2019 report of the Intergovernmental Panel on Climate Change (IPCC, 2019), according to numerical simulations, pointed out that **balanced diets** based on foods of plant and animal origin produced in a sustainable way in systems that generate few emissions of greenhouse gases (GHG) present **more opportunities for adaptation to climate change** a**nd for mitigating its effects**.

Although in Europe the efficiency of animal protein production is high, based on the analysis of the consequences that a healthier diet would have, Poux and Albert (2018) have proposed to reduce the consumption of animal protein by 50% by 2050 in order to achieve a sustainable agri-food system and reduce GHG emissions by 40%. Other studies reach similar conclusions in the United States (Pimentel et al., 2008), but it should be noted that energy consumption and GHG emissions due to the food chain in Europe **will not necessarily be reduced by acting only on diet**, if the productive schemes move in a global environment driven by the trade balance and exports and imports. This is especially important for the livestock sector and the meat industry, which import cereals and soybeans to feed animals, whose meat is exported to third countries.

The success of this European industry is counterbalanced by the environmental cost of the intercontinental transport of nutrients, especially nitrogen and phosphorus, and that these remain mostly in the manure in the area of animal production. As this intensive livestock farming is not part of the circuits of organic farming, mechanisms for the recovery of these nutrients must be created to substitute fossil mineral fertilizers (phosphorus) and synthetic fertilizers (nitrogen).

Food waste and food loss

The Green Deal strategy proposes to intensify the fight against food waste, and the reduction of 50% per capita by 2030. A third of all food produced globally is lost (chapter 2) or wasted, according to the Food and Agriculture Organization of the United Nations (FAO), this equates to about **1.3 billion tons per year**, enough to feed 3 billion people.

There are several causes of food loss related to the food industry such as processing problems and lack of appropriate planning. Food consumption patterns also play a key role for sustainable agriculture with regard to food wastage, Conrad et al. (2018) found that the average US consumer produces a food waste equivalent to 30% of the calories available for consumption per day and a quarter of daily food available for consumption and 7% of annual cropland. From approximately one-third of the food produced globally that is not consumed, around 14% corresponds to post-harvest loss. This is a practice, mainly in relatively rich countries, to control market prices, preventing the prices from going below production costs. This practice has a high environmental impact due to a depletion of natural resources that finally do not contribute to the market and are often produced unsustainably with high inputs from water, nutrients and agrochemicals (Martínez-Valderrama et al., 2020).

Food loss and waste occur in all links of the food chain, production, cultivation, processing, distribution and consumption processes. In other words, farmers, production and transformation, distribution and catering companies, as well as consumers, are responsible for the exorbitant amount of food that is lost. Reducing food wastage thus offers a complementary approach to the reduction of the use of resources and the environmental impact of agriculture. The circular economy in food offers many possibilities.

This occurs while there are 821 million hungry people in the world, and the trend is not decreasing. One in nine people is food insecure, when in fact today more than enough food is produced for everyone.

A double food system

17% of the European population lives in extreme poverty and 40% is overweight, these data predate the impact of the pandemic. It is important to analyse the impact of the Green Deal on the population from different angles, because this panorama can lead to a situation of imbalance, a double food system in the EU, on the one hand, **citizens who can afford a certain type of diet,** for example, organic with more expensive products, not necessarily safer or more nutritious, and the other **citizens who cannot afford this type of food**.

Given the gravity of the situation with climate change, there may be a tendency to give precedence to alleviating its effects, which is essential, but relegating, more or less implicitly, the need **not only to produce enough food for the entire population, but at an affordable price for all segments of society**, including those with the lowest purchasing power. This gives rise to a **dual food system, for "rich" and for "poor"**. The need to buy the cheapest products can give the guilty feeling of being undernourished forgetting that a healthy and adequate diet is possible at a reasonable price.

In reality, **we are not going towards a double food system, we are already in it** and we always have been, because throughout the history of humanity there have always been populations that go hungry. This should not be the case, but, as we have already indicated, it is estimated that currently 17% of the European population lives in extreme poverty. In Europe we assume that we are not "third world", but we have the "fourth

world", the poor of developed countries, that the crisis of the COVID pandemic has increased in number and whose situation has worsened.

Despite being a developed continent, Europe still faces problems of food insecurity derived from the difficulties of economic access to a healthy diet for a part of the population. A measure of the magnitude of the problem is given by the number of people living at risk of poverty or social exclusion (AROPE indicator). Illustrative is the study Food and social inequalities with respect to health in France (Darmon, N. and G. Carlin, 2013), where it is found that these inequalities in the last twenty years have increased between the two extremes of the social scale, especially regarding nutrition, obesity and diabetes. This inequality begins in childhood and is exacerbated by economic, social, structural and psychological problems.

According to a survey carried out in France in 2012, the study highlights, that the percentage of obese adults in families with a net monthly income of less than 900 euros was 1.7 times higher than that of the general population (25.6% compared to 15 %) and 3.65 times higher than in families with incomes above 5,300 euros per month. Obesity, especially childhood obesity, also affects the economically weaker classes and the poorest countries, as much or more. They are called "obese due to malnutrition." This trend continues despite many efforts to remedy it.

In this sense, there is an interesting study (Clotet, R., 2016), which confirms the fact that **the first need of the individual is to satisfy the appetite and that later it comes to reflect on the type of diet,** showing that the availability of resources conditions the choice of food. The study compares the cost per calorie of three different products: gourmet salad / bean stew / chocolate croissant. It is verified that if we only obtained the daily energy necessary for our organism (minimum 1500 kilocalories) exclusively with only one of these products, the daily cost of our intake would be respectively €42.45 for the salad, of 4.95 for the beans and €3.15 for the croissant with chocolate.

The diet (consumption of necessary kcal) increases dramatically in price by increasing the proportion of vegetables (especially vegetables and fruits), and this decreases by increasing the presence of starches, proteins, fats and, especially, of sugars and flours. There is therefore a long stretch of possible actions, in the form of subsidies or taxes, for example, and also information and training, to promote healthy diets and facilitate access to them.

In turn, this challenge is not without its difficulties, among others, whether within the EU there will be **two speeds between countries in food consumption**, dividing between countries that mostly consume organic food and countries that those which mostly consume conventional food. Also, if there will be an increase in the price of organic food over conventional food due to the possible loss of yield, the increase in the cost of inputs authorized to be used in organic farming and to climate change.

With regard to food energy and food prices, it should be noted that the characteristics of citizens of the European Union are not based exclusively on consuming food that is only produced in the Union, but rather as the level of life and education raises, consumers introduce foods in their diet, preferably diversified and new, produced both in the EU and the rest of the world. The **modern consumer of food** is not satisfied with

the energy that is intrinsically provided (kcal) but wants a varied and diversified offer wherever they are produced.

It is also necessary to consider, as seen in Chapter 4, that the CAP will deepen the path of encouraging models of extensive, diversified, ecological agriculture and the protection of habitats, from which a lower yield per hectare or head of cattle can be expected resulting in higher costs. Also consider the cost that all environmental externalities will entail, which today are not affected by the price of food or the cost of fossil energy and its derivatives, which will increase. Some approaches and considerations give the feeling that, in order to reconcile the balance of our food system with the planet, that is to say its sustainability, **the planet is prioritized** over the survival and basic needs of its citizens.

The double diet referred to in this chapter is based on the **economic differences** in the cost of the shopping basket on the one hand and the **purchasing power** of the citizen on the other. If this is not resolved, it will not be possible to achieve a balance in the food system, nor will it be possible to reach a single adequate and sustainable diet for the entire population.

Concern for the dual food system has been the subject of literary and cinematographic creations. In 1966 the American writer Harry Harrison published his novel: "Make room, make room!", the basis of the film Soylent Green (1973), which shows with very polarized and dramatic examples, double food and its relationship to overpopulation, the global economy and the purchasing power of the citizen.

CHAPTER 6

The EU in the international food market

The EU is a world food power both in terms of production and processing. The Green Deal should offer the opportunity to maintain the EU's position in the international scene, as an example of the proper functioning and balance of the sustainable global food system. The proposed balance between production and transformation, the planet and human consumption, must influence policies and international trade.

This chapter reflects on the EU's contribution to world food security and future projections, based on the challenges posed by the implementation of the Green Deal, given that internationally renowned institutions such as the US Department of Agriculture (USDA) or the report of the Joint Research Centre have expressed their doubts regarding it.

In the framework of the European Green Deal presented by the European Commission in its Communication of December 2019, there are important initiatives related to agriculture and food under way, which will have a great impact not only within the EU but also globally, given that Europe is the world's leading exporter and importer of agricultural and food products, and therefore is a key player in world food trade.

The EU is also a global participant in the field of food security, and **its decisions affect world food trade and the food policies** of the rest of the States substantially, especially those where the work of trade is necessary to ensure sufficient food supply for its population.

As has been seen, within these initiatives the reform of the CAP, whose entry into force is scheduled for the period 2023-2027, and the F2F strategy stand out. The first, proposes a new instrument, **eco-schemes** to remunerate farmers for the effective provision, not abstract and imaginary, of environmental services. The second raises quantitative goals to reduce the use of **agrochemical products** and increase the area dedicated to organic farming in the EU by 2030. Both initiatives are related since eco-schemes can be a valuable instrument to achieve these goals, without the cost of farmers seeing their incomes reduced.

The first thing that should be analysed is what the driving forces behind these food and agriculture-related changes in the EU are. In principle, the key lies in the EU's commitment to maintaining **biodiversity**, preserving the environment and natural resources and, above all, turning the EU into a **climate-neutral zone by the 2050 horizon**. However, there is a second aspect that is less cited, which is the pressure from EU consumers to consume food with less chemical residues and towards more organic food. This second driving force is very important and can have enormous consequences outside the EU.

USDA report

After the publication of the strategies "from the farm to fork" and Biodiversity, the French Unions, among others, have expressed their complaints about the fact that the proposed measures have not previously been accompanied by a quantitative impact study. However, this task has been carried out by the United States Department of Agriculture (USDA), in its report (Beckman et al, 2020) "Economic and Food Security of Agricultural Input Reductions Under the European Union Green Deal 'Farm to Fork and Biodiversity Strategies" **three scenarios** are analysed:

• The **first scenario** considers that the European Union implements the Green Deal strategies alone and does not carry out restrictions on international trade, that is, in this first scenario, said strategy is adopted only within the European Union.

• The **second scenario** or medium scenario extends the restrictions on the agricultural inputs of the traders that depend on the agricultural and food exports of the EU. In this second scenario, the strategy is adopted by the European Union together with EFTA countries, Eastern European countries and African countries.

• The **third scenario**, the "global scenario", the study considers the impacts of the extreme case of global adoption of the global transition strategies suggested by the European Green Deal. In this third scenario, the adoption of the Green Deal of the European Union is carried out by the rest of the world.

According to this study, in the three scenarios there is significant impacts on production, prices, international trade, agricultural income, food insecurity, etc. In the first scenario, the negative impacts are produced in the European Union itself: a reduction in agricultural production of 12%, an increase in prices of 17%, a reduction in agricultural exports of 20% and an increase in imports of 2%. Although in relation to the global world, the loss of production is minimal (1%) and the increase in world food security, although important (22%), is the scenario with the least impact in this regard. On the contrary, in the third scenario, the worst impacts occur at the global level in terms of a drop in production, an increase in prices, an increase in the cost of food and a growth in food insecurity. Table 3 reproduces the summary table of the referred study.

The study estimates that global food insecurity, measured as the number of people who do not have a diet of at least 2,100 calories per day, increases significantly in 76 low- and middle-income countries, mainly in Africa, due to the increase in international food prices. In 2030 the number of food insecure people in the world would increase by 22 million according to this study (first scenario).

The aforementioned USDA report shows how the adoption of the Green Deal would cause a significant reduction in production in the EU which would lose competitivity in world markets and an increase in prices and the cost of food. Along the same lines, the study by the JRC Joint Research Centre (Barreiro-Hurle, 2021), a study by the ones Commission's internal scientific service, which predicts that agricultural production will fall by up to 15%, exports will also fall, mainly cereals, pork, beef and poultry, and producer prices will rise 10%.

Summary of the main impacts of the Strategies under the three scenarios[1]

	European Union	United States	Worldwide
Scenario: EU adoption only			
Production (percent change)	-12	0	-1
Prices (percent change)	17	5	9
Imports (percent change)	2	-3	-2
Exports (percent change)	-20	6	
Gross farm income (percent change)	-16	6	2
Increase in food cost (annual per capita change in U.S. dollars)	153	59	51
Increase in food insecurity[2] (millions of people)	na[1]	na	22
GDP (change, in billions of U.S. dollars)	-71	-2	-94
Scenario: middle[3]			
Production (percent change)	-11	0	-4
Prices (percent change)	60	1	21
Imports (percent change)	-10	-7	-9
Exports (percent change)	-10	-2	
Gross farm income (percent change)	8	1	4
Increase in food cost (annual per capita change in U.S. dollars)	651	16	159
Increase in food insecurity (millions of people)	na	na	103
GDP (change, in billions of U.S. dollars)	-186	-86	-381
Scenario: global adoption			
Production (percent change)	-7	-9	-11
Prices (percent change)	53	62	89
Imports (percent change)	-5	-15	-4
Exports (percent change)	2	3	
Gross farm income (percent change)	15	34	17
Increase in food cost (annual per capita change in U.S. dollars)	602	512	450
Increase in food insecurity (millions of people)	na	na	185
GDP (change, billions of U.S. dollars)	-133	-74	-1,144

Table 3. Source: USDA. Economic Research Service calculations using the GTAP-AEZ model and USA, ERS's international Food Security Assessment Model. (1) Percent change represents an on-time change from the counterfactual values (i.e.., nom policy change); all annual changes expressed in U.S. dollars represent the impacts evaluated over the period of a year after the changes have occurred.

Faced with these predictions, it is argued that structural changes such as innovation and technological adoption, changes in diets and the reduction of losses and waste, which will contribute to increased food availability, must be considered. This does not eliminate the fears of producers of greater exposure to competition from third countries demanding changes in trade policy. In any case, the need arises to act in several ways and to carry out rigorous impact evaluations on prices and production.

In general terms, the three scenarios are characterized by the fact that the United States is the least affected country, the European Union would be in an intermediate position, and **the world as a whole would be the most affected** if the European Union's "Farm to Fork" strategy were adopted. However, it should be noted that this study is based solely on traditional economic indicators that do not evaluate any sustainability criteria. The EU proposes a change in the economic and social model, with the adoption of the circular economy. This should imply a change in the indicators used, substituting GDP for other indicators, such as the human development index and its possible positive assessment, from an economic point of view, of the impact of said policy on environmental sustainability and its effect regarding climate change.

However, estimates of the impact of the EU Farm-to-Fork Strategy appear excessive. In the first place, the model used is based on very high levels of aggregation and fixed production functions. Second, the model is not dynamic and does not consider the evolution of technology and consumption patterns, so it would be necessary to distinguish between the effects in the short and long term, taking into account this evolution. Third, and this is the key issue, EU agriculture is very intensive with very high yields, so that many farms in the EU are close to their technical optimum or even have already exceeded it, that is, they are already in the phase of diminishing marginal returns (section of the marginal productivity curve with negative slope). Therefore, reducing the use of agrochemicals would not reduce production or it would do so by a very limited percentage, less than the 12% estimated by the model used in the USDA ERS study. Prices would therefore increase less and the impact on world food security would be less than estimated.

Analysing the three scenarios proposed (Beckman et al, 2020), that in which only the Green Deal is adopted within the European Union does not make sense, since the **commercial markets are interdependent**, the third countries that would like to export to the Union should abide by its rules (otherwise the Union would become an autarchy). However, these countries may be adapted to export to the Union, but not to import from it. In this sense, the Union could claim the right of reciprocity or perhaps establish compensation to the organic food producers for their contribution to environmental sustainability and as a fight against climate change (either within the framework of the CAP or either in the carbon market, or both).

Competitivity of European productions

These measures, within the prevailing food system and the technologies currently used, will have a **severe impact** on production structures, significantly reduce production and raise costs. This, without corrective measures, will affect the competitivity of European productions and consequently will affect the balance of world agri-food trade and will have disruptive effects on global food security, given that Europe is the leading factor in world food trade.

Logically, a reduction in the supply will affect the global food balance and the increase in costs will have an **impact on prices**, with possible consequences for access to food for the most disadvantaged population. In addition, all this coincides with a growing pressure of demand for food worldwide and with an increasingly active climate change causing the destruction of resources and production.

Faced with a drop in production, an alternative would be to import from third countries outside the European Union to guarantee the food supply in Europe. This carries the risk of exporting unsustainable practices. That is, to produce in other countries without the same environmental limitations as in Europe. In the words of the Ministers of Agriculture of the European Union, **"the new sustainable policies carry the risk of unsustainable imports".**

The European Union is aware of this risk, as well as the global nature of the challenge, and will therefore encourage and support the establishment of global standards. In a way, the European Union aspires to be a benchmark for sustainable agricultural policies. However, it is a difficult aspiration, as it will be necessary to prevent products

manufactured with more relaxed environmental requirements from competing with European products, which will require border protection measures to be negotiated within the framework of World Trade Organization (WTO).

In this sense, on December 17, 2020, at the request of the United States, the WTO published a draft of a particularly explicit title: "Advancing towards sustainability objectives through trade rules to level the playing field." In it, it recognizes the importance of the challenge of sustainability and advocates establishing a **threshold of fundamental standards**, which would indicate, on the one hand, the limit of environmental dumping, which can be corrected with compensatory measures, by the affected country or, conversely, they would indicate the unacceptable limit of import requirements. The negotiation of international sustainability standards for food production will be part of the important concerns of the European Union and it does not seem that the task will be easy.

In this context, it is appropriate to recall the opinion of Olivier de Shutter, former UN rapporteur on the right to food: "We must stop treating food as a basic product and treat it as a common good."

A plausible future scenario

From a **world food security perspective**, continuing in the EU with very intensive agriculture, often even beyond the technical optimum, which causes a strong environmental deterioration and climate change, to ensure the availability of food on a global scale, does not make sense. World food production should be increased as a priority in regions where the use of agrochemicals is very low (5 kg of fertilizer per hectare) and the margin for increasing yields is enormous, as in the case of Africa. Furthermore, the problem of world hunger cannot be solved only by increasing food production, but also by increasing the availability of food, by reducing post-harvest losses and waste in the food chain, and by redistributing food consumption from the most important regions developed to the least, through change in diet.

A **plausible future scenario** could be one in which a large part of global food transactions are organic food and conventional food production is reserved for self-consumption in countries with a lower level of development, but at the same time, these countries with a lower level of development would be encouraged by the production of organic food to have an export income. We should not lose sight of the challenge of adequately feeding a growing world population. This approach involves specific social problems, as explained in Chapter 5.

The **risk of externalizing the damage of intensive agriculture** to other countries is one of the main risks of agricultural strategies supported by the Green Deal, pointed out by Fuchs et al. (2020). According to those authors EU member states are taking the risk to outsource environmental damage to other countries, while taking the credit for green policies at home. For instance, Fuchs et al. (2020) explain how, compared to the European Union, pesticide and herbicide use and deforestation are higher in several countries outside the EU supplying oilseeds to the region. The EU acknowledges the risk of externalities in the F2F text, recognizing that the EU food system should be accompanied by policies that help raise standards globally, to avoid the outsource and export of unsustainable practices.

European products

European foods have the **prestige** of being safe, nutritious and of quality and now they also aspire to be the world reference for sustainability. Citizen expectations are already evolving and causing significant changes in the food market.

However, the environmental ambition of the **Green Deal will not be achieved if Europe acts alone**. The causes of climate change and biodiversity loss are global in nature and not limited by national borders. Without going any further, Europe imports practically all of the soy consumed there, as well as significant quantities of meat and other essential agricultural products. Currently each country defines and establishes different criteria in relation to sustainability, and if clear requirements for imports are not incorporated, the improvements achieved in Europe will probably come at the cost of a negative impact on other parts of the planet. The impact of food production by conventional methods cannot be dissociated from its environmental impact and climate change. It is essential to be rigorous and maintain an integrated approach to the Paris and Glasgow Agreements.

The EU-28 **livestock sector** generated a production with a value of € 170,000 million in 2017, 40% of agricultural activity, with a production of 47 Mt of meat, being the second largest world producer after China, and 160 Mt of milk, with a production in the order of 12 Mt of protein. It is the world's leading exporter of meat and dairy products, with a value of € 33,700 million in 2019. Meat consumption contributes approximately 50% of the protein in the European diet, with a downward trend, but globally growth is expected until 2050, especially in poultry and pork products (Peyraud and MacLeod, 2020).

Fight against fraud

The EU can take on the responsibility of being the **international motor in the fight against fraud** and take advantage of the use of innovative quality control and data management tools in the food industry to certify food obtained under sustainable conditions and facilitate its traceability within the EU. The key for this type of certified products to be competitive in the international market is that the price does not rise and the offer is wide, varied and uninterrupted.

The **sustainability certificate and labelling** can provide added value in exports to countries with a high degree of development and commitment to climate change, but not so much to the rest of the world. In fact, for countries at risk of food insecurity (lack of availability), this certificate does not contribute anything and a possible increase in prices can jeopardize the supply. The system is also complicated in the case of imports from third countries, if commercial channels are not ensured by strict regulations, since they can be direct competition from European producers for offering more affordable prices with less bureaucratic burdens.

In short, the **EU has legislative and regulatory instruments** on agriculture, livestock, fishing, production and processing of food produced or imported in the EU to protect the health of consumers by acting on food hygiene, animal and plant health, and establishing maximum limits for contaminants and residues in food and feed.

Economic impacts

Once the productive impacts have been reflected, we proceed to evaluate the economic impacts. The 12% drop in food production in the EU has macroeconomic effects that could be the increase the prices of 17% on a European scale and what is important, a 9% increase on a world scale (Beckman, 2020). This increase in prices on a world scale would imply that 22 million people would worsen their current food security level and fall into food insecurity (all of them in developing countries). This increase in prices on a European scale represents an increase in food expenditure that would rise to 153 $ / person/year (about 600 EUR / year for a family of 4 members).

Regardless of the precision of the study results, the trends it offers are undoubtedly consistent. A **unilateral option** for the European Union entails a loss of competitivity for the latter and a moderate impact on world food security. On the contrary, a **global option** can have significant impacts on world food security.

The EU "Farm-to-Fork" Strategy not only responds to the objective of reducing environmental impact and mitigating climate change, but also meets the **demand of European consumers**, who are increasingly sensitive to safe food without agrochemical residues and even organic farming, and the mitigation of climate change. This will imply that the EU will not only demand these targets from domestic farmers but will also try to demand these targets to reduce the use of agrochemicals from farmers in countries that export to the EU. This can have an **important impact** on large exporting countries to the EU such as the **Mercosur** countries, and a notable influence on **international agricultural trade**. This issue will surely end in the WTO, to prevent the EU from using these goals of its Strategy as new non-tariff barriers to agricultural imports.

There are fears that this new orientation towards a reduction of inputs leads to the need to increase the area to maintain current levels of production, which would necessarily lead to a global reallocation of crops worldwide. However, until then many **small and medium-sized producers** have had to stay by the wayside, and in the meantime large **competitors from third countries** have been able to emerge stronger.

The **economic effort that the Member States have to make is immense**. The Strategy contemplates it from various aspects, such as financial aid, advice, VAT reduction on organic products, outreach and awareness campaigns, legislative pressure, as well as more investment in basic research and R&D. It is essential to plan spending, synchronizing all these aspects well, otherwise only partial results will be obtained that will make the transition period more dramatic and prolonged.

The document refers to the "enormous economic opportunity" that the transition towards a sustainable food system represents for "farmers, fishers and aqua culturists, food processing companies and food services", and although it is intended to take into account the intrinsic characteristics of each one of the agents receiving funds, **small and medium-sized companies will be the most vulnerable**. In addition, many of these companies could have solvency problems due to the pandemic crisis. Unlike other sectors, small and medium-sized companies predominate in food production and transformation, in many cases family-owned, in which innovation and the application of new technologies are usually more limited. The **effort to create a "fair" legislative framework** as soon as possible is of vital importance, so that the imposition of regulations is consistent with business objectives and capabilities, and at the same time,

obtaining sustainability certificates is perceived as a commercial and also fiscal incentive.

In general, the adoption of measures in the production systems in the first instance, and also along the entire value chain, will necessarily have a strong impact on the food market within the EU and will condition the competitivity of the products of European brands, as, at least initially, it is foreseeable that there will be an increase in prices due to the increase in production costs and this can have a negative impact on the market. The States can contribute with **economic aid** to cushion this effect during the transition, so that the most optimistic scenario is that once sustainable production is implemented following the principles of energy and production efficiency, more competitive products can be achieved both in terms of quality and price.

Explicit reference is made to **the benefits of shortening supply chains**. Local production and consumption has a direct impact on making prices more competitive, but the effect may be insignificant if the food and beverage processing industries are not included in this scheme, especially large companies, whose targeted activity towards more sustainable practices (energy efficiency technologies, circular economy, biodegradable packaging, quality control and waste reduction, carbon footprint monitoring, etc.) could be easier to implement and have a greater impact in the early stages of the transition.

Need for a holistic approach

At the same time, the need for a holistic and integrative approach such as that posed by the OneHealth paradigm to face the challenges posed by the new food system is becoming more and more important. One of the challenges is globalization as a result of the greater integration of world economies, societies and cultures that will have repercussions in new free trade agreements, and especially with the so-called emerging economies. This will lead to an even **more complex food system** to control throughout the production chain and anticipate new risks.

Not only will trade and the control of possible regulatory **fraud** have to be contemplated but special attention will have to be paid to the introduction of **new foods and ingredients in formulations, new processes** for food production such as the growing demand for minimally processed or ready-to-eat foods, that may increase known risks or reintroduce risks already controlled. In this process, the EU will need to ensure that the existing high standards of food safety are universally adopted. For this, cooperation with organizations with which EFSA has already been working, such as WHO, FAO, World Organization for Animal Health (OIE), Codex Alimentarius or the Organization for Economic Cooperation and Development (OECD), among others, should be strengthened to promote high standards in risk assessment in a harmonized approach to provide global solutions to global challenges.

On the other hand, the new food safety strategy must understand and integrate the perceptions and expectations of citizens regarding food safety where an additional task of **communication and global education** and in incidents and emergencies is necessary. RASFF (Rapid Alert System for Food and Feed), as explained in Chapter 4, is a network for the exchange of information on direct or indirect risks to human health derived from food or feed. The RASFF system involves the Member States, EFSA and the European Commission, but it can be extended to third countries and international organizations,

being the contact point of the EU that participates in the Network of International Food Safety Authorities (INFOSAN) operated by WHO.

Global food insecurity has been increasing since 2015 according to FAO reports, due to climate change and **political instability and armed clashes in low- and very-low-income countries.** These factors surely influence the increase of global food security more than the EU's Farm-to-Fork Strategy, which would instead produce notable benefits in preserving the environment and natural resources and in mitigating climate change. Even more important would be the adaptation to climate change in agriculture, which would mitigate the impact of climate change on reduced yields.

To achieve the objectives of sustainable food production in the international context, the EU can apply specific trade policies, publicize and raise awareness among the population and impose restrictive regulations for the importation of products, but it can also **"export" knowledge and boost European investment** in countries with fewer resources to facilitate the adoption of more sustainable processes.

During this entire period, how can a "sustainable bubble or capsule" in Europe be achieve without losing competitivity with the rest of the world? The EU is firmly convinced about applying trade policies geared towards the production of sustainable food, but **it should be asked if it can impose them without the support of other great powers**, such as the United States, China, the United Kingdom, etc.

The EU world reference in production, transformation and sustainable consumption

The conclusions shown in Chapter 1 of this report analyse a little-considered factor. On average over the last three years, **photosynthetic production in the EU** (based on agriculture, aquaculture and intensive livestock) potentially destined for human consumption is practically **in balance with the consumption data**, as calculated in chapter 1.

The result considers the EU as a world power in food processing, but shows that no extra net food production will be generated significantly if current consumption patterns are continued. These data are consistent with the import and export figures for recent years. **Imports of raw materials are higher than exports**, while in processed products of all kinds the figures are significantly inverted (Sumoy R., 2016). These results invite reflection.

The EU, apart from the possible ups and downs generated by the implementation of the Green Deal strategy, has a relevant and strongly solidified role in world public opinion, and therefore with influence on trade, as a space for producing quality products both nutritional and sensorial, related to culture, as well as safety in its preparation. The EU can have **world leadership**, apart from the export of processed products, as a reference power in the export of transformation technologies and criteria for scientific training in both processes and safety (EFSA, alarm networks, inspection criteria ...). The Green Deal can represent an opportunity to make the EU a world benchmark in sustainable production, transformation and consumption.

CHAPTER 7. CONCLUSIONS

First of all, we must positively value the initiative of the European Commission in publishing the Communication on the Green Deal and its strategies from Farm- to-Fork and Biodiversity, which place the sustainability and accessibility of the food system as a priority in the European Union. This has raised concern about the various approaches to finding a solution to a complex global problem with diverse and multiple effects, which are reflected in the previous six chapters.

The complexity of this environment has led the Commission itself to request an assessment of its communication on the Green Deal strategy (European Commission, 2021) from one of its most active Joint Research Centres (JRC). According to the conclusions of this report, whatever the scenarios considered, the effect of the strategies referred to will be an unprecedented reduction in the EU's production capacity and farmers' incomes. Most of the reduction in agricultural emissions achieved through these strategies will be erased by a leak of sustainability to third countries resulting from this loss of production. This result is also aligned to the report of the United States Department of Agriculture (USDA, 2020).

It should be noted that, according to the authors of the JRC report, this is not an exhaustive impact evaluation since "some goals were not considered or only partially, and the model used has certain limitations to evaluate the complex effects of the objectives that it deals with". Therefore, new models of approach should be focused to consider the participation of processing companies, distribution and consumer behaviour, in balance with human development, the right to life, and as a subsidiary need to a correct diet.

The authors of the JRC (2021) report call for a more complete analysis on targets and models, and for our part, we cannot do more than support this demand. The report will surely cause a lot of controversy in the coming months and will be a counterpoint to the philosophy that some consider to be the unequivocal key to the Green Deal proposed by the Commission itself.

Given this, there is the question of whether it would be possible to propose a really complete and exhaustive analysis of the effects of the “From farm to Fork” strategy, including an evaluation of its impact, before adopting legislative measures too hastily". Throughout its six chapters, this document has analysed the impact of the Green Deal from the approach of the Triptolemos Foundation to the sustainable global food system. The report of the JRC (2021) or the USDA (2020) are aligned to some of the opinions of this document, but they affect others weakly in some fundamental aspects.

Ultimately, the findings of these studies should alert stakeholders beyond the farming community and create a public debate, as these policies may have a negative impact on our strategic food autonomy, consumer prices, or relocation of our agriculture.
Accessibility to safe and sufficient food for the entire population has been an unsolved strategic problem throughout history and defined as a fundamental human right. The EU has the opportunity to align its strategy from an approach that has not been present

until now: maintaining the sustainability of the planet in balance with human development.

Now more than ever, a broad debate and commitment in society is necessary, considering all the factors and protagonists, not only in the EU but also worldwide, so that politicians, representatives of society, approve the essential legal necessities, based on proven scientific knowledge and with a vision of a sustainable global food system. This, without losing sight of the fact that the short-term vision that sometimes predominates in our political system constitutes a major obstacle to allowing the broader risks of climate change to be quickly and directly translated into effective actions.

The Green Deal runs the risk of being more of a change in form than in substance in the European agri-food sector, if only a change in the production system is proposed, without making assessments regarding what it may represent in quantitative and qualitative aspects and, therefore, in farming and associated sectors. This is even more serious if the enormous edaphoclimatic and cultural differences among the different countries and regions of the EU are taken into account. Achieving the objectives of the Green Deal will require the full use of the knowledge and technologies available at all stages of the chain, from promoting plant breeding, such as the use of genomic editing, to processing technologies and conservation.

The EU must use all its capacities to mobilize its neighbours and associates, in order to join in an urgent sustainable development strategy in the short term due to the climate emergency and the urgencies of environmental disasters, but which is longlasting and sustained over time, accepting the need to preserve its security of supply and competitivity, through safe quality food, respectful of the environment and social conditions.

Europe must take advantage of this opportunity (perhaps the last) to position itself at a global level, leading the development of solutions and clean technologies to combat climate change, while promoting the generation of a competitive agricultural sector that produces food in a sustainable way economically, socially and environmentally.

The Triptolemos Foundation has analysed the impact of the Green Deal from its vision of a sustainable global food system which is defined in four interconnected axes: 1) availability and accessibility, 2) economy, 3) legislation and regulations and 4) knowledge, behaviour and culture (Colomer, Y. et al, 2016). The 4 axes are aligned to the 17 Sustainable Development Goals (SDG). The challenges identified in this report will only be resolved if they are approached holistically as a food system, considering all its variables and not just the economic and environmental ones. The equilibrium will work, as happens in biological systems, when there is no dominance of any of the factors over the rest. If there is dominance of any factor or any axis, the equilibrium is destroyed.

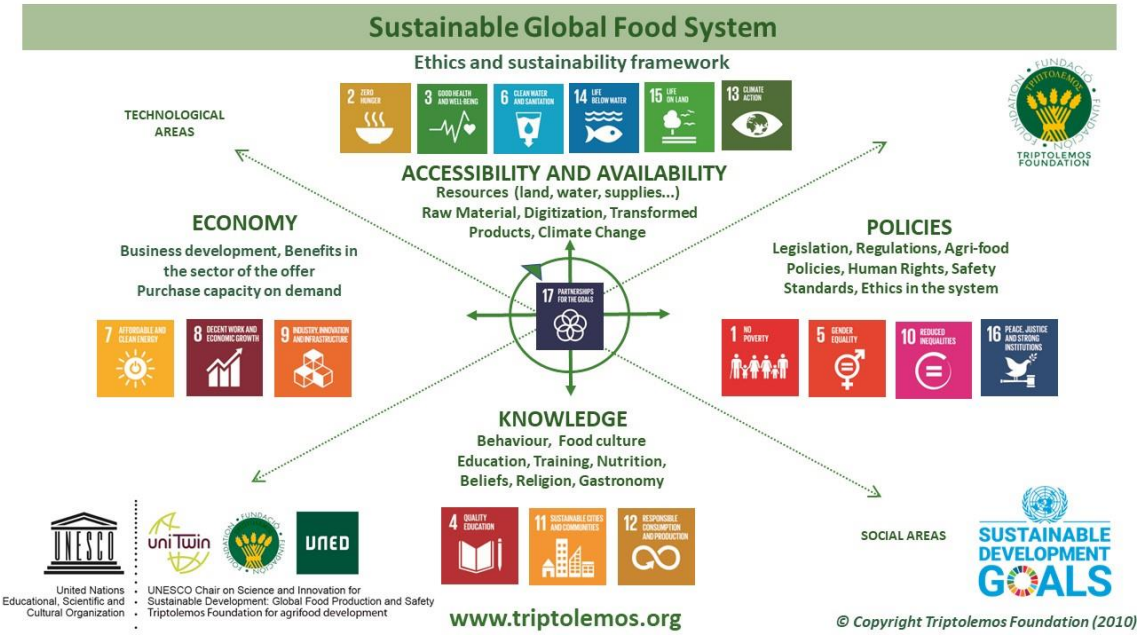

Figure 1. Sustainable Global Food System

We must act in coordination, with commitment and with a global projection in the four axes to achieve a sustainable and socially balanced global food system. The EU cannot act in isolation. Acting on only one or some of the axes, either out of interest or ignorance, unbalances the system, with serious consequences, which, as we can see, this implies. **The success of the Green Deal will depend on the proper harmonization of all this: this is a challenge.**

ACRONYMS

AE	Agroecology
AECM	Agri-Environmental and Climate Measure
AHAW	EFSA Thematic Panel on Animal Health and Welfare
ANS	EFSA Thematic Panel on Food Additives and Nutrient Sources
BIOAHZ	EFSA Thematic Panel on Biological Hazards
CAPRI	Common Agricultural Policy Regionalized Impact Model
EC	European Commission
CEF	EFSA Thematic Panel on Food Contact Materials, Enzymes and Processing Aids
CEIGRAM(UPM)	Center for Studies and Research for the Management of Agricultural and Environmental Risks - Polytechnic University of Madrid
CIAL-CSIC	Food Science Research Institute Superior Council of Scientific Investigations
CONTAM	EFSA Thematic Panel on Contaminants in the Food Chain
CJUE	Cour de Justice de l'Union Européenne
CSIC	Superior Council of Scientific Investigations
RD	Rural development
EEA	European Environment Agency

EU	European Union
EFSA	European Food Safety Authority
ETSIAAB (UPM)	Higher Technical School of Agronomic, Food and Biosystems Engineering Polytechnic University of Madrid
ETSIAM Albacete	Higher Technical School of Agricultural and Forestry Engineers (ETSIAM) of Albacete
F2F	Farm to Fork Strategy (COM 2020_381)
FAO	Food Agriculture Organization
FEEDAP	EFSA thematic panel on additives and products or substances used in animal feed
GHG	Greenhouse gases
GMO	EFSA Thematic Panel on Genetically Modified Organisms
IBMCP-UPV	Institute for Cell and Molecular Plant Biology-University Polytechnical of Valencia
ICTAN-CSIC	Institute of Science and Technology of Food and Nutrition - Spanish National Research Council
IFT	Institute of Food Technologists (USA)
INFOSAN	International Food Safety Authorities
IPCC	Intergovernmental Panel on Climate Change
IRTA	Agri-Food Research and Technology Institute
IVIA	Valencian Institute of Agricultural Research
MAR 1-MedECC	Climate and Environmental Change in the Mediterranean Basin – Current Situation and Risks for the Future First Mediterranean Assessment Report (MAR1) Mediterranean Experts on Climate and Environmental Change
NDA	EFSA Thematic Panel on Diet Products, Novel Foods and Food Allergens
NUE	Nitrogen Efficiency Use
SDG	Sustainable development Goals
OECD	Organization for Economic Cooperation and Development
OIE	World Organization for Animal Health
WHO	World Health Organization
UN	United Nations
CAP	CAP Common Agricultural Policy
PPP	Plant protection products
PLH	EFSA Thematic Panel on Plant Health
PPR	EFSA Thematic Panel on Phytosanitary Products and Their Residues
RASFF	Rapid Alert System for Food and Feed
SI	Sustainable Intensification
UAB	Autonomous University of Barcelona
UAL	University of Almeria
UB	University of Barcelona
UCO	University of Córdoba
UdL	University of Lleida
EU	European Union
UPC	Polytechnic University of Catalonia
UPV	Polytechnic University of Valencia

USDA	United States Department of Agriculture
UNFCCC	United Nations Framework Convention on Climate Change
VCS	Voluntary Coupled Support
WTO	World Trade Organization
TPF	Total Factor Productivity
BNF	Biological nitrogen fixation
CRISPR	Clustered Regularly Interspaced Short Palindromic Repeats
CPPAFF	Committee on Plants, Animals, Food and Feed
ADI	Admitted Daily Intake
NGTs	New Genome Editing Technologies

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