

The Impact of the European *Green Deal* from a Sustainable Global Food System Approach

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I. 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 the said activity. To determine the result of this

balance, we can calculate the real energy demand of the European population, taking into account cultural and social factors, such as diet, food waste and the fact that the consumption of certain food (for instance, meat from intensive cattle raising, 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, 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 Eu-

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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, we must take 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, the average purchasing power of the European population or modification of diets. An added 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* made public by the European Commission 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, raises a series of challenges and doubts that should at least be pondered. 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 a 25% of the agricultural area under organic cultivation by 2030 and 4) reduce productive agricultural land by 10%. A study carried out during the year 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, a Technical Report of the JRC Joint Research Centre (2021)², a study

of the Commission's internal scientific service, predicts that agricultural production will fall by up to 15%.

However, other authors, from 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 legumes³. 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.* (hereafter the "USDA Report"⁴). 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 possible 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 attention. That is why the 'Triptolemos Foundation' has recently promoted the realization of a study, 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 distribution chain from farm to fork.
- Add to the demand the additional photosynthetic calories needed to obtain calories from food not from 100% photosynthetic food. This implies an additional energy cost of transformation, a feed conversion factor, which has also been considered, since direct energy efficiency has been lost.
- Subtract from the food supply 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

2 See, <<https://publications.jrc.ec.europa.eu/repository/handle/JRC121368>>

3 Connor, D.J., 2018. Organic agriculture and food security: A decade of unreason finally implodes. *F. Crop. Res.* 225, 128–129 - <https://doi.org/10.1016/j.fcr.2018.06.008> (Consulted October 2021).

4 Beckman, J., Ivanic, M., Jelliffe, J.L., Baquedano, F.G., Scott, S.G., 2020. Economic and food security impacts of agricultural input reduction under the European Union Green Deal's Farm to Fork and Biodiversity Strategies. Economic Brief Number 30, November 2020. United States Department of Agriculture (USDA), Economic Research Service.

Food energy self-sufficiency in the EU 27 (2017-2019) Source: Triptolemos Foundation (2021).

	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%

other related variables to ensure consistency⁵. 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, the calculation of real caloric needs of the population must take into account more than the theoretical needs. 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. As an example, to obtain 1 kcal of farmed beef, the animal must consume slightly more than 31 kcal of feed⁶.

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 production (production of energy, alcohol, textiles, biodegradable packaging, etc.).

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 article. 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.

⁵ See, <<https://publicacions.iec.cat/repository/pdf/00000277/00000002.pdf>> (Consulted October 2021)>

⁶ See, <<http://www.fao.org/3/w7452s/w7452s03.htm>> (Consulted October 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 cattle raising, 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, that is the more successful this activity is, the more livestock manure remains in the territory of the producing regions.

The cattle raising 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 cattle raising, 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 competitiveness 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 third world 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.

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 has almost been reached. This should have implications and considerations in the *Green Deal* strategy.

II. The Green Deal and the Challenges in Agricultural Production

1. Sustainability

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.

In this area, we want 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 faces and be able to choose the practices that best suit his 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 objectivity of the European Food Safety Authority (EFSA).

2. The Need for the Green Deal Strategy

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. 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 accredited⁷, 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 Agreement on climate change. It is a courageous proposal but one that represents a radical change in the productive structures of the Union. 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 *Green Deal* affects agri-food production, above all, through the strategies “F2F”⁸, and the strategy on Biodiversity. Both strategies are closely related, since agroforestry or bioeconomic activity necessarily take place occupying the natural space. The above mentioned “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”. We must rethink what is meant by growth and progress and what it means for global sustainability. The Union aspires to become a world leader in sustainability and competitiveness, and to achieve this, the agri-food sector will have to play a crucial role. The “F2F” 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 already mentioned United Nations Conference on Climate Change 2021 in Glasgow.

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 generates 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 COVID-19 pandemic. 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 abovementioned Report 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 and which analyses the impact of the *Green Deal* on three scenarios. The Technical Report of the Joint Research Centre (2021) commissioned by the Commission itself has also been considered.

3. 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 cumulatively⁹. However, this improvement in production efficiency is not enough to achieve the relevant targets by 2030.

The *Green Deal*, and especially the achievement of the different goals set out in the F2F strategy and the

7 See, <https://ec.europa.eu/food/horizontal-topics/farm-fork-strategy_en>.

8 European Environment Agency (EEA), “Grow without economic growth”: <<https://www.eea.europa.eu/publications/growth-without-economic-growth>>

9 Fuglie, K. and Rada, N., 2013. Growth in global agricultural productivity: an update (USDA Amber Waves No. 1490-2016-128359) <<https://ageconsearch.umn.edu/record/212282/files>>

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 (11%) in the European Union, ahead of the industrial sector. For this reason, the *Green Deal* aims to implement a gradual and irreversible change in EU 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 the Food and Agriculture Organization of the United Nations (FAO), 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.

It cannot 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 EU

agriculture cannot ignore, 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).

4. 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 cattle raising densities are among the highest in the world.

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.

5. Objectives of the Green Deal

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

- Expand protected areas to 30% of the Union 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 Directive¹⁰ or the Water Framework Directive¹¹, 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%. 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.

Biogas produced from all waste effluents in the food chain, and biomethane for injection into the network, or renewable hydrogen, have the advantage of

10 See, <https://ec.europa.eu/environment/water/water-nitrates/index_en.html>

11 See, <https://ec.europa.eu/environment/water/water-framework/index_en.html>

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. However, 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 low¹².

6. Is the European Commission Too Optimistic?

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 at around 60%, this reduction of 10 points is even higher than the efficiency improvement achieved over 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.

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 the negative impact of the use of agrochemicals on production losses by 50% 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 farmers 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, and it requires a radical reconversion of farmers. Organic farming in the EU has grown remarkably, from 6 million ha (2002) to 13.8 million ha (2019), that is to say about 450,000 ha / year. Twenty-five percent 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 Commission 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 challenge¹³, 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.

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 NUE¹⁴; and b) the available evidence shows that the yields of organic vs. conventional are on average 80% of conventional crops, which 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 dietary adjustments and waste reduction, among others. The combination of the

12 See, <<https://publications.jrc.ec.europa.eu/repository/handle/JRC9612>>

13 See, <<https://doi.org/10.1038/s41467-017-01410-w> (Consulted November 2021)>

14 Biernat, L. *et al.*, "Is organic agriculture in line with the EU-Nitrate directive? On-farm nitrate leaching from organic and conventional arable crop rotations." *Agriculture, Ecosystems and Environment* (2020) 298: 10696.

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 abovementioned JRC Report. Assuming the projections of reduction in agricultural productivity of the “MedECC - Climate and Environmental Change in the Mediterranean Basin, First Mediterranean Assessment Report”¹⁵ are true, it becomes even more difficult to understand how it is intended to get food for the EU population and export. Considering the data on the evolution of agricultural land and 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 the Union, while the number of family-type companies in the sector is progressively decreasing (23% in the period from 2003 to 2020).

7. Size of Farms

It must be considered that the challenge proposed by the *F2F strategy* will not be inexpensive, 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 assume the change. Moreover, the necessary technological advances often lead to oversizing the efficient minimum size of the agricultural establishment. 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 be necessary more than ever. These farms are essential for territorial balance and the maintenance of rural vitality. The realization of the various strategies of the *Green Deal* will have to take into account the extraordinary diversity of EU Member States and, therefore, will have to take into account regional peculiarities, from which conclusions apparently contradictory to the general objectives can be drawn.

8. Sustainable Intensification, Is it Possible?

The *Green Deal* proposals are aimed at better production hand in hand with the developments offered by *agroecology* and the most advanced developments in technology, for example, the possibility of obtaining biological pesticides, varieties resistant to pests or diseases, and innovations and agricultural practices that reduce or prevent negative environmental impacts. 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 through technology and through efficient irrigation, in balance with the sustainability of the system, will also be necessary to reduce food loss 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”¹⁶, but as some authors¹⁷ 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

15 See, <http://www.medecc.org/wp-content/uploads/2021/05/MedECC_MAR1_3.2_Food.pdf>.

16 See, <<https://www.cimmyt.org/news/what-is-sustainable-intensification/>>.

17 See, <<https://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1416&context=agronomyfacpub>>.

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. 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. Indeed, SI and AE aim at achieving, among other goals, 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.

We can conjecture how both systems approach sustainable agriculture:

SI could be summarized in the lemma “Feed the world sustainably”¹⁸. 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. SI also includes *agroecological* methods and 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 industry. 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 Commission must lead the coordination of international initiatives to build a coherent financial system that supports the development and implementation of sustainable solutions.

9. 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 the agriculture of the Union that only innovation can solve, combining multidisciplinary approaches to obtain sufficient food production from agriculture and cattle raising, 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 EU level, without forgetting the repercussions at the international level. To attain 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 food supply sector, by promoting fair trade and creating new business opportunities.

Following the description made at ‘COP 21’ in Paris (2015), it was corroborated at COP 22 in Marrakesh (2016) and at the recent ‘COP 26’ in Glasgow (2021) that the agricultural sector is the cause of climate change. Thus, the role of agriculture and cattle raising 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 must be 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 and information instruments or their hybrid forms of de-

18 See, <<https://doi.org/10.1007/s10113-016-1027-y>>.

sign and implementation), 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 or possibilities of payments for the provision of environmental services (e.g. agri-environmental programs of the CAP or conservation banks).

Some studies warn 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 Institutions of 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.

10. The Green Deal could be a Good and Sensitive 'Idea'

It could be concluded that the *Green Deal* is a good and generous proposal, but it will be unfeasible 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 Gross Domestic Product (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 recurrent assessments regarding what it may represent in quantitative and qualitative aspects and, therefore, hence, in farmers and associated sectors, especially taking into account the enormous *edaphoclimatic* and cultural difference of the diverse 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. It must also be sustained over time, accepting the need to preserve its security of supply and its competitiveness through safe quality food, and respectful of the environmental and social conditions. The EU 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, environmentally and socially sustainable way as well as being competitive.

It must also not lose sight of the fact that global agriculture is facing a new climate reality due to greenhouse gases. Climate change could significantly affect the yield in the production of cereals, a basic source of food.

III. The role of Science and Technology

1. General Overview

Recognised 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 the agriculture of EU Member States 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, and 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 “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 percent of the joint agricultural area of the Union to be dedicated to organic crops, to obtain new varieties 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 fact is that the *Green Deal* strategy will put great pressure on our agricultural production systems.

The critical reality is that, at present, our agriculture is not ready for this change. In order to *change*

to the new situation, we need crops that produce more with less input. We also need to develop new and better comprehensive strategies for pest control, to adapt our varieties to climate change and to learn to acquire and better process 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 fulfilment 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 EU agriculture that only innovation address. 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. However, in addition to continuing to advance in technological innovation, it is essential to get substantial improvements in the transfer of knowledge, making these new technologies accessible to farmers.

Given these prospects, it is logical to ask a question: *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 basic necessities to all of society in an increasingly sustainable way, not only locally but globally:

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 for 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 consequently 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.

Obviously, these engagements need a *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 of them (from environmental engineering or econometrics to data science, through genetic improvement and biotechnology). Therefore, the use of scientific advances 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 be fruitful if it is freed from apriorism and ideological prejudices. This in no way means giving up supervision of the ethical values associated with R + D + i. Responsible innovation is the one which embarks on transparent projects, with legitimate objectives that respond to properly identified societal challenges and whose risk-benefit *ratio* is duly evaluated.

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 enormous prospects to provide our plants with new characters to face the challenges of climate change. These new technologies are fundamental elements of the *philosophy* 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 agriculture in the Union 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 the EU.

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 waste. 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 pests or attack by pathogens such as viruses, fungi and bacteria that, in turn, are also developing 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 un-intelligent production strategies that lead to the disposal of crops because their marketing value does not compensate for production costs. 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 13 in a tomato plant. 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. 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 the char-

acteristics of the parents are randomly mixed in the sexual crossing, it is necessary to resort to successive backcrosses. This 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 into them 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 *absorb* 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 improving 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 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; cucumber or potato, resistant to viruses; bacteria resistant oranges, grapefruits or tomatoes or new drought tolerant varieties of soybeans and corn. Soybean, groundnut and rapeseed varieties with an improved fatty acid composition or tomato varieties with high lycopene or GABA¹⁹ 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

19 *Gamma-Aminobutyric acid*, or *γ-aminobutyric acid* (GABA) is the chief inhibitory neurotransmitter in the developmentally mature mammalian central nervous system.

been understood by many countries that have already gone ahead to distinguish from the 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. For its part, 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 a study published on 29 April 2021²⁰, recognizes the limitations of current EU 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 accepts 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 do 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 kind of agriculture promoted by the *Green Deal* presents doubts regarding the hygienic and sanitary safety of production (see, for instance, the crises of organic food bacterial contamination of fresh spinach from the USA in 2006 and that of "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 pros of the *Green Deal*.

2. Loss of Agricultural Land

Assuming the projections of reduction in agricultural productivity of the abovementioned "MedECC - Climate and Environmental Change in the Mediterranean Basin, First Mediterranean Assessment Report" are correct, it becomes even more difficult to understand how it is intended to provide food for the population and exports from the EU. When considering the data on the evolution of agricultural land and from the type of agricultural holdings in the Union context, we see that functional agricultural area and farmers are lost. The European Union lost 27,139,520 has. of agricultural land between 1990 and 2015 due to a process of land grabbing or concentration in an increasingly reduced number of agricultural companies. This has resulted in a situation in which 3% of all EU agricultural holdings control 50% of all land cultivation in the Union, while the number of businesses in the family-type sector is progressively decreasing (by 23% in the period from 2003 to 2020).

3. The Role of the Food Industry

The optimization of the associated agri-food industry must be studied, which has to be considered with new performance indices, due to a fewer inputs from the field, a greater need to reduce waste, water and energy consumption (water and carbon footprint), and a very high level of food safety (chemical and biological controls). Again, science, technology and common sense are key to produce the functional change of 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 trans-

²⁰ See <https://ec.europa.eu/food/plants/genetically-modified-organisms/new-techniques-biotechnology/ec-study-new-genomic-techniques_en>.

formation 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's 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 diet 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. The review of the regulation of expiration dates and preferred consumption dates to avoid food waste is a notable action included in 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.

4. The Transition to More Sustainable Models: An Opportunity

The transition to sustainable food systems also offers a great economic opportunity for farmers, fishermen 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*.

IV. Legislation and Food Safety

1. The Importance and Value of the Technical Evidence Provided by the Scientific Community

The EU must continue to be an international benchmark for food law. Food security must consider the nutritional needs of the population and the economic resources of citizens, ensuring access to safe and healthy food. Community policies on food safety must safeguard the protection of these rights in an increasingly complex food system. Therefore, in *the Green Deal environment*, we will analyse 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 citizens. The regulation is based on the rigorous analysis of scientific evidence provided by the scientific community. Their work must 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 permanently updates its knowledge, and once its hypotheses have been contrasted and verified, they are incorporated into national and international regulations. This proper legislative harmonization is a very important aspect of the success of the *Green Deal*.

As we have already stated, 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 *ex post*) evaluation of these risks and the impact on economic sectors and consumers themselves is required, especially in the case of the most vulnerable.

2. The Green Deal: A Unilateral Communication from the Commission

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 experienced “Green Paper - White Paper” method that has produced such good results to date.

Using a Communication, which according to reiterated jurisprudence of the CJEU 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 especially essential. Yet, the projected actions are formulated with the ambiguity and generality inherent in a *simple* Communication. However, the effects of its future application may be of great significance for all stakeholders in the EU Food System. In this sense, it cannot be excluded 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 EU²¹ (if so the intervention of the European Union Agency for Fundamental Rights²² would be unavoidable).

Moreover, it is expected and recommended that the “last in first out” principle²³ will be applied in the promulgation of new regulations.

3. The “Farm to Fork” Strategy and the Common Agricultural Policy (CAP)

Within this framework of the *Green Deal*, various initiatives have emerged, including the Farm to Fork

strategy, *transporting* to the agri-food sector the guidelines of the “Deal” measured in quantitative goals to be achieved in 2030. Previously, in June 2018, the reform process of the 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 food 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 should introduce 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

21 See, <https://ec.europa.eu/info/aid-development-cooperation-fundamental-rights/your-rights-eu/eu-charter-fundamental-rights_en>.

22 See, <<https://fra.europa.eu/e/>>.

23 Which means that the approval of a new regulation must entail the annulment of a previous one.

Objective 1	Support a viable farming income and the resilience of the sector throughout the EU to improve food security.
Objective 2	Increase agricultural competitiveness 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.

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

specificities of 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 with political will, but that the activity must be beneficial and cost-effective. 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 CAP measures that help to strengthen the position and bargaining capacity of farmers in the chain of value, strengthen crisis management mechanisms, improve living conditions and facilitate the adaptation of production to non-demand must be considered independently of environmental and climate measures aimed at reducing emissions from the sector.

4. 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, to which we have had access when writing this article, aim to continue to provide strong support to EU agriculture, promote the pros-

perity of rural areas and produce quality food, as well as make a significant contribution to the *Green Deal*, especially within the framework of the *F2F strategy* and the Biodiversity policy, establishing as general goals the equitable treatment of farmers and a stable economic future, more ambitious protection for the environment and climate action 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.

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 CAP requires the preparation of strategic plans to achieve nine objectives, of which three are environmental and climate: action against climate change, protection of the environment and conservation of the landscape and biodiversity. Indeed, 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 contribut-

ing to the capture of carbon in soils, agriculture, 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 fabric, in addition to casting 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.

In this framework, the *F2F 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 EU Institutions between now and 2050 and, temporarily, by 2030. The question is whether the transitional period of nine years will be sufficient or will be extended for a few more years.

5. The F2F 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 Safety²⁴ applied an integrated approach from “Farm to Fork” that involved the main participants of the food supply chain, such as primary production, the processing industry, consumers 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 Euro-

pean Parliament and of the Council²⁵, establishing the principles and general requirements of food law, creating the European Food Safety Authority (EFSA) and procedures related to food safety were determined. 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 measure. 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 should 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

²⁴ See, <<https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=LEGISSUM%3A132041>>.

²⁵ See, <<https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=celex%3A32002R0178>>.

to public authorities, such as EFSA, but also requirements to agri-food businesses 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.

6. 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 Feed²⁶). Information is shared between competent authorities and *food businesses*²⁷, 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, cattle raising, 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 to granting enforcement powers to public authorities. 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 framework, 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 life²⁸.

In this context, 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 *Green Deal* in terms of preserving affordability and access to food, promoting the competitiveness of the agri-food sector and sustainability of production and consumption by reducing waste, reducing emissions that generate environmental impact, promote fair trade or reverse the loss of biodiversity, are not the 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

26 See, <https://ec.europa.eu/food/safety/rasff-food-and-feed-safety-alerts_en>

27 Article 3.2 of the Regulation (EC) 178/2002.

28 See, <https://www.fao.org/fileadmin/templates/faaitaly/documents/pdf/Food_Security_Cocept_Note.pdf>

in 2002, it has been adapted to the needs and changes in the *European regulatory environment* where it operates, so it will not be oblivious to the challenges presented by the roadmap of the *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), and 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 Council²⁹, on the transparency and sustainability of the determination or evaluation of risk in the EU in the food supply chain. This Regulation 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 pro-

tection 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, in its 2020 strategic plan, EFSA “[t]rusted science for safe food Protecting consumers’ health with independent scientific advice on the food chain”³⁰ and has identified a series of potential regulatory gaps where greater collaboration is needed: 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. EFSA's strategic plan proposes specific areas, e.g. firstly, to continue advancing in the improvement of food security but together with an alternative and sustainable production of food systems. In this way, EFSA is maintaining its 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.

7. 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

29 See <<https://eur-lex.europa.eu/legal-content/en/ALL/?uri=CELEX:32019R1381>>.

30 See, <https://www.efsa.europa.eu/sites/default/files/corporate_publications/files/strategy2020.pdf>

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 European Directive 2001/18/EC³¹, approved in accordance with the so-called *precautionary principle*, which addressed some supposed dangers that its consumption could have for the health of consumers and the environment. These dangers have not materialized in more than twenty years during which this Directive has been in force. However, the restrictions it imposes have hampered scientific research and entrepreneurship in the European agro-biotechnology sector. On the other hand, the implementation of 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 EU legislation that regulates transgenic crops. The use of genetic engineering techniques in genome editing procedures was probably decisive in this ruling, and although it is valid to consider that such editing technologies can also be used to introduce genes into specific places in the genomes³², 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 were 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 a logical assumption. 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”³³, has requested the authorities of the Union to make an urgent change in the regulation of genomic editing techniques. The European Commission in a study regarding the status of New Genomic Techniques under Union law³⁴ 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 deepening the studies that could lead to a modification of the current legislation.

8. 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’³⁵, to face the challenges posed by the new food system is becoming more and more important. One of them is globalization as a result of the greater integration of world economies, peoples 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* and 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

31 See, <<https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32001L0018>>

32 In such case we would speak of new transgenic crops.

33 See, <<https://www.eu-sage.eu/>>

34 Published on 29 April 2021 - see, <https://ec.europa.eu/food/plants/genetically-modified-organisms/new-techniques-biotechnology/ec-study-new-genomic-techniques_en>.

35 See, <<https://www.biomedcentral.com/collections/OneHealth>>

global challenges. Finally, 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 education is necessary.

V. Economy, Training and Nutrition in the EU: Are we Moving Towards a New and Increased Inequality in Access to Food?

1. Rich and Poor

Prior to the pandemic, 17% of the European population lives in extreme poverty and 40% is overweight. For that reason, we must 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 redoubled inequality in access to food in the EU. The different realities in the EU related to food approachability, nutritional status and economic availability should be studied from a systematic approach, considering that there can be no sustainable and socially equalised development, if a balance is not maintained between all of them: *Do we save the planet or do we save humanity?*

The “F2F” 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 assumed and integrated as a whole and from a vision of a sustainable global food system.

2. Feed the World: A Challenge of the 21st century

In “Feeding the world. A challenge for the 21st century”, Vaclav Smil states: «the only way to maintain 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 tripling 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 power from work to agriculture ... which makes this option a mere theoretical conception. 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 and organic. Climate change has and will continue to 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, 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 meet the total demand. In any case, it is indicated that the *solvent demand* is considered, that 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 availability, and the destabilization of prices are the gateway to new legions of hungry people. It has been estimated that if there is a 20% rise in real food prices by 2025, the world's undernourished population would increase by 440 million people³⁶. 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 the monoculture agriculture for export. Obviously, it is not about idealizing “primitive” agriculture, but it must be considered that some models of “unbridled” development reveal weaknesses if forms of regulation and guaranteed 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. A very widespread current today, especially among people

36 Senauer, B. and Sur, M., Ending global hunger in the 21st century: projections of the number of food insecure people *Applied Economic Perspectives and Policy* (2001) 23 (1), 68-81 - <[https://scholar.google.com/citations?view_op=view_citation&nandhl=en&user=jwLaDRUAAAAJ&ncitatio-for_view=jwLaDRUAAAAJ:Y5dfb0dijaUC](https://scholar.google.com/citations?view_op=view_citation&nandhl=en&user=jwLaDRUAAAAJ&ncitatio-for_view=jwLaDRUAAAAJ:Y5dfb0dijaUC>)>

who can choose what, when and how much they eat, is the desire to consume food "as 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 while living inside and eating 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 prevention of eggs seems to have been considerably exceeded, which, due to their economic price and 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 in the Technical Report of the JRC Joint Research Centre (2021); nevertheless, it is not adventurous to predict 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 agricultural input reductions. 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. Inequality needs to be solved not only in North America, Europe or Australia, but especially in Asia, Latin America and Africa.

3. Organic Food

Biological or organic 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 convention-

al 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. If there are, they 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. And the allegations or advertisements that suggest that if you do not consume organic food, you do not have a healthy diet, which suggest that if you cannot pay for these foods you are condemned to an incorrect diet, are ethically 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, is an area to encourage. Regarding the possible increase in the prices of organic food with respect 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 products) contribute, especially if they are not used with prudent and restrictive criteria, is a problem that must be considered and combatted. 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. This should always be done with the perspective of producing sufficient, safe and affordable food for the entire population, considering that the danger depends on the amount and repeated exposure.

It must be remembered that all foods properly sold or bought in the EU Internal Market, 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 and 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 and not fall into simplifications, schematics and reductionist approaches. In this framework, 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 from certain misunderstood forms of environmentalism.

4. Healthy and Sustainable Diets

According to the global sustainability standard, EU food is characterized by being statistically safe, nutritious and of suitable quality. On the other hand, access to resources is considered a fundamental question of strategic security for the Commission'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 less processed food 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 of 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 leads the popula-

tion to a double and unfair level of accessibility to food, with citizens who can afford the consumption of certain types of more expensive foods, and those who have been forced to reduce spending on food: the lack of economic resources determines the choice of food purchased. The concept of “nutritional security” contemplates *the constant access, availability and affordability of foods that promote well-being, while preventing and, if necessary, treating disease*. Food, agricultural and trade policies were originally designed to guarantee the quantity rather than the quality or *superiority* of food. A radical transformation of food systems is necessary for all consumers to have access to nutritious, safe, affordable and sustainable diets.

The *Green Deal* strategy projected in the *F2F line of attack*, with its challenges of transforming the way of producing and consuming food in the EU to reduce the environmental footprint of food systems, strengthen their resilience in the face of future crisis and guarantee the availability of healthy and affordable food for the current population and for future generations, can be *an opportunity to eliminate the current scenario of double feeding. 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 disease 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 level of food accessibility” 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 *Green Deal*, the roadmap with which the Commission aims to achieve a sustainable and neutral climate economy by the year 2050, respond to the demands of the Union's upper-middle-income population, but pose the problem of economic accessibility to those foods of low-income consumers. These consumers are especially sensitive to the price in their purchasing choices, and are the segment of the population that suffers the most from disease 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 it also includes among its objectives «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 its Communication on this strategy, the Commission goes further and puts on the table 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 that support numerous studies³⁷. Other authors, however, argue that achieving a healthy diet for all is only possible if food policies are framed within broader economic and social policies that address the grassroots problem, poverty and social inequality in European countries³⁸. Surely this

is the key that can allow the development of all the objectives of the *F2F plan* and eliminate the existing discriminating and recurrent division of economic classes of consumers. 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. We have to understand and accept that there is a risk that the challenge of food insecurity and food affordability will continue to grow. All this is due to the weakening 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 global average demand for animal products and their share 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. Organic agriculture combined with a reduced number of animals in livestock production and reduced food competing feed requirements 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 attending to nutrition deficits to overcome hunger and obesity. For all this, the European Commission has suggested the possibility 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 improve.

European food, which has the prestige of being safe, nutritious and of high 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, fishermen and aquaculture producers, as well as for food processors and suppliers of food services. This

37 Recanatì, F. et al., Assessing the role of CAP for more sustainable and healthier food systems in Europe: A literature review. *Science for the Total Environment*, (2019) 653: 908-919.

38 For instance: Penne, T. and Goedemé, T., Can low-income households afford a healthy diet? Insufficient income as a driver of food insecurity in Europe. *Food Policy*, (2021) 99: 101978.

transition will allow them to be pioneers, making sustainability part of their brand to guarantee the future of food in the EU. 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 supply chain must see this as their responsibility as well as a great *opportunity*. The consumers, whose education begins 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 the sustainable production, promoting local consumption or also including attractive biodegradable packaging systems (obtained without competing with the production of food for human consumption). In any case, this transition will be difficult to be completed without a radical transformation of the economy and a cultural change, producing less and consuming less and in a responsible way.

5. Consumption of Meat and Greenhouse Gases

The consumption of meat contributes approximately 50% of the protein in our diet. Despite a downward trend, worldwide growth is expected until 2050, especially of poultry and pork products. The 2019 report of the Intergovernmental Panel on Climate Change³⁹, 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 and for mitigating its effects. Although in the EU the efficiency of animal protein production is high, based on the analysis of the consequences that a healthier diet would have, Poux and Albert⁴⁰ 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 emis-

sions by 40%. Other studies reach similar conclusions in the United States, but it should be noted that energy consumption and GHG emissions due to the food chain in the EU will not necessarily be reduced by acting only on the 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 cattle rising 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 cattle farming is not part of the circuits of organic husbandry, mechanisms for the recovery of these nutrients must be created to substitute fossil mineral fertilizers (phosphorus) and synthetic fertilizers (nitrogen).

6. Food Loss and Food Waste

The *Green Deal* strategy proposes to intensify the fight against food waste, and achieve a reduction of 50% waste *per capita* by 2030. A third of all food produced globally is lost or wasted, according to the FAO. This equates to about 1.3 billion tons per year, enough to feed 3 billion people⁴¹.

There are several causes of food waste 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. 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 cropland⁴². From approximately one-third of the food produced

39 See, <<https://www.ipcc.ch/>>.

40 An agroecological Europe in 2050: multifunctional agriculture for healthy eating. Findings from the Ten Years For Agroecology (TYFA) modelling exercise (2018). Study (Paris: Iddri-AScA), núm. 09/18.

41 See, <<https://www.fao.org/food-loss-and-food-waste/flw-data/>>.

42 Relationship between food waste, diet quality, and environmental sustainability (2018). PLoS One 13, 18 pp.-
<https://doi.org/10.1371/journal.pone.0195405> (Consulted October 2021).

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 do not contribute to the market and are often produced unsustainably with high inputs from water, nutrients and agrochemicals. Waste occurs in all links of the food chain: production, cultivation, processing, distribution and consumption processes. In other words, farmers, production and transformation, distribution and catering business, as well as consumers, are responsible for the exorbitant amount of food that is lost. Clearly, reducing food wastage offers a complementary approach to the reduction of the use of resources and the environmental impact of agriculture. The *circular economy* in the food sector 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 have trouble getting food, when in fact today more than enough food is produced for everyone.

7. Two Categories of Consumers?

Seventeen percent of the Union's population lives in extreme poverty and 40% is overweight⁴³. In consequence, it is important to analyse the impact of the *Green Deal* on the population from different angles because this scenery can lead to a situation of imbalance, a differentiation between consumers in the EU: on the one hand, citizens who can afford a certain type of diet, for example, organic with more expensive products (but not necessarily safer or more nu-

tritious) and, on 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 prioritize 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 discriminatory segregation: "rich" and "poor" *food consumers*. The need to buy the cheapest products can trigger the guilty feeling of being undernourished, forgetting that a healthy and adequate diet is possible at a reasonable price. In reality, we are not moving towards a first- and second-class groups of citizens; *we are already in it* and we always have been because there have always been populations that are hungry or malnourished throughout the history of humanity. This should not be the case, but, as we have already indicated, it is estimated that currently 17% of the EU population lives in extreme poverty. In the Union we assume that we are not part of the "third world", but we have the "fourth world": the poor of developed countries, that the crisis of the COVID-19 pandemic has increased in number and whose situation has worsened. Despite being a developed continent, Europe still faces problems of food security 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 indicator⁴⁴). Illustrative is the study Food and social inequalities with respect to health in France, 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 diabetes⁴⁵. There is another interesting study, 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 and 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, €4.95 for the beans and €3.15 for the croissant with chocolate⁴⁶.

43 These data predate the impact of the pandemic.

44 See, <[https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:At_risk_of_poverty_or_social_exclusion_\(AROPE\)](https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:At_risk_of_poverty_or_social_exclusion_(AROPE))>.

45 Darmon, N. and Carlin G., 2013. "Alimentation et inégalités sociales de santé en France". Cahiers de nutrition et de diététique, 48: 233-239. 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.

46 Clotet, R., 2016. Alimentación correcta: poder adquisitivo, impuestos y formación. *nuevatribuna.es*, 20 January 2016.

The diet (consumption of necessary kcal) increases dramatically in price by augmenting 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 list of possible actions, in the form of subsidies or taxes, for example, and also with 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 categories of countries in terms of food consumption, divided between countries that mostly consume organic food and countries that mostly consume conventional food. This could occur if there would be an increase in the price of organic food over conventional food due to the possible loss of cultivated arable land, a rise in the cost of inputs authorized to be used in organic farming and as a result of 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 quality of life and education rises, consumers introduce foods in their diet, preferably diversified and new, produced both in the EU and the rest of the world. The modern food consumer 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 insist that the CAP will deepen the path of encouraging models of extensive, diversified, ecological agriculture and the protection of *habitats*, from which a lower harvest per hectare or head of cattle can be expected to result in higher costs. We have also to 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 confirm the opinion that in order to reconcile the balance of our food system with the planet, that is to say its *sustainability*, the planet must be prioritized over the survival and basic needs of its citizens.

The coexistence of two (or more) categories of consumers is caused by 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 bal-

ance in the food system, nor will it be possible to reach a single adequate and sustainable diet for the entire population.

VI. The EU in the International Food Market

1. To Be or Not to Be the World's Leading Exporter and Importer of Agricultural and Food Products

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. Based on the challenges posed by the implementation of the *Green Deal*, the EU's contribution to world food security and future projections could be in danger. Certainly, internationally renowned institutions such as the US Department of Agriculture (USDA) and the abovementioned Report of the Joint Research Centre have expressed their doubts about it.

In the framework of the *Green Deal* presented by the European Commission, 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 the Union 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 substantially world food trade and the food policies of many third countries, 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 thing that should be analysed is what the driving forces behind the expected 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 organic food. This second driving force is very important and can have enormous consequences outside the EU.

2. The USDA Report

After the publication of the “F2F” and Biodiversity strategies, 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. Unexpectedly, this task has been carried out by the USDA in its Report titled “Economic and Food Security of Agricultural Input Reductions Under the European Union Green Deal ‘Farm to Fork’ and Biodiversity Strategies”. In the USDA Report 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 operators 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 USDA Report 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. The number of food insecure people in the world would increase by 22 million by 2030, according to this study. It shows also how the adoption of the *Green Deal* would cause a significant reduction in production in the EU, which would lose competitiveness in world markets and an increase in prices and the cost of food.

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.

Along the same lines, the abovementioned Report by the Joint Research Centre, a study carried out by the Commission's internal scientific service, 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%.

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.

Summary of the main impacts of the Strategies under the three scenarios¹

	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	2
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: middle³			
Production (percent change)	-11	0	-4
Prices (percent change)	60	1	21
Imports (percent change)	-10	-7	-9
Exports (percent change)	-10	-2	4
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	17
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

However, estimates of the impact of the *F2F 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 nec-

essary 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 in the USDA Report, the scenario in which only the *Green Deal* is adopted within the European Union does not make sense. Since the commercial markets are interdependent, the third world 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 producer 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).

3. Competitiveness 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 competitiveness of European productions and consequently will affect the balances 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. What is more, all this coincides with a growing pressure of demand for food worldwide and with an increasingly active climate change causing the destruc-

tion of resources and production. Faced with a drop in production, an alternative would be to import from third world countries outside the European Union to guarantee the food supply in the Internal Market. This carries the risk of exporting unsustainable practices. That is, to produce in other countries without the same environmental limitations as in Europe. The European Commission 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 the World Trade Organization (WTO). As a matter of fact, 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 Special Rapporteur on the Right to Food: «we must stop treating food as a basic product and treat it as a common good».

4. 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 agro-

chemicals is very low (5 kg of fertilizer per hectare) and the margin for increasing yields is enormous, 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). 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*. It may be that 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, 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.

5. EU Products Sustainability

European foods have the prestige of being safe, nutritious and of high quality, *now they also aspire to be the world reference for sustainability*. Citizen expectations are already evolving and driving significant changes in the food market. But the environmental ambition of the *Green Deal* will not be achieved if the Union acts alone. The drivers of climate change and biodiversity loss are global in nature and not limited by national borders. Without going any further, the EU imports practically all of the soy consumed in the Internal Market, as well as significant quantities of meat and other essential agricultural products. Currently each country defines and establishes dif-

ferent criteria in relation to sustainability, and if clear requirements for imports are not incorporated, the improvements achieved in the Union 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 accords.

The EU-28 cattle raising 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 world producer behind 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.

6. 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. It is possible that 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 world countries, if commercial channels are not ensured by strict regulations, since they can be direct competition from the Union's producers for offering more affordable prices with less bureaucratic burdens. In short, the EU has legislative and regulatory instruments on agriculture, cattle raising, 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.

7. 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 in prices of 17% on a Union's scale and what is important, a 9% on a world scale. This increase in prices on a world scale would imply that 22 million people would worsen their current level to fall into hungry and malnutrition (all of them in developing countries). This increase in prices on a EU scale represents an increase in food expenditure that would rise to 153 EUR / person (about 600 EUR / year for a family of four members). Regardless of the precision of these forecasts and calculations, the trends it offers are undoubtedly consistent. A unilateral option for the European Union entails a loss of competitiveness 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 *F2F Strategy* not only responds to the objective of reducing environmental impact and mitigating climate change, but also meets the demand of EU consumers, who are increasingly sensitive to safe food without waste agrochemicals 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. But until then many small- and medium-sized producers have been able 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 *new 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 Commission refers to the “enormous economic opportunity” that the transition towards a sustainable food system represents for “farmers, fishermen 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 food businesses will be the most vulnerable*. In addition, many of these *businesses* could have solvency problems due to the pandemic crisis. Unlike other sectors, small- and medium-sized *businesses* 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 professional objectives and capabilities and, at the same time, obtaining sustainability certificates is perceived as an incentive commercial and also fiscal. 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 competitiveness of the products of the Union's 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 Member States can contribute with economic aid to mitigate 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.

We do not have to forget the convenience 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.

8. Need for a Holistic and Integrative 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 them is globalization as a result of the greater integration of world economies, peoples 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 threats already controlled. In this process, the EU Institutions will need to ensure that the existing high standards of food safety are universally adopted.

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. Global food security has been worsening 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 worsening of global food security more than the EU's *F2F Strategy*, which would instead produce notable benefits in preserving the environment and natural resources and in palliating climate change. Even more important would be the adaptation to climate change in agriculture, which would mitigate the impact of climate change on reduced

crops. To achieve the objectives of sustainable food production in the international context, the EU Institutions 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 investment in countries with fewer resources to facilitate the adoption of more sustainable processes.

During this entire period, how to achieve a “sustainable bubble or capsule” in the Union and not lose competitiveness with the rest of the world? The EU Institutions are firmly convinced of 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.

9. The EU World Reference in Production, Transformation and Sustainable Consumption

We have already analysed a little-considered factor. In the average of the last three years, photosynthetic production in the EU (based on agriculture, aquaculture and intensive cattle raising) potentially destined for human consumption is practically in balance with the available consumption data. The result considers the EU as a world power in food processing, but the results show 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; 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.

VII. 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 our article. The complexity of this environment has led the Commission itself to request an assessment of its communication on the *Green Deal strategy* from one of its most active Joint Research Centres (JRC). According to the conclusions of this JRC 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 world countries resulting from this loss of production. This result is also aligned with the USDA Report. It should be noted that, according to the authors of the JRC Report, the study 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 that consider the participation of processing businesses, 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 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 im-

pact, before adopting legislative measures too hastily. We have analysed the impact of the *Green Deal* from the approach of the ‘Triptolemos Foundation’ to the sustainable global food system. The JRC Report and the USDA Report are aligned with some of the opinions of this article, 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 Union but also worldwide, so that politicians, representatives of society, approve the essential legal necessities, based on reliable, independent and trustworthy 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 Union's 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. This is even more serious if the enormous edaphoclimatic and cultural differences among the different Member States 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 food 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 long-lasting and sustained over time, accepting the need to preserve its security of supply and competitiveness, through quality food, safe and respectful of the environment and social conditions.

Europe must take advantage of this opportunity (perhaps the last) to position itself at the 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.

Following the document on this matter of the 'Tripolemos Foundation' we have scrutinized and evaluated the impact of the *Green Deal* from holistic conception of a sustainable global food system which is defined in four interrelated axes: 1) availability and accessibility, 2) economy, 3) legislation and regulations and 4) knowledge, behaviour and culture. The four axes are aligned with the 17 Sustainable Development Goals (SDGs)⁴⁷. The challenges identified in

this article 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, the stability is terminated.

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 these elements: *this is a challenge*.

⁴⁷ The 2030 Agenda for Sustainable Development <<https://sustainabledevelopment.un.org/content/documents/21252030%20Agenda%20for%20Sustainable%20Development%20web.pdf>>.