Carbon Footprint and European Green Pact

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Agriculture and related activities generate a significant amount of greenhouse gas emissions with environmental and biodiversity implications. In the European region, the organically cultivated area and economic growth reduce the carbon footprint, while fertilisers, aquaculture production, investments in road infrastructure and agricultural area determine its increase. The EU has changed its paradigm since 2008–2009. Economic growth has been slowly decoupling from the carbon footprint since 2016, and the rest of the factors analysed have become more environmental since the late 2010s. The EU has positioned itself towards achieving the objectives set by the Green Pact at a slow pace, justified by the heterogeneity of members' national characteristics, in addition to its purpose not to harm the food security of the population. In order to achieve the objectives proposed by the Green Pact, it is necessary to focus on more extensive organic farming and traditional production methods, more extensive efforts to reduce nitrogen surplus in fertilizer content, to support short agri-food chains and to identify new production techniques, including the use of nanotechnology and high-performance technologies.

Keywords: carbon footprint ; agricultural chains ; economic growth

1. Introduction

Climate change and environmental degradation are major current concerns. The main objective, of the EU through the Green Pact, according to the European Commission (2021) [1], is for the EU to become a competitive and resource-efficient economic formation. They intend to eliminate greenhouse gases by 2050, and to decouple the process of economic growth from the use of resources, without omitting any person or region. European policies in the fields of climate, energy, transport and taxation will be in line with the goal of reducing greenhouse gas emissions by at least 55% by 2030, compared to the 1990s. The Green Pact focuses its actions in eight directions, i.e., climate, environment and oceans, energy, transport, finance and regional development, industry, agriculture, research and innovation. The European Commission (2021) [1] considers the European agricultural and food system to be a standard of safety and security in terms of supply, nutrition, and quality, however, this standard should become a benchmark in terms of sustainability. There would be social, environmental, health and economic benefits. This is the reason why the EU ensures food security in the context of climate change and biodiversity, to reduce the impact of the agricultural and food system on the environment and climate, to strengthen food resilience and determine a global transition to competitive farm-to-consumer sustainability [1].

The above context motivates researchers to assess the carbon footprint of agricultural chains in the case of European OECD member countries. The carbon footprint refers to a certain amount of greenhouse gas emissions, relevant to climate change, associated with human activity related to production and consumption, although etymologically, it would be described as an exclusive measure of dioxide emissions. Carbon results directly or indirectly from an activity or is accumulated over the life cycle of a product [2]. It is also believed that the carbon footprint measures the intensity of greenhouse gases in products, bodies and processes which take place worldwide [3].

In Europe, the agricultural sector is very different among regions [4], and agricultural sustainability is not high enough. Agriculture is the largest contributor to anthropogenic greenhouse gas emissions; therefore, the quantification of various specific and related activities is essential [3]. The mechanisation of agriculture has greatly increased productivity and production, contributing to industrialisation but there are implications for the environment, especially concerning the carbon footprint [5]. Agriculture is the main source of nitrogen pollution due to increasing product demand and inefficiency along the entire food supply chain, from the production of synthetic fertilisers to waste management [6]. It generates 20% of anthropogenic greenhouse gas emissions due to fuel consumption, land use change, soil cultivation, nitrogen oxide emissions, animal waste and enteric fermentation [7]. Within the agri-food chain, the agricultural stage bears the highest impact on final products and on the environment [8], but supports food security too. Climate change and biodiversity destruction due to anthropogenic action require a change in vision and in the understanding of the system in which agricultural and food policies operate [9].

2. Key Factors of Carbon Footprint

Agriculture has a complex multiplier effect in all sectors of the economy. The role of agriculture and its effects on the carbon footprint are an important scientific concern. Agriculture is related to two challenges of global sustainability, climate change and biodiversity loss [10]. It is associated with problems related to pollution, disruption of nutrient cycles, scarcity of drinking water, hunger, poverty and the struggle for resources. Intensive agriculture, as shown by Garske et al. (2021) [10], is responsible for about a quarter of the carbon footprint and three quarters of biodiversity loss, and if the reporting includes the entire food sector, the percentage increases. Schiavon et al. (2021) [11] note that there is a vicious circle between agricultural production and climate change in which agriculture is a trigger and a victim, which is why climate and energy targets provide for a 40% reduction in emissions by 2030 for all sectors of the economy, which implies changes including in agriculture as well. Jehlićka et al. (2020) [12] note that the technologically and economically sophisticated industrial agri-food system, adopted almost globally and a landmark for less developed countries, contributed to soil degradation, biodiversity loss and climate change, thus calling sustainability into question.

The carbon footprint began to increase with the mechanisation of agriculture, and the maximum threshold was reached in the first decades of the agricultural industrialisation process, according to Aquilera et al. (2019) [5]. The carbon footprint can be traced from the direction of five economic sectors, i.e., energy, industry, construction, transport and AFOLU (agriculture, forestry and other land uses). A study by Lamb et al. (2021) [13] for the period 1990–2018 reveals that at the European level there was a modest decarbonisation of energy systems, and the region was the only one in the world to reduce its carbon footprint since 2010. Europe pollutes the most through energy systems, industry, transport and, to a lesser extent, through AFOLU. The EU has reduced its carbon footprint by 8% since the early 2000s, the main determinant being technology, but the effort is minor and visible only in 2007–2008 [14].

The calculation of the carbon footprint of food production systems for 14 European countries covering 65% of global food production in the period 2000–2014 showed that the carbon footprint decreased and its determining factors were GDP per capita, population density, nitrogen fertiliser production, agricultural area, animal production and per capita energy consumption per capita [15]. Crippa et al. (2021) [16] consider that agriculture and agricultural land are sources of the highest contribution to the carbon footprint, followed by retail, transport, consumption, fuel production, waste management, industrial processes and product packaging. According to the study by Crippa et al. (2021) [16], in 2015, 27% of emissions were from developed countries, 73% from developing countries, and over 71% were associated with land use for agricultural purposes. Tubiello et al. (2021) [17] show that the agricultural area, the energy consumed on the farm, the transport of products and food waste disposal significantly contribute to the carbon footprint. Renner et al. (2020) [18] also claim that agriculture generates half of the carbon footprint.

Organic production contributes positively to agricultural and natural biodiversity compared to the conventional one [19]. Meier et al. (2015) [20] consider that organic farming has a low impact on the carbon footprint compared to conventional agriculture if the cultivated area is analysed. The impact increases if the quantity produced is analysed, especially under the influence of chemicals contained in fertilisers. Stoi et al. (2020) [21] consider that organic production is a solution to environmental problems such as global warming, biodiversity loss and desertification. Organic farming adds value to local economies, however, the demand for organic products is low [22], and the decision to consume organic products is related to environmental issues.

Fisch-Romino and Guivarch (2019) [23] assessed the need to invest in transport infrastructure, given that this activity is one of the largest emitters of greenhouse gases since the 1970s. The transport effect on the carbon footprint must be reduced if people want to keep the global temperature rise under two degrees Celsius. Analysing the relationship between transport infrastructure and the carbon footprint for OECD countries for a period of about 150 years, Churchill et al. (2021) [24] conclude that transport infrastructure determines the long-term carbon footprint. Investments in road and air transport infrastructure increase the carbon footprint, while those in railroad infrastructure contribute to its reduction, according to the conclusions of Erdogan's study [25] for 21 OECD countries in the period 2000–2015. Road transport is responsible for 74% of emissions from the entire sector [25]. Therefore, investments determine the quality of the environment by promoting the use of conventional vehicles, which contribute to the increase of carbon footprint. The same study argues that investments in infrastructure involve constructing roads which cause biodiversity loss, degradation of drinking water sources, and which change the destination of land.

Given that transport is the second most important determinant of the carbon footprint, Georgatzi et al. (2020) [26] analysed the relationship between emissions and transport activity for 12 European countries between 1994 and 2014. The results show that investments in transport infrastructure do not affect carbon footprint. They are located at the intersection of climate and development issues and, although they do not reduce the absolute carbon footprint, they reduce the intensity of pollution, except for those in road infrastructure which have a neutral effect.

Fertilisers are an important component of the agricultural chain, necessary for food security, which contributes to carbon footprint increase [27]. Agriculture depends on large amounts of fertilisers and pesticides and, according to a study conducted by Tripathi et al. (2020) [28], excessive use of chemicals and technology has led to severe environmental degradation, more specifically to soil pollution and biodiversity degradation with irreversible effects on long term. The shift from the use of chemical to organic fertilisers increases agricultural productivity in a sustainable way according to a study by Koondhar et al. (2021) [29]. The researchers claim that, in the long run, reducing the carbon footprint in agriculture by 10% leads to increased production. Improper use of fertilisers is the reason of the increase in the carbon footprint [30], which is why the main challenge in organic agriculture is precisely the improvement of fertiliser management [31]. Organic farming involves the use of methods which exclude the intake of chemicals, consequently the use of fertilisers in small quantities reduces the carbon footprint, but also the agricultural yield [32].

Aquaculture is a developing sector, with a growth rate of about 6%, which increases its carbon footprint without an accurate estimate of its impact, only the certainty that it will increase. In 2030, anthropogenic emissions from aquaculture production will likely account for 5.72% [33]. Aquaculture production contributes to the carbon footprint through energy consumption, transport and feed. The contribution of this activity to the carbon footprint is low according to Maulu et al. (2021) [34] but compared to other activities in the food sector it is significant. MacLeod et al. (2020) [35] argue that aquaculture production has modest effects on the carbon footprint, but they increase post-production. The direct and indirect contribution of aquaculture production to food security is important, but not harmless to the environment. The researchers claim that in 2017, approximately 0.49% of the carbon footprint was caused by aquaculture production. According to Gephart et al. (2021) [36], aquaculture production negatively affects the carbon footprint, but not as much as land use. The conclusions lead people to analyse the research hypothesis, (H_3), according to which *fertilisers, agricultural area, aquaculture production and investments in transport infrastructure reduce the carbon footprint in OECD member states*.

This draws attention to the role of short production and supply chains. In Europe, short agri-food chains play an important but marginalised role. A study conducted in 15 European countries by Rivera et al. (2020) [37] shows that the European system is dominated by large agricultural producers, able to achieve increases in productivity, efficiency and economies of scale. Small producers, more traditional in production methods, are marginalised on the market, although they have an important contribution to agri-food security, support local biodiversity, contribute to environmental sustainability, maintain agricultural culture and resilience of local communities.

Agricultural area, road transport infrastructure, organically cultivated area, fertilizers, and aquaculture production are components of the agricultural chains. Their study is of interest in assessing the carbon footprint of European OECD member countries along with economic growth, an important process to ensure well-being. The importance of agricultural chains crystallizes two other research hypotheses, i.e., (H_4), European agricultural chains reduce the carbon footprint of each European OECD state, and (H_5) the agricultural chains of European OECD member states have contributed, since the end of the first decade of the 2000s, to the carbon footprint reduction.

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