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ORGANIC FARMING POTENTIAL FOR CLIMATE CHANGE RESILIENCE AND ADAPTATION IN BULGARIA

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Abstract

Climate change is a global challenge, reshaping and transforming production and consumption patterns. In order to meet the EU Green Pact's ambitious objectives, agriculture has to reduce energy consumption and improve resource efficiency. Organic farming is a sustainable approach with a significant role in climate adaptation strategies, offering possible pathways for resilience and mitigation of climate change effects. The paper focuses on exploring the potential of organic farming in the context of climate change efforts. Given the complex influences, the study emphasizes the need to assess the benefits and challenges of organic farming while identifying opportunities for mitigating climate change. The survey is based on data from EUROSTAT and European Environment Agency methodology. It conducts a systematic literature review on the prospects of organic farming in addressing climate change through resilience and mitigation. The results show that organic farming provides prospects for greenhouse gas emissions reduction, an adaptation of the farming system, soil fertility improvement and biodiversity maintenance. On the other hand, there are some challenges related to organic practices, such as lower productivity, market access and economic barriers, certification requirements and costs, and knowledge and research issues. The EU makes efforts to achieve climate neutrality, and agriculture is at the centre of the policies and regulations, which presents its essential role in green transformation.

Key words**:** *sustainable farming, greenhouse gas emissions, Green Deal*

INTRODUCTION

Climate change is a global challenge that is transforming the production and consumption systems. The Intergovernmental Panel on Climate Change (IPCC) report states "the global average temperature has increased by 1.09°C in the last decade compared to the pre-industrial period between 1850 and 1900". [48]. Greenhouse gas emissions from human activities, including the agricultural sector, are considered major drivers of the temperature rise [4, 28, 47, and 78]. Agriculture significantly contributes to the issue while being highly vulnerable, particularly related to the crop production results. The sector is defined as the cause and victim of climate change by [64]. In order to achieve the goals presented by the EU Green Deal, agriculture has to minimize energy consumption and be more resource-efficient. [21, 93]. The EU Farm to Fork Strategy included "a reduction of the use of fertilizers by at least 20% and the use of chemical plant protection products by 50% "[22].

Climate change leads to new patterns of production closely linked to sustainable development. Climate-resilient paths of adaptation are essential steps toward a climate-neutral Europe. Sustainable agriculture systems are needed to help the agricultural sector transform and adapt to the changing weather conditions. Organic agriculture is defined as a sustainable way to produce food [77].

The EU Organic action plan targets "25% of the EU utilized agricultural area to be organic by 2030" [23].

The paper aims to outline organic farming potential in the context of climate change paths of resilience and adaptation. Due to the complexity of climate change impact, there are no simple answers.

Therefore, it is important to observe the benefits and challenges related to organic farming and to highlight future opportunities for climate change mitigation.

MATERIALS AND METHODS

The study is based on EUROSTAT data and follows the methodology provided by European Environment Agency [26].
The survey aims to present a systematic literature review directed towards the potential and prospects of organic farming in climate change adaptation, resilience, and mitigation. The methodological framework is based on the survey of [92]. The keywords used in the survey are: organic farming, climate change, adaptation, and resilience. Specific search criteria are applied to filter and sort the research terms. Articles, reports and documents that met the criteria are reviewed, with those outside the study's scope excluded.

RESULTS AND DISCUSSIONS

Agriculture's contribution to greenhouse gas emissions

Paris Agreement tend to combat climate change and boost the low-carbon economic development [29]. The document discusses two major aspects - emission reduction and capturing CO2 from the atmosphere [73]. In order to follow the Paris requirements, the European Climate Law is presented in 2021.
Greenhouse gas emissions from economic activities are related to anthropogenic climate change. The EU has an essential role in the attempts and steps to combat climate change by reducing greenhouse gas emissions and achieving climate neutrality [21].

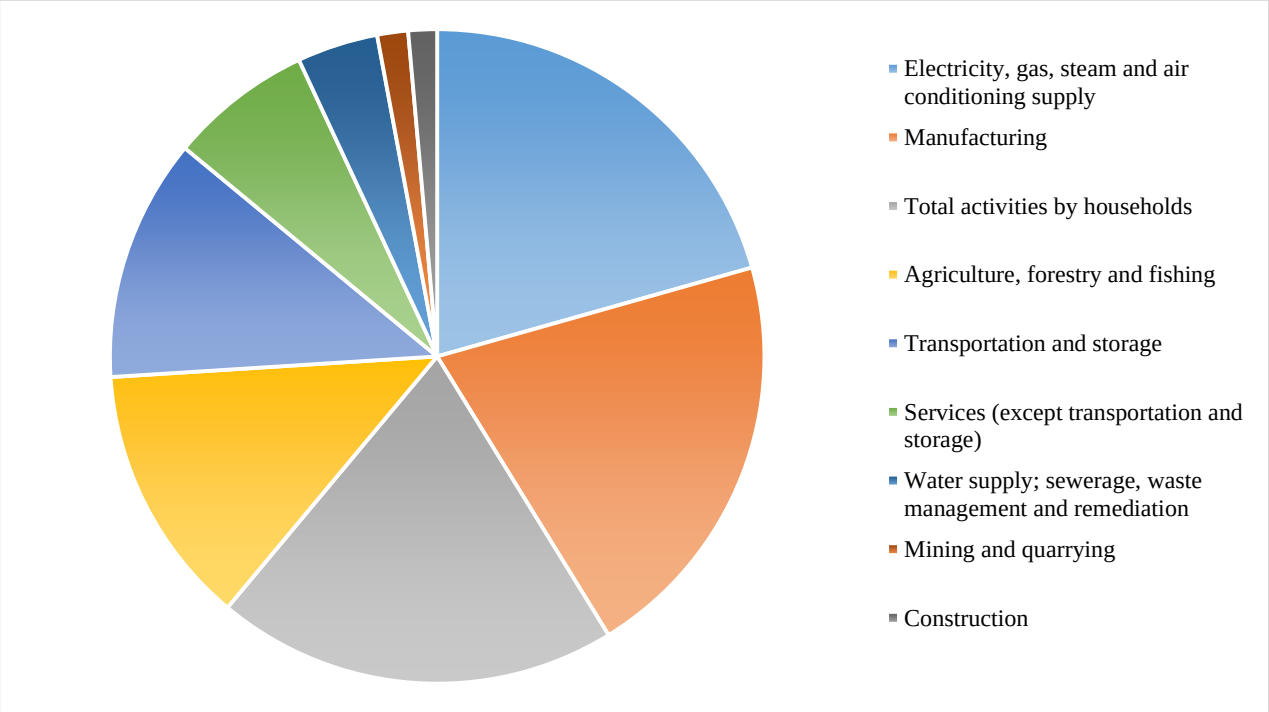

Fig. 1. Greenhouse gas emissions by NACE classification in the EU, 2022.
Source: [26].

According to Eurostat [26], greenhouse gas emissions decreased from 1990 to 2022. The latest data from 2022 shows that they are 3.5 billion tons of CO_2-equivalent, a reduction of almost 30% for 1990-2022.
Due to the COVID-19 crisis, the indicator dropped significantly in 2020, followed by a slight increase in 2021 and 2022. The target proposed for 2030, a reduction in emissions by 55% compared with 1990 levels, is still an ambitious goal.
At the national level, the highest decrease is registered in Germany (-485 million tons), Romania (-147 million tons) and France (-139 million tons). On the other hand, in three Member-states, a growth is recorded – Spain (+17 million tons), Ireland (+7 million tons) and Cyprus (+3 million tons). In Malta and Portugal, no difference is observed.

According to Eurostat data [26], greenhouse emissions are decreasing in almost all sectors, except fuel combustion in transport. The highest absolute reduction is recorded in the energy sector connected to electricity generation. Significant reduction is registered in fuel combustion in manufacturing industries and construction.

In 2022, the highest share of greenhouse gas emissions is concentrated in electricity, gas, steam supply and manufacturing, with around 21% (Figure 1). Agriculture, forestry and fishing generate 13% of the greenhouse gas emissions. It can be concluded that agriculture still remains a major contributor to the emissions and a cause of climate change and global warming. Mining and construction represented the lowest share of greenhouse gas emissions.

Based on the United Nations Framework Convention on Climate Change methodology, greenhouse gas emissions in agriculture represented 11% of all recorded in 2022 [26].

From 1990 to 2022, the sector decreased emissions by 117 million tons of CO_2-equivalent, or around a 24% reduction.

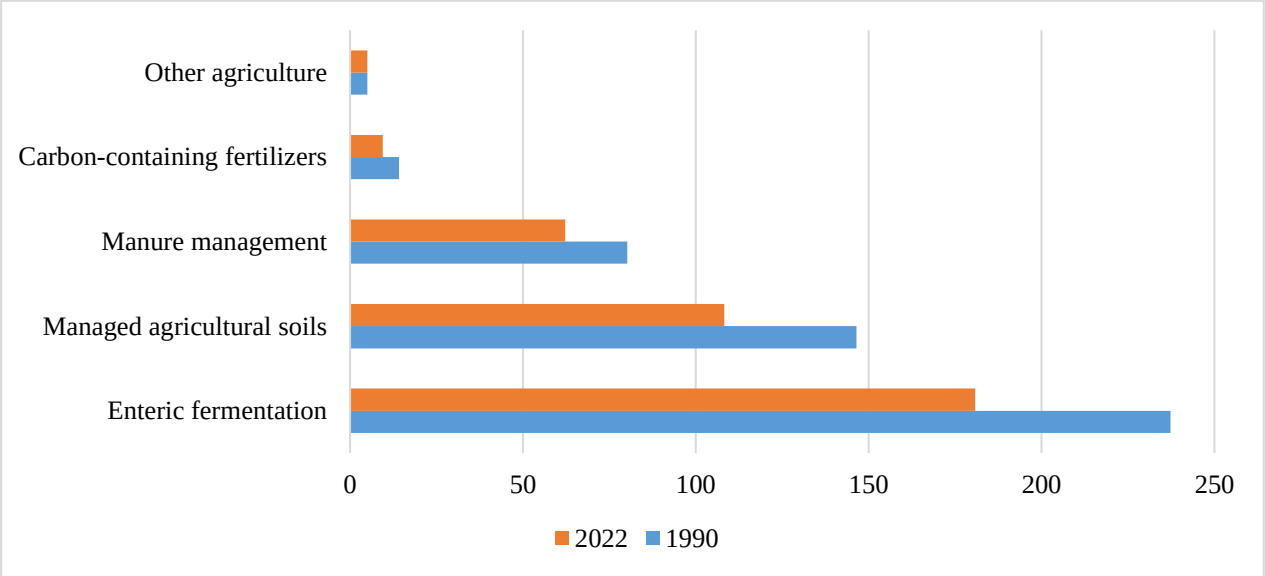

Fig. 2. Greenhouse gas emissions from agriculture, 1990/2022 (million tons of CO_2 equivalent)
Source: [26].

Methane emissions from enteric fermentation (49%) are the primary source of emissions, followed by managed agricultural soils (29%) and manure management (17%) (Fig. 2).

According to Eurostat data [26], for the period 1990-2022, enteric fermentation decreased by 24%. The main part of the emissions comes from cattle digestion. The highest decrease in this direction emerged during the first decade, and the emission dropped only 8% from 2001-2022.

Managed agricultural soil emissions decreased by 26% and carbon-containing fertilizers by 33%.

The EU archived serious progress in reducing emissions and has adopted several regulations, such as the Regulation on binding annual GHG emission targets by Member States for 2021-2030 and the Regulation on the inclusion of greenhouse gas emissions and removals from land use, land use change and forestry in the 2030 climate and energy framework [26].

The agricultural sector is the centre of the global, European and national effort to adapt to climate change and improve resilience.

European Environmental Agency published a comprehensive study on climate change adaptation in the agricultural sector in Europe [19]. The document emphasized the policy context in fighting climate change effects and developing adaptation and mitigation measures (Figure 3).

International agreements and policies play a crucial role in setting the framework and shaping future patterns in climate change adaptation. The Paris Agreement is a major effort towards adaptation measures and

mitigation actions directed at achieving less vulnerability in food production systems [91]. The Paris Agreement highlighted the importance of resilience fostering and lowering greenhouse gas emissions targets in agriculture without endangering food security. [66]. The Paris Agreement led to the countries' commitments related to their priorities and measures. Most countries participating in the United Nations Framework Convention on Climate Change place agriculture at the core of their mitigation targets and adaptation strategies [19].

The Sendai Framework for Disaster Risk Reduction and the Sustainable Development Goals are other major milestones in global efforts for climate change mitigation, adaptation and resilience. The Sendai Framework for Disaster Risk Reduction establishes targets and outlines four key priorities for action related to deserter risk reduction, governance and responses [89]. The 2030 Agenda for Sustainable Development [90] is another substantial attempt to mitigate climate change, putting agriculture in different SDGs aspects. In addition, FAO (2018) also published a guide for the agricultural sector's transformation to achieve the UN targets [30].

On the other hand, agriculture can lead to negative impacts on soil, water, biodiversity, air quality [18]. Therefore, a number of regional and national adaptation strategies are developed.

At the EU level, policies are made to address the issues related to agriculture's environmental impact. At the national level, EU Member States implemented adaptation strategies and/ or action plans linked to their specific features and needs.

After 2013, in 2021, the new EU adaptation strategy was adopted. It included four principle objectives: “to make adaptation smarter, swifter and more systemic, and to step up international action on adaptation to climate change.” [24].

The Common Agricultural Policy (CAP) developed the main policy framework for the agriculture.

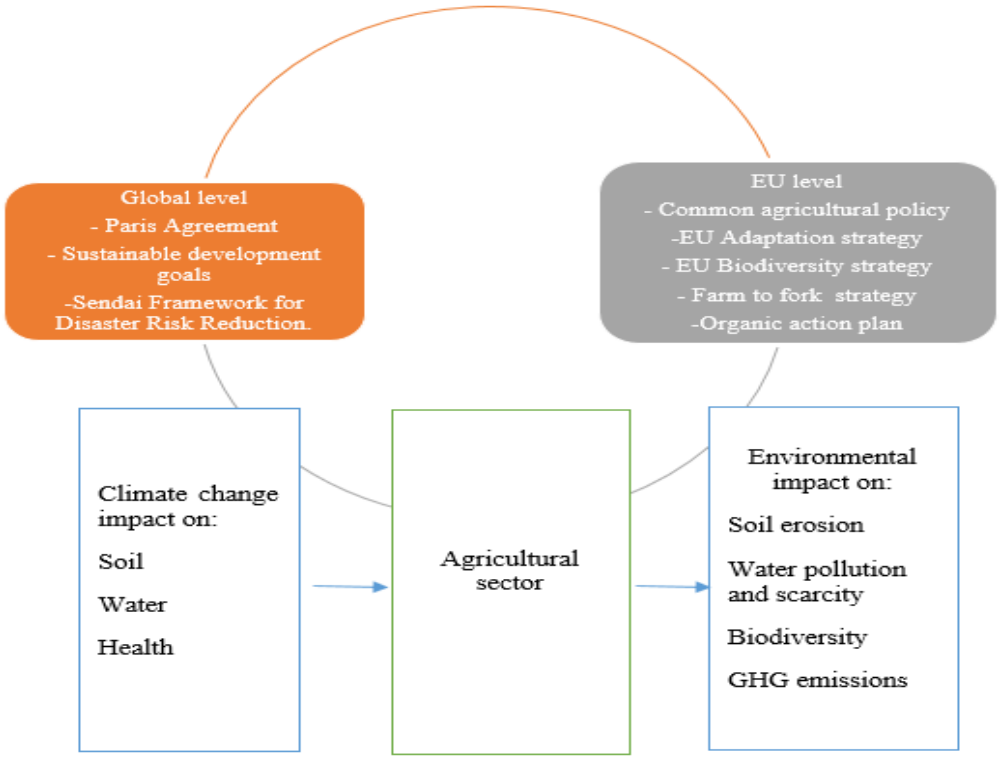

Fig. 3. International and EU policy framework for climate change adaptation in the agricultural sector
Source: Own survey based on [19, 50]

In the new programming period 2023-2027, the policy implemented higher greener ambition and efforts to achieve the Green Deal targets. In addition, there are eco-schemes (25% of the budget), and 40% of the CAP budget is climate-relevant [25]. Studies assessed the potential of CAP Strategic plans under Pillar II to help mitigate and adapt to climate change [12, 16, 60].

The EU adaptation strategy and the CAP allow Member States to help the agriculture sector adapt and be more resilient to climate change. Environmental policies on water management and biodiversity further support these efforts.

In addition, the Green Deal presented the Farm to Fork Strategy in order to ensure sustainable food production [22].

The 2019 report of EEA [19] proposed several measures for adaptation and mitigation to climate change. They include adapted crops, cover crops, crop diversification and rotation, no-tillage and minimum tillage, precision farming and organic farming. According to the document, organic agriculture has the potential to increase resilience toward extreme weather conditions [19].

Organic farming and climate change resilience and adaptation

Organic agriculture is a farming system that focuses on "biological pest control, crop rotation and composts to maintain soil fertility, with no use of synthetic pesticides and fertilisers" [45]. In recent decades, surveys have compared organic and conventional agriculture results and effects. At the beginning of the new century, a number of studies analyse the potential and impact of organic farming in mitigating climate change [39, 45, 51, 85].

There are serious efforts and global support for promoting organic agriculture as an option for climate change resilience [10, 70]. Its potential is linked to reducing greenhouse gas emissions while increasing soil carbon sequestration [45].

Recently, IFOAM EU and FiBL [44, 46] published two reports related to the role of organic farming in climate change mitigation and adaptation. Based on the literature review and surveys, the documents highlighted the main benefits of organic farming (Figure 4). The reports outline three groups of benefits linked to the organic farming systematic approach: (1) Mitigation of climate change; (2) Supporting adaptation to climate change; (3) Creation of resilient farming systems.

Based on the advantages highlighted by FIBL and IFOAM reports [44, 46], a literature review is made to observe the main features of organic farming's potential for climate change adaptation and resilience.

Long-term field experiments concluded that organic farming maintained and/or increased soil organic carbon and soil productivity [65, 71]. In the United States, studies indicated that organic amendments and cover crops led to a bigger accumulation of soil organic carbon [55, 62, 75].

According to [39], which show similar to the latest FIBL reports [44, 46], organic farming practices that can reduce greenhouse gas emissions and increase soil carbon sequestration are associated with (1) Lower fossil fuel consumption and reduced energy inputs. (2) Substitution of fossil fuels with organic biomass (3) Higher soil carbon sequestration in organic farms (4) Reduced carbon losses due to decreased soil erosion. According to some studies [58, 68, 72, 81, 86], organic farming systems reduce energy dependence and improve energy efficiency. Some authors outlined that energy inputs for organic production are 30% lower than for conventional farms [68, 69]. In organic farming, energy consumption is lower due to the lack of mineral fertilization [58]. Organic livestock farms are more energy-efficient than conventional ones [1], consuming 70% less energy due to reduced reliance on imported feed [54]. A study found that while organic farming relies more on machinery, the energy demand per hectare was 21% to 35% lower than conventional systems [67].

The improved agricultural practices and techniques in organic agriculture can lead to better soil structure, higher soil water infiltration [38, 57], and decreased soil erosion and carbon loss [38, 59]. Some authors [9, 79], considered that organic farming improves soil fertility.

Soil organic matter across the EU has declined due to land management in farms and climate conditions [84]. By improving soil quality and fertility, organic farming can help counteract this decline and significantly increase soil organic carbon sequestration compared to conventional agriculture [41, 52].

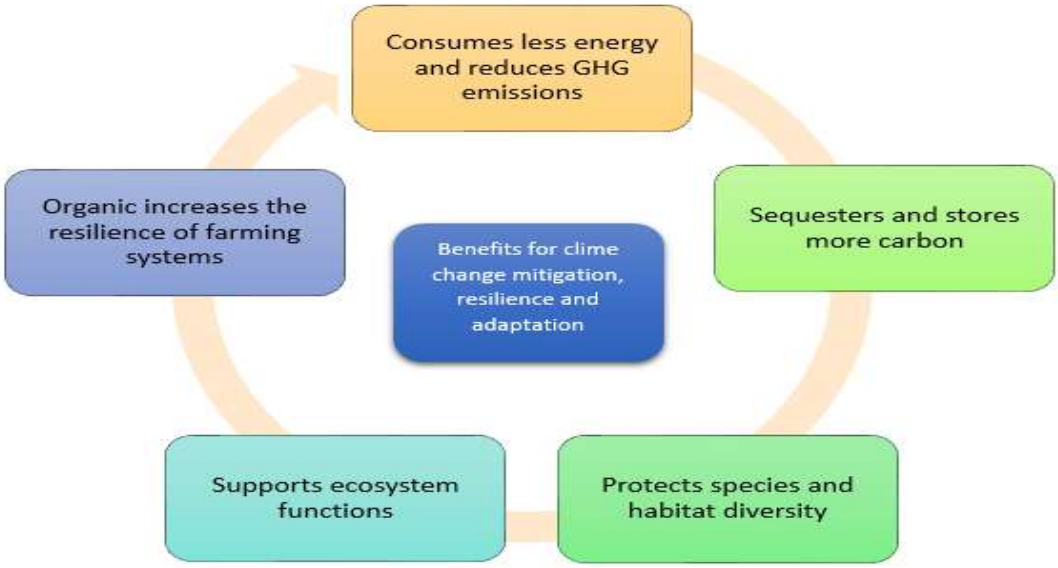

Fig. 4. The multiple benefits of organic farming for climate change
Source: Own survey based on [44, 46].

Organic agriculture is linked to a diverse range of crops, rotations, and farming practices [64], which improves farm resilience [7, 33, 35, 51, 59], and pest prevention [71, 96]. In addition, it optimises the use of soil water and nutrients [2].

Surveys concluded that fertilisation significantly impacts the carbon footprint in crop production [32, 49]. Several authors highlighted that organic farming can minimise nutrient losses [11, 13]. In addition, studies indicate that eliminating synthetic fertilisers can reduce global greenhouse gas emissions by about 20 % [77]. Organic farming could close the nutrient cycles and optimise nutrient availability to lower nitrogen levels. Some authors reveal that organic systems emit around 40%-45% less nitrous oxide per hectare compared to conventional [80].

Methane from enteric fermentation is a significant source of agricultural emissions, alongside nitrous oxide. Organic farming is related to strict limits on the number of animals per hectare to match the land's holding capacity [46].

According to Eurostat data [26], manure management concentrate around 16 % of the agricultural emissions. Manure composting has the potential "to reduce nitrous oxide by 50% and methane by 70% "[46].

Studies indicate that organic farming is capable of adapting to challenging environmental conditions while producing lower greenhouse gas emissions [5, 82, 95]. Skinner et al. [80] pointed out that that organic farms can produce significantly fewer emissions than conventional ones.

Furthermore, research shows that organic farming can help improve soil fertility, decline emissions, and boost climate resilience [94]. Some authors [34, 37] highlighted that organic agriculture leads to less emissions and is also environmentally friendly.

Climate change's consequences can be global challenges and probably will increase in the future. Healthy soils and higher soil organic matter improve water retention, reduce erosion, and enhance the resilience of organic farming to changing weather conditions.

Sustainable resource use, diversified production systems, and innovation are essential for building socio-economic resilience. Some authors outlined that organic farming can help farmers to adapt to climate change and be more resilient to extreme weather and land degradation [3, 39, 76].

Organic farming is an alternative that is closely linked to the concept of sustainable development [15]. The fight against hunger and poverty requires agricultural practices that preserve healthy ecosystems [15]. Several studies have analysed the relationship between organic production and the preservation of the environment [20, 82, 88].

The positive impact of organic farming systems on biodiversity is investigated in the scientific literature [7, 38, 59, 90, 87, 91]. Several studies show that organic farming promotes species diversity [43, 53] and supports rare insects [56]. Biodiversity in species and habitats strengthens adaptability to extreme weather events and environmental issues [17, 40].

Along with the benefits related to organic farming, there are number of challenges [42, 64, 83]. According to some authors, the major weaknesses of organic agriculture are lower yields and lower productivity. [8, 14, 63]. The lack of pesticides and herbicides in organic farming can make crops more vulnerable to pests, diseases, and weeds, especially as climate change has increased these threats. [64]. Certification costs present another challenge for organic farming, creating barriers, especially for small farmers due to the lack of resources [72]. In addition, there are some issues related to the procedures and administration of organic certification process [6, 38]. The market challenges are linked to the higher price of organic products [74].

Organic farming knowledge and best practices need more investment and funds. In addition, there are difficulties in knowledge transfer and sharing [77].

Organic farming in the EU and Bulgaria-trends and perspectives

Organic farming in the EU is essential to the EU Green Deal and Farm to Fork strategy [21, 22]. These strategic documents outlined ambitious targets. Although there are undoubling benefits related to organic farming, as provided by different studies, trends in the EU show that the established targets are unlikely to be achieved.

Different member states have diverse paths of development.

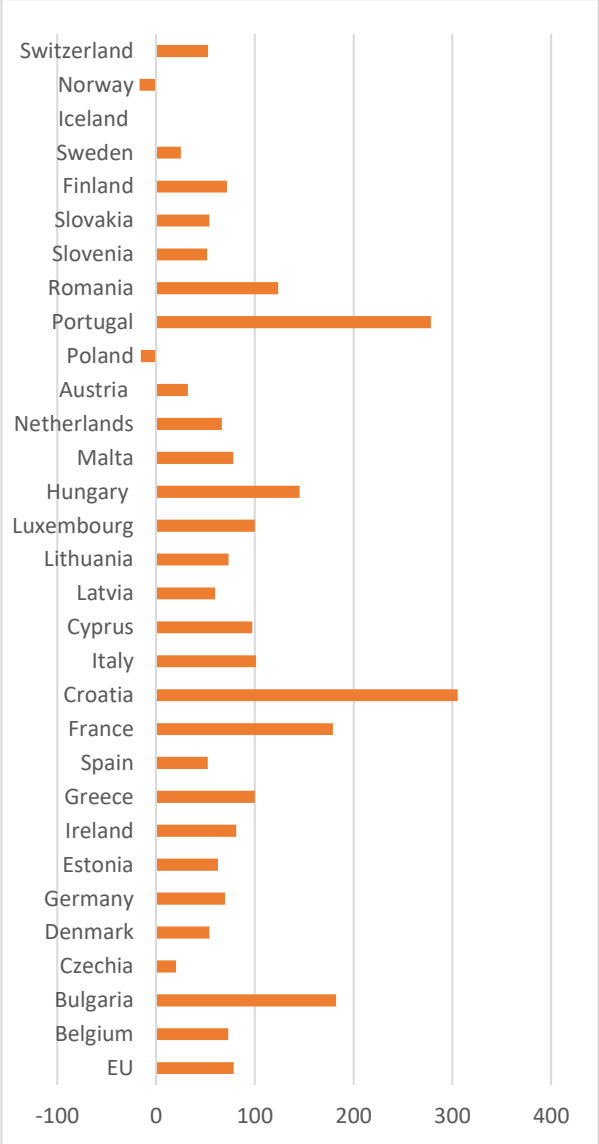

Fig. 5. Total organic area 2012/2022 (% change)
Source: [27]

The organic area in the EU continues to rise. In 2022, it is 16.9 million hectares (10.5% of the total UAA) [27]. For 2012-2022, the organic area increased in almost all member states. The highest share is registered in Croatia, Portugal and Bulgaria.

Austria, Estonia, and Sweden recorded the most significant shares of the total UAA organic area. On the other hand, five Member-states have a share below 5%, with

the lowest level of indicator registered in Malta, Bulgaria and Ireland.

Based on Eurostat data, countries can be divided into: (1) close to or above the 2030 targets (Austria, Estonia, Sweden); (2) Likely to achieve the target -Italy, Portugal, Finland, Czechia, Denmark, Latvia; (3) The lagers with share between 7-10%; (4) six countries, the share of organic farming area was below 5% which have to consider prioritizing the sector.

Table 1. Indicators for organic farming and food processing in Bulgaria (in numbers), 2018-2022

Indicators	**2018**	**2019**	**2020**	**2021**	**2022**
Total producer operators	6,822	6,660	6,405	6,476	4,913
Farmers	6,471	6,213	5,942	5,313	4,352
Processors	181	234	249	330	286
Others (traders)	130	171	185	207	275
Importers	NA	26	22	27	43
Exporters	NA	4	2	5	5
Food processors	202	222	241	256	266
Fruit and vegetable processors	74	85	76	77	47
Dairy processors	12	24	26	23	19
Grain/ milling processors	5	5	3	8	6
Bakery processors	10	9	8	15	13
Vegetable Oils and Fats	23	30	47	52	37
Other food processors	58	59	78	127	140
Beverage processors	15	12	8	22	20
Wine makers Producers	11	12	8	14	9

Source: [61].

The Ministry of Agriculture database (2023) reports trends in organic farming in Bulgaria. The number of organic operators (farmers, processors and traders) decreased by 15% between 2021-2022 [36].

The number of organic farms in 2022 also reduced by 19 % compared to 2021.

The number of organic food processors also decreased by 14%. On the other hand, the number of traders continues to grow by 34 % to 275 companies, showing higher dynamics in the consumer market compared to local production and processing. This development was encouraged by consumer demand for processed organic products.

Organic farmers face number of challenges: labour shortage and administrative issues, insufficient capacity, despite official policies aiming to prioritize the organic farming and industry [36]. These key drivers have hinder the potential and production capacity of organic farming, making it less attractive.

According to the Ministry of Agriculture Report, the Bulgarian organic industry is not keeping pace with the growth of the broader organic markets in the EU [61].

Table 2. Organic retail sales (million €)

Years	EU	Austria	Romania	Bulgaria	Germany	France
2012	18,753	1,064.7	11.75	7	6,970	4,020
2013	20,068	1,064.7	14.15	7	7,420	4,383
2014	21,707	1,260	24.84	7	7,760	4,830
2015	24,924	1,360	24.84	15.05	8,620	5,534
2016	28,455	1,541.6	40.65	28.01	9,478	6,736
2017	32,162	1,723.2	40.65	29.21	10,340	7,921
2018	35,819	1,810	40.65	30	10,910	9,959
2019	38,994	1,920	40.65	30	11,970	11,295
2020	45,043	2,265	40.65	33.27	14990	12831
2021	46,665	2,397	40.65	32.97	15,870	12,659
2022	53, 100	2,657	41	38	16,080	12,018

Source: [31].

In 2022 the organic market in the EU is 53.1 billion €. Germany is the largest market in the EU (16.1 billion euros) and the second globally [31]. From 2012 and 2022, the EU organic market doubled by size.

In Bulgaria the organic industry is still developing. However, the higher consumer demand for organic products and the new lifestyle, alongside with the new EU policy supporting organic are drivers for growth and expansion.

Although the challenges should be outlined, organic farming provides a sustainable agricultural system with significant environmental and human health benefits and the potential for climate change mitigation and adaptation. Furthermore, organic farming promotes rural development and strengthens resilient communities.

CONCLUSIONS

Agriculture significantly contributes to greenhouse gas emissions while being influenced by climate change and extreme weather.

International and EU policies are directed towards agricultural sectors in order to mitigate climate change impact and build adaptive capacity. In this regard, organic farming has significant potential for enhancing resilience.

The literature review in the study shows number of benefits related to organic farming practices: reduction of greenhouse gas emissions, higher resource efficiency, improved soil structure and fertility, reduced soil erosion, maintaining biodiversity, and ensuring long-term agricultural sustainability.

Organic farming integrates sustainable practices to strengthen farming systems, enhance resilience, and adapt effectively to the challenges of climate change.

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