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BIODIVERSITY, CLIMATE AND AGRICULTURE – AN INTERCONNECTED SYSTEM

ABSTRACT

Agriculture and rural areas are facing a major challenge in adapting to current environmental conditions. As the climate is changing, sustainable crop management and rational land use become essential to guarantee sustainable agricultural production each year and to maintain a low environmental and climate impact from agricultural activities.

To prevent and reduce the effects of extreme events, it is essential to ensure that water resources and agricultural production are constant. These phenomena have led, on the one hand, to an increase of environmental protection efforts, and on the other hand, to the development of organic farming, which is one of the most efficient and concrete modalities to protect the environment.

The importance of the European Green Deal for Romania is huge, starting from the way of financing agriculture with EU funds conditional on the implementation of environmental measures, the increase of agricultural area under organic farming, the implementation of the Farm to Fork Strategy and the 2030 Biodiversity Strategy.

The paper explores how biodiversity, agriculture and climate change are interconnected, highlighting challenges and possible solutions for sustainable management.

Key words: agriculture, climate change, environment, environmental economics, biodiversity conservation.

JEL Classification: Q01, Q15, Q51, Q54, Q56, Q57, O13

1. INTRODUCTION

More and more often, nature “revolts” against anthropic actions, manifested through deep changes in the balance of natural ecosystems, due to pollution, across the world. We are witnessing the aggravation of extreme, destructive phenomena – floods, landslides, decrease of natural soil fertility, pollution, desertification, etc. Thus, climate change represents a critical problem, globally, with impact upon the environment and the agricultural sector, being considered one of the greatest challenges for agriculture, which calls for the integration of consistent climate and ecological measures into the CAP, in order to ensure the long-term sustainability of agriculture and support farmers to adapt to the new climate reality.

Sustainable agriculture involves the rational management of agroecosystems, namely maintaining the production potential over a long period of time, using

rational farming practices, managing and protecting natural resources, maintaining agricultural biodiversity, ensuring the profitability of farmers' specific activities, as well as providing sufficient and quality food for the entire population.

The Common Agricultural Policy (CAP), a key instrument for supporting transition to organic farming, provides for measures through which Romanian farmers benefit from European subsidies to implement the agro-environmental measures and adapt to climate change, as well as from financial support programmes that encourage organic farming and biodiversity conservation.

Although the organic farming sector is on the rise, there is no question of completely overlooking the advantages of technological progress in agriculture, but it's necessary to reduce the application of polluting technologies and find alternative solutions to prevent and decrease pollution caused by agricultural practices, so as to create a resilient, sustainable and eco-friendly European agri-food system.

2. STATE OF KNOWLEDGE

Biodiversity is one of the main global priorities in the context of transition to a greener economy and a more sustainable world. Also known as "the world's natural capital", biodiversity, defined as the variety of living organisms and ecosystems throughout the world, is protected by coherent public policies, and has been the subject of COP climate summits and international treaties that establish norms for environmental conservation and protection for many years.

The information on biodiversity come from the Biodiversity Information System for Europe, a platform that has chapters dedicated to each country.

At global level, there are discussions on "improving knowledge about biodiversity" and work is underway on a reporting standard for biodiversity-related information, through the International Sustainability Standards Board (ISSB).

The European Green Deal has established important areas of action that focus on biodiversity conservation and environmental protection, such as: developing sustainable agriculture, stimulating organic farming, using renewable energy sources, eliminating pollution and taking action on climate change. All these actions are in line with the National Strategy for the Development of the Agri-Food Sector 2020–2030, which provides for actions for an economically viable agriculture (through the application of eco-friendly practices), an agriculture that is resilient to climate change.

3. MATERIAL AND METHODS

This paper is based on public policies, strategies and reports on agriculture and environmental and biodiversity protection: the Common Agricultural Policy of the European Union (CAP 2023–2027), the package of environmental policy initiatives aimed at placing the EU on the path to green transition – the European

Green Deal, the Farm to Fork Strategy, the Biodiversity Strategy for 2030, the EU's Climate Strategy, the 2030 Agenda for Sustainable Development. Furthermore, the specialised literature (treatises, research projects, scientific articles/papers from established journals), sustainable development strategies, studies and analyses of reputed institutions, analyses, reports and unofficial studies represented significant landmarks.

To prepare the raw material for analysis, one of the methods used was the personalised query of available official databases, followed by the author's own processing of data. Evaluating public data sources, the paper highlighted the national concerns in the field of biodiversity, climate change and their impact on the agricultural sector. Thus, the data source was mainly from the databases of the National Institute of Statistics (NIS) – TEMPO Online, as well as EUROSTAT, OECD, World Bank databases. The results of NIS publications, Environmental Statistics, press releases, as well as available data found on the website of the Ministry of Environment, Waters and Forests were also used.

Another method used in this study was filtering, collecting and analysing complementary information (internet, online publications).

4. RESULTS AND DISCUSSIONS

The three clear environmental objectives of the **Common Agricultural Policy (CAP)** are found in the European Green Deal and in the Farm to Fork Strategy: *tackling climate change*, through measures that encourage organic farming and ensure compliance with environmental norms, *protecting natural resources*, through the responsible management of natural resources (soil, water and air), essential for agriculture and forestry, across the EU and *enhancing biodiversity*, with a view to protect the ecosystem of farmland and biodiversity.

The Common Agricultural Policy, biodiversity and climate change are inextricably linked, influencing and interlinking each other, and thus the CAP influences biodiversity. The environmental objectives set out in the CAP focus on the contribution to climate change mitigation and adaptation, on the promotion of sustainable development and efficient management of natural resources, as well as on the contribution to biodiversity protection, enhancement of ecosystem services and conservation of habitats and landscapes. All these objectives are intended to support the coexistence of agriculture and biodiversity.

CLIMATE CHANGE INFLUENCE ON BIODIVERSITY

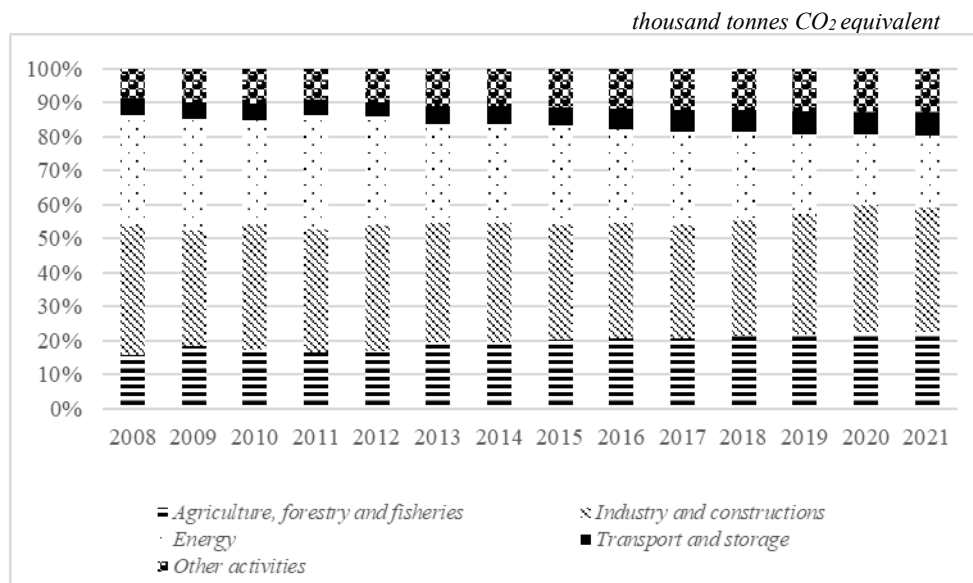
Climate change represents one of the greatest threats to biodiversity, globally, with an impact on the environment (influencing both natural habitats and species) and on the agricultural sector, on the population's food security implicitly, being considered one of the greatest challenges for agriculture. The increase of global

temperatures, the changes in rainfall pattern and extreme weather phenomena have caused major disruptions to ecosystems, resulting in significant biodiversity loss.

All these require the integration of climate and ecological measures into the Common Agricultural Policy, to ensure, on the long term, a sustainable agriculture and to support farmers to adapt to the new climate conditions, by encouraging organic farming, the adoption of drought- or pest-resistant crops and conservation of biodiversity. But before implementing any measure, it is necessary to know the **causes of climate change**. One of these is represented by monocropping and excessive use of chemical fertilisers, which significantly contribute to **GHGs emissions** (for example, in the counties Constanța and Ialomița, where intensive agriculture is practised).

The European Green Deal aims for a climate-neutral Europe by 2050. The European Climate Law sets an interim target to reduce greenhouse gas (GHG) emissions to be reached by the year 2030, by 55% lower than in 1990. All countries in the region reduced GHG emissions, compared to 1990, and Romania achieved the greatest reduction (56%) among all member states, above the target set by the European Commission.

The GHG emissions from energy systems, industry and constructions, agriculture, transport and households are the main causes of climate change. In the period 2008–2021, in Romania, the main generator of GHG emissions was the industry and construction sector, which contributed by over one third of total GHG emissions in all years (Figure 1).



Source: NIS, Tempo Online, Sustainable development _ 2030 Targets.
Figure 1. Greenhouse gas emissions by economic activities, period 2008–2021.

In the year 2021, continuing the trend of the last 15 years, the main generators of GHG emissions were: industry and construction activities (36.5%), followed by agriculture, forestry and fisheries (22.7%) and production and supply of electricity and heat, gas, hot water and air conditioning (21%).

Another cause of climate change is represented by **high summer temperatures**. According to the reports from the National Meteorological Administration (ANM), climate change effects are felt in Romania, including an increase in the average yearly temperature by approximately 1.4°C compared to the pre-industrial period. This accelerates the evaporation of water from soil, affecting crops depending on irrigations and causing productivity decrease in maize, wheat and sunflower crops (mainly those grown in the Romanian Plain and Dobrogea).

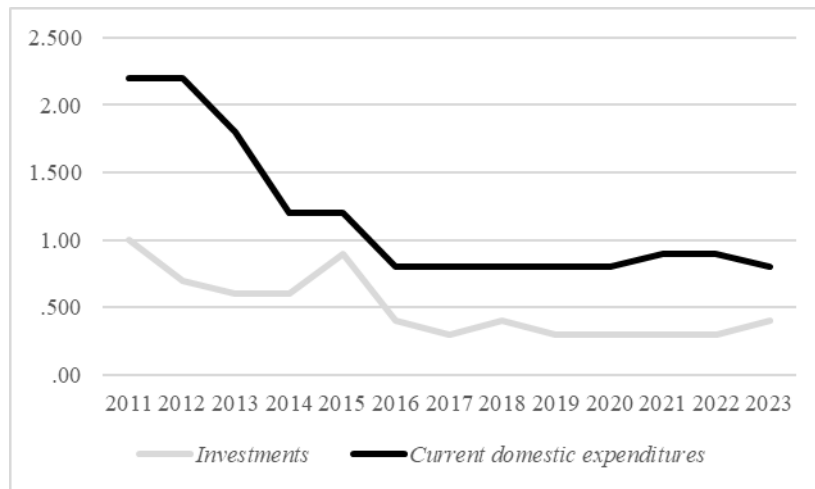
Increasingly erratic rainfall, with prolonged drought periods, followed by heavy rains, is affecting staple crops, with the southern and eastern parts of the country being the most affected. **Torrential rains** have led to floods, with devastating effects on harvests and accelerated soil erosion, mainly in the hilly areas of Moldova.

CLIMATE CHANGE MITIGANTS

Public spending on environmental protection is an attenuator of the effects and it could finance measures to restore the precarious ecological balance and improve the natural capacity to absorb CO₂. However, in the year 2023 in Romania, annual public spending for environmental protection was the lowest in the EU (0.9% of GDP). In the period 2011–2023, the share of investments and current domestic spending on environmental protection in GDP continuously decreased. While at the beginning of the analysed period, total expenditure for environmental protection represented 2.2% of GDP, in the year 2023 it decreased to 0.9% (Figure 2). Under these conditions, it is necessary to find and develop renewable energies to limit the increase of global temperature, which in turn contributes to negative climate change.

Land use change, infrastructure development, inappropriate exploitation of natural resources, invasive species, climate change and pollution are considered the greatest pressures on biodiversity. In Romania, approximately half of the country's area is represented by natural and semi-natural ecosystems (forest ecosystems, grassland ecosystems, freshwater ecosystems, marine and coastal ecosystems, underground ecosystems), the other half being occupied by agricultural ecosystems, constructions and infrastructure.

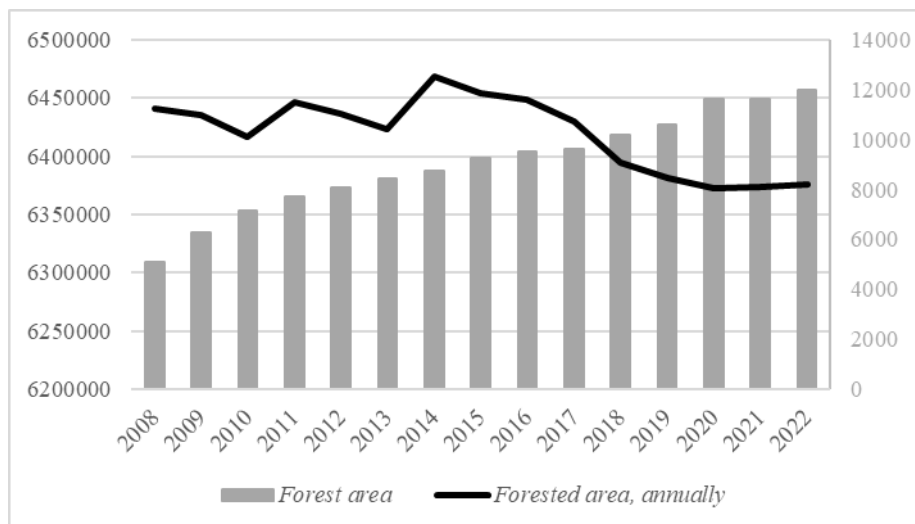
Forests regulate ecosystems, protect biodiversity, play an essential role in carbon cycle, support livelihoods and provide goods and services that can lead to sustainable growth, acting as a climate change mitigant.



Source: NIS, Environmental Statistics Series, Environmental protection expenditure.

Figure 2. Share (%) of investments and current domestic expenditure for environmental protection in GDP (2011–2023).

The resistance of natural environment to human intervention can be achieved not only through the preservation and sustainable management of forests, but also through sustained afforestation actions in certain areas. Romania's forest area increased by 2.3 percentage points in the period 2008–2022, with an average annual growth rate of 1.21% (Figure 3).



Source: NIS, Tempo Online, Sustainable Development 2030 Targets.

Figure 3. Forest area, of which annual forested area (2008–2022) (hectares).

Afforestation actions on agricultural and non-agricultural land represent one of the main measures towards biodiversity restoration, contributing to the reduction of greenhouse gas concentration in the atmosphere (by CO₂ sequestration), of soil erosion, to water retention in soil as well as to Romania's agriculture adaptation to climate change. However, in the reference period, the forested areas continuously decreased, starting with 2016. In the year 2022, compared to the beginning year of the analysed data series, 2008, the forested area decreased by more than one quarter.

CLIMATE CHANGE EFFECTS

As temperatures rise, extreme weather events occur (winds intensify, hurricanes appear even in places where they are not common, storms become more powerful, rain and snow are less frequent, temperatures are higher). These are accompanied by natural disasters (floods, drought and wildfires) and destroy infrastructure and agricultural production (resulting in lower yields and food insecurity), also impacting marine habitats (leading to reduced fish stocks) and cause a decrease in water availability.

The effects of global warming are also found in the loss of biodiversity, habitats are destroyed and many species are in danger of extinction. The disappearance of predators and high temperatures allow the increase in number of animals that transmit diseases, determining people's death. At the same time, extreme temperatures and poor air quality can influence human health, by spreading viruses, treating diseases and managing health crises requiring significant costs for healthcare systems.

The effects of climate change are quantified through a set of impact indicators, such as: number of heating and cooling degree days, monthly/annual rainfall in Romania, annual flood damage, area of land equipped with irrigation facilities and irrigated agricultural area, economic losses caused by climate change, average monthly/annual temperature in Romania, etc.

INTERDEPENDENCE BETWEEN BIODIVERSITY AND AGRICULTURE

Agricultural biodiversity in Romania is an inestimable resource, but it is threatened by agriculture intensification and climate change. By promoting sustainable farming practices, supporting small farmers and putting into value traditional agricultural landscapes, Romania can preserve biodiversity and contribute to a more resilient agriculture.

On the other hand, **agriculture** is one of the essential human activities for ensuring food security, **yet with a significant impact on biodiversity**. Intensive farming practices cause the loss of natural habitats and decline of wild species. The expansion of agricultural land, through the conversion of forests, wetland and other natural ecosystems, leads to the loss of essential habitats for biodiversity. Moreover, unsustainable agriculture contributes to soil degradation and erosion, as well as to water pollution; it also influences climate change, through greenhouse

gas emissions, mainly methane (from livestock) and nitrous oxide (from fertilisers), and these, in turn, impact biodiversity and food security.

At the same time, **biodiversity** plays an important role in maintaining the health of agro-ecosystems, supporting essential ecosystem services and contributing to the increase of crop and livestock resilience to diseases, drought and climate change; it is **essential for agriculture**, through its functions: pollination, soil fertilisation and natural pest control.

The complex relationship between agriculture and biodiversity, both in terms of the negative impact of unsustainable farming practices and of the benefits brought by **organic farming practices**, is based on a deep knowledge of the interdependence between agricultural techniques and biodiversity conservation.

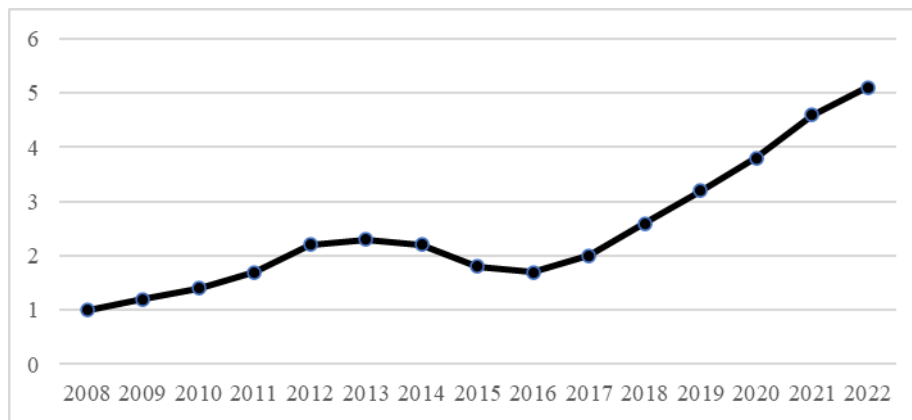
Organic farming has the role to produce cleaner, fresh and authentic food, respecting natural and environmental factors. Organic farming contributes to the sustainable development of agriculture, being a farming method that aims to use energy and natural resources responsibly, to preserve biodiversity, preserve regional ecological balances, increase soil fertility and maintain water quality.

In recent years, organic farming has had an upward trend, Romania being one of the European leaders in organic farming, with more than 350,000 hectares of organically certified land in 2022. In the period 2008–2022, the share of organic production in total agricultural production had an oscillating evolution (Figure 4), and since 2018 it has followed an increasing trend up to the present.

Although this indicator has had an increasing trend, its value is quite low, in relation to total agricultural production. Therefore, Romania is deficient in terms of organic farming, but the area under organic crops is on the rise.

The indicator share of organic production in total agricultural production is correlated with the utilised agricultural area under organic farming, both following the same trends, as mentioned above. The area under organic farming in Romania (as percentage of total) is among the smallest in Europe, almost three times smaller than the European average (very far from the target established by the European Commission for the year 2030 – 25% of EU's total agricultural land under organic farming).

Although the general trend is to increase the land area under organic farming, the agri-food production will be affected in the absence of a trade-off between organic farming (that ensures the conservation of biodiversity, increases soil fertility and maintains water quality, but does not meet the food needs of the population) and conventional agriculture (which threatens biodiversity through the use of monocropping, pesticides and chemical fertilisers, but ensures significant agricultural productions).



Source: NIS, Tempo Online, Sustainable Development_2030 Targets.

Figure 4. Share (%) of organic production in total agricultural production (2008–2022).

In addition, the adaptation to current environmental conditions is a critical challenge for agriculture and rural areas, and ensuring the necessary water resources and constant agricultural productions represent a top priority in developing policies to prevent and reduce the **impact of climate change**, determined by extreme phenomena.

Agriculture and climate change are interdependent. On the one hand, **climate change has a negative impact upon agriculture**: increase of temperatures (which affect crops determining changes in the growing period of crops); frequent droughts; reduced rainfall (which can influence the availability of water for irrigation); floods; changes in the crop growing period (that can increase the risk of pests and diseases) – all these representing major threats for agricultural production. On the other hand, **agriculture contributes to GHG emissions** that mainly come from the use of fertilisers.

Romania is at considerable climate risk, and climate change effects are reflected by the changes in the temperature and rainfall pattern, which affect a significant part of the country's agricultural area, mainly in areas located in the southern, south-eastern and eastern parts of Romania. The agricultural area that received at least one watering during an agricultural year increased from 258 thousand hectares in 2008, to 528 thousand hectares in 2022.

In the context of climate change, forest indicators have become increasingly important for a sustainable management of forest resources, ensuring sustainable harvesting and reducing the environmental impact. Forests regulate ecosystems, protect biodiversity, play an important role in the carbon cycle, support livelihoods and provide goods and services that can lead to sustainable growth. Throughout the analysed period, forest area had a significant increasing trend, year by year. In the year 2022, compared to 2021, the area under forests increased by 7 thousand hectares (0.1%), while compared to the first year of the data series, 2008, it increased by 148 thousand hectares (2.3%) (Figure 3).

Biodiversity, agriculture and food security are essential parts of an interconnected global system, which ensures the well-being of people and environment. Agriculture depends on biodiversity for soil fertility, pollination and natural pest control, while the loss of biodiversity can compromise food security on the long term.

To reduce agriculture vulnerability and minimise the impact on biodiversity and food security, Romania began to adopt measures to create resilient agricultural systems, through crop rotation and agricultural production diversification, cultivation of drought-resistant varieties (National Agricultural Research and Developed Institute of from Fundulea wheat and maize varieties adapted to arid conditions, which are already widely used in areas affected by drought), rehabilitation of irrigation systems (to combat drought effects), and implementation of projects for water harvesting and storage in artificial basins.

5. CONCLUSIONS

Romania's biodiversity is significantly affected by climate change, and its protection is crucial not only for the environment, but also for the communities that depend on natural resources. It is essential to implement conservation measures, such as reforestation, wetland restoration and development of sustainable agriculture, to fight against biodiversity loss and ensure ecosystem resilience.

Biodiversity and agriculture are interdependent: healthy biodiversity can support agricultural production, while responsible agricultural practices contribute to the maintenance of ecosystems. In Romania, a broader transition towards sustainable agriculture is needed, which protects biodiversity, ensures food security and combats climate change.

Agriculture contributes to climate change, but at the same time it is affected by it. Romania must reduce greenhouse gas emissions from agriculture and adapt the food production system to cope with climate change. Under current conditions, completely giving up the advantages of technical progress in agriculture is out of question, but reducing the application of polluting technologies and finding alternative solutions to prevent and reduce pollution due to intensive agricultural practices are issues to be taken into consideration.

Last but not least, the ecological education of population, of experts in agriculture and food, the formation of eco-consciousness can be achieved through a sustained campaign to promote the knowledge and scientific technological practices of organic agriculture through specialisations in this field. An important step is farmers' awareness of the consequences of climate change and intensive agriculture (without regard for natural resources and their conservation), of the importance of implementing good agro-ecological practices, also taking into account the economic efficiency of their own agricultural activity.

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