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ALTERNATIVE FARMING SYSTEMS – THEORETICAL PERSPECTIVES

ABSTRACT

Modern agricultural systems have succeeded to provide large quantities of food, but they are based on external support and intensive use of resources, generating increasing amounts of greenhouse gases that add to those already existing in the atmosphere, thus contributing to global warming. However, agriculture has a dual role, on the one hand it is a provider of greenhouse gases, on a smaller scale than other economic sectors, and on the other hand it provides solutions to climate change problems.

The present study is an analysis of the theoretical framework of alternative agricultural systems, based on sustainable farming practices. The study aims to identify alternative farming systems that contribute to the protection of environment, soil and biodiversity, thus leading to the increase of agricultural systems stability, avoiding ecological imbalances and conserving resources for sustainable development.

Key words: farming systems, alternative agriculture, sustainable development.

JEL Classification: Q01, Q10

1. INTRODUCTION

There is an obvious climate change impact on agriculture, as extreme weather phenomena; prolonged drought and floods affect both agricultural production and soil quality.

At the same time, agriculture is a source of greenhouse gas emissions, contributing to the acceleration of climate change. Yet agriculture can also find innovative and sustainable solutions to prevent the acceleration of climate change, and thus it plays an essential role in the global climate equation.

Given that in recent decades resources have been consumed excessively, and humans have consumed and emitted more than nature can regenerate each year, innovative measures are required to support food production and manage and conserve global resources for future generations.

Agriculture can become a part of the solution to climate change problem, by adopting responsible farming practices that can contribute to the increase of food production and guaranteeing food security worldwide. The adoption of sustainable farming practices is vital to ensuring a secure and sustainable future for agriculture and the environment, and farmers can play an essential role in adopting and using these farming practices.

2. STATE OF KNOWLEDGE

In the recent decades, humanity has been aware of its limited resources and that it is "forced to evolve towards a system that uses renewable resources" (Zaman *et al.*, 2021). The transition of global economy to green economy is a key to the development of sustainable economy, and "the extensive exploitation of raw materials is depleting global resources at a fairly rapid pace" (Chojnacka, 2020).

Humanity has always needed food and "the development of agriculture throughout past centuries and decades has led to the consumption of carbon reserves in soils", reserves that "were created over a long period of time" (Carlier, 2009).

Amid global challenges "the EU has proposed a horizontal action framework to reach the goal of climate neutrality, enabling member states to manage climate and ecological issues in a unified way and in real time" (EIR, 2022).

The high level of carbon dioxide in the atmosphere can be reduced, and one of the mechanisms to reach this goal is to adopt sustainable farming practices and methods, such as the farming practices that sequester carbon in soil. Thus, agriculture can contribute to the removal of carbon from the atmosphere thorough sustainable farming systems that capture carbon through photosynthesis and store it as living biomass (in plants) and organic carbon in soil.

3. METHODOLOGY

The main objective of the present study is a theoretical approach to alternative agricultural systems; for this purpose, the method of bibliographic study, of specialised literature was used, in order to delimit the concepts subject to analysis.

Agricultural activities are a source of greenhouse gas emissions, contributing to the acceleration of climate change, and the need to implement measures to reduce greenhouse gas emissions gives rise to a series of alternative solutions. The study aims to identify the alternative agricultural systems based on farming practices that contribute to the protection of environment, soil and biodiversity, with a focus on low-carbon agriculture, which contributes to carbon removal from the atmosphere and its storing in soil or biomass.

4. RESULTS AND DISCUSSIONS

Human activities have an increasing influence on climate, generating increasingly large amounts of greenhouse gases that add to those already naturally existing in the atmosphere, thus contributing to global warming.

In the next section, different agricultural systems are analysed from a theoretical point of view, with an emphasis on those that promote farming practices that are more environmentally friendly and can contribute to reducing the impact of climate change.

Agricultural systems. There are numerous approaches and methods used to grow plants and produce food in modern agriculture. By the degree of intensification, there are two types of agriculture, namely conventional agriculture and alternative agriculture.

Conventional agriculture uses chemical inputs to help plants and animals grow faster and be less affected by potential pests. The most commonly used inputs are pesticides, to protect crops from pests, herbicides to kill weeds, fungicides to eliminate diseases and insecticides to kill insects. This practice has been increasingly criticised in recent years, as the crops and the soil in which they are grown are affected.

Conventional agriculture includes *extensive agriculture*, in which the increase in crop and livestock production is based on increasing cultivated areas and livestock herds and *intensive agriculture*, which focuses on maximising the output per unit of area. A third category adds to these two types of farming, namely industrial agriculture, which specialises in obtaining products from a given species under fully controlled conditions, such as animal industrial complexes, vegetable greenhouses etc.

Alternative agriculture is a holistic and sustainable approach to farming, in which a wide range of practices, techniques and methods are used that are different from those used in conventional farming, yet not extremely different and extremely well-defined, but have common features and largely respect the agro-ecological principles.

There are a large number of documents addressing different alternative farming systems, but there a few attempts to classify the variety of such systems into frameworks or schemes. Thus, the following were identified:

Conservation agriculture. The main focus is on the conservation of soil quality and properties through alternative soil tillage strategies, the key features being minimising tillage and crop rotation.

The literature of the last decade provides a slightly broader understanding of conservation agriculture. Mitchell *et al.* (2016) describe conservation agriculture as a “variety of measures to reduce soil erosion, to improve water retention capacity and increase the organic matter content of soil, to improve soil health and increase crop yields”. The above-mentioned study lists the following three key principles of conservation agriculture: "minimising soil tillage (reduced tillage or zero tillage), keeping crop residues on soil surface throughout the year and stimulating crop and soil biodiversity".

Low-input agriculture, which, in the opinion of some experts, is extensive agriculture. There are a number of common features, namely optimising the management and use of internal production inputs; minimising the use of external production factors, such as fertilisers and pesticides; avoiding pollution of surface and ground water; reducing pesticide residues in food; reducing overall risk of farmers; increasing farm profitability in both short and long term.

In the literature, low-input farming is characterised as having "a low input intensity per hectare or animal unit" (Viglizzo, 1994). The same author considers that "low energy and money use are sufficient conditions to describe a low-input system". On the other hand, a Canadian study defines the low-input farms as "those farms that use synthetic herbicides at rates lower than those recommended by the government" and some agricultural practices used on such farms can replace the use of herbicides (Stonehouse, 1996). Common practices in these systems are identified mainly in terms of their contribution to weed management and include crop rotation, cover crops, intercropping, and also the use of composts and manure.

Integrated agriculture*.* The concept is often used to refer to agricultural systems that fall between conventional and organic farming. Integrated farming differs from conventional farming practices in that sustainability is a core objective, like in the case of organic systems. However, unlike organic farming, integrated farming still uses inorganic inputs, although at lower levels or used in a less systematic manner than in conventional systems. Integrated farming is increasingly seen as a combination of biological cycles for the management of nutrients, weeds, pests and diseases with the tactical use of fertilisers and other agrochemicals. Sustainable and efficient production in these systems depend on careful monitoring of soil conditions and requirements, and use of water and nutrients.

The concept of integrated farming began to be used more intensively in the literature following the initiation of research projects in the Netherlands for the development of new farming systems with significantly lower inputs of pesticides and fertilisers. Integrated farming differs from conventional farming "through the limited chemical control of weeds and pests that is mainly based on mechanical operations, use of resistant varieties and minimum tillage" (Lotz *et al.*, 1993).

The generally accepted definition of integrated farming is "a combination of biological cycles for the management of nutrients, weeds, pests and diseases with the rational use of fertilisers and other agrochemicals. Sustainable and efficient production in these systems depends on the careful monitoring of soil conditions and requirements and the use of water and nutrients" (LIFT, Deliverable D1.1, 2018).

Organic agriculture*.* Organic agriculture is also known as ecological agriculture or biological agriculture. In the European Union, different member states use different terms, which are considered synonymous, namely: ecological agriculture – used in German-speaking, Danish and Spanish speaking countries, organic agriculture – used in English-speaking countries; biological agriculture – used in French-speaking, Italian, Portuguese and Dutch-speaking countries. In Romania, the term used is ecological agriculture.

Organic agriculture is widely recognised worldwide, established through legislation, regulations and certification schemes. In the European Union (EU), organic farming is defined as a holistic production management system that promotes and improves the health of agroecosystems, including biodiversity, biological cycles and soil biological activity. Organic agriculture is a system of crop and livestock farming based on natural and sustainable methods, designed to maintain a biological balance. This involves the use of organic fertilisers, such as compost and manure, instead of chemical fertilisers and pesticides used to control pests and diseases.

There is a significant number of comparative studies on conventional versus organic agriculture to assess the difference in terms of economic and environmental performance.

Most experts in the field agree that the principles of organic farming include most principles pertaining to conservation and integrated agriculture, the main additional feature being the ban on synthetical chemical active principle for pesticides and use of mineral fertilisers.

Precision agriculture implies the use of advanced technologies (sensors, geographical information systems, drones, etc.) to gain a more accurate understanding and a more efficient management of agricultural resources, such as water, fertilisers and pesticides. Precision agriculture thus helps to optimise production and reduce environmental impact.

In recent decades, "precision agriculture has emerged as a modern concept of agricultural management, which uses a combination of new information and communication technologies (ICT) and sensing devices to provide real-time data-driven information to support farm management and agricultural decisions" (Cisternas *et al.*, 2020). Existing evidence shows that "the adoption of digital agricultural technologies promotes resource efficiency, contributes to sustainable agricultural production with higher yields, improves access to markets, promotes value chain integration and coordination, and reduces the environmental footprint of agricultural production" (Deichmann *et al.*, 2016).

In the European Union, the integration of precision agriculture has been essential for reaching the goals set in the agricultural and environmental strategies, including the European Green Deal and the Farm to Fork Strategy (EU Commission, 2020). The promotion of precision and sustainable agricultural practices in the EU, including precision agriculture technology, is expected to boost the production of crop and animal products with increased efficiency and reduced ecological footprint (EU Commission, 2020). However, the adoption of precision agriculture technologies by EU farmers is "a dynamic problem for farmers, extension services, agri-business and policy-makers" due to a series of technological, infrastructural, economic, local and environmental considerations (EU Commission, 2017).

Low-carbon agriculture or regenerative agriculture focuses on the regeneration and improvement of soil health, using practices that promote biodiversity increase, maintaining soil cover and reducing tillage. Regenerative agriculture aims at carbon sequestration in soil, restoration and improvement of natural resources and soil fertility in the long term.

Innovative approaches are needed for "carbon sequestration in agricultural landscapes". In the context of climate change, research in this field has been steadily increasing over the past 30 years (Spotorno *et al*., 2024).

Carbon sequestration offers a number of environmental benefits; in addition to mitigating climate change, it "can have a wide range of advantages for sustainable agriculture (Spotorno *et al.*, 2024). These include "soil fertility increase, improvement of nutrient cycle, maintaining biodiversity and ecosystem services" (Aertsens *et al.*, 2013). With these solutions it is possible to increase resilience to climate change impact, "while contributing to a high stability of crop yields through a more efficient use of nutrients" (Spotorno *et al.*, 2024). Therefore, carbon sequestration in agricultural soils is seen as "a multidimensional strategy that balances social, economic and environmental objectives" (Spotorno *et al*., 2024). Thus, the "benefits of carbon sequestration in soil can contribute to reaching the Sustainable Development Goals in terms of zero hunger, water and sanitation, climate actions and life on land" (*Bouma et al*., 2019).

In the context of soil carbon sequestration, low-carbon agriculture has emerged as a solution to "mitigate climate change in agriculture and to encourage sustainable soil management, while conventional agriculture has been shown to negatively affect sustainable agriculture" (Agovino *et al*., 2019). Low-carbon agriculture "comprises a series of agronomic practices ranging from land use change to more technological solutions", to livestock farming and manure management and ending with "nutrient management on cropland and grassland" (Spotorno *et al*., 2024). Low-carbon agriculture involves the management of both land and livestock, of "carbon in soil and vegetation, plus carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) fluxes" (Spotorno *et al*., 2024).

Adopting sustainable agricultural methods and practices contribute, on the one hand, to reducing carbon in the atmosphere, and on the other hand, to soil carbon sequestration.

The alternative agricultural systems previously presented represent sustainable solutions for protecting environment and soil, for preserving biodiversity, for healthier food and for soil carbon sequestration in order to minimise greenhouse gas emissions, a priority goal at EU level for the not too distant future.

It is sometimes difficult to differentiate the characteristics of one alternative agricultural system from another, because there are a number of common characteristics and most of them comply with the agroecology principles. A summary table of the alternative agricultural systems and of the agricultural practices analysed in the present study was neccessary to be provided, with the areas of action on which they have a major influence.

Table 1

Summary table – alternative agricultural systems, sustainable farming practices and areas of action

Alternative agricultural systems and Sustainable farming practices	**Areas of action***				
	a	**b**	**c**	**d**	**e**
Conservation agriculture					
– minimum tillage	X			X	
– crop rotation	X			X	
Low-input agriculture					
– efficient management of input application	X	X	X	X	X
Integrated agriculture					
– biological cycles for nutrient management	X	X			
Organic agriculture					
– conversion to organic agriculture		X	X	X	
– maintaining organic agriculture		X	X	X	
– fallow lands with different species for biodiversity			X		X
– creation and improvement of semi-natural habitats	X	X	X	X	X
Precision agriculture					
– IT technologies and devices	X		X	X	
Low-carbon agriculture					
– rehumidification of wetlands/peatlands	X		X	X	X
– proper waste management, burial of agricultural residues	X		X	X	
– creating and maintaining permanent grasslands	X		X	X	X
– extensive use of permanent pastures	X		X	X	
– erosion prevention and wind protection curtains		X		X	X
– feed additives to reduce greenhouse gas emissions generated by enteric fermentation	X				

Note: *Areas of action are presented below.
Source: Author's summary.

Characteristics of agricultural systems and sustainable farming practices covering different ***areas of action*** in the field of environmental protection, climate change, biodiversity, conservation:

a. climate change mitigation, including the diminution of greenhouse gas emissions generated by agricultural practices, as well as maintenance of existing carbon stocks and enhancement of carbon sequestration;
b. adaptation to climate change, including the reduction of greenhouse gas emissions generated by agricultural practices, as well as maintenance of existing carbon stocks and enhancement of carbon sequestration;
c. protecting and/or improving water quality and reducing the pressure on water resources;
d. preventing soil degradation, restoring soil, improving soil fertility and nutrient management;
e. biodiversity loss, preserving or restoring habitats or species, including maintaining and creating landscape features or non-productive areas.

5. CONCLUSIONS

Agriculture contributes to climate change, and at the same time it is affected by it, being dependent on weather conditions.

Modern agriculture has evolved from traditional and natural farming to production systems that use large amounts of industrial agricultural inputs that result in environmental degradation. Such intensive systems mainly focus on production increase to the detriment of environmental protection. In the current context of climate change and increasing concerns for healthy food systems, the alternative agricultural systems based on sustainable farming practices have gained ground and visibility.

In the conditions in which in recent decades humanity has consumed and emitted more than nature can regenerate each year, innovative measures and sustainable agricultural practices are needed to support food production and manage and preserve the planet's resources for the next generations.

The demand for agri-food products will increase at the same speed as population growth, and thus environmental protection will become increasingly necessary due to the consequences of climate change, and in this context the adoption of sustainable agricultural practices and methods is the solution.

Maybe it is time to change the way we produce our food, to better weigh what and how much we consume, to protect and maintain biodiversity and soil to a larger extent, and one solution can be a large-scale transition to various alternative agricultural systems.

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