

# Balancing Economic, Environmental, and Technological Systems for Sustainable Agricultural Development in Romania

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## ABSTRACT:

The aim of this research is to ascertain and evaluate the optimal equilibrium in the interaction of four critical systems: social, economic, technological and environmental. This will enable a functional process that is both dynamic and adaptable within the context of long-term sustainable development. The research centers on significant enduring obstacles, such as the expansion of the global population, strain on natural resources, and global warming, which establish a fresh framework for necessary measures to attain this equilibrium.

The research methodology employed in this study encompasses an extensive examination of existing literature, along with the analysis of case studies and statistical data. The objective is to evaluate the influence of demographic and environmental factors on agriculture and rural regions. The analysis centers on the following factors: worldwide population growth, urbanization, escalating energy and fertilizer costs, strain on water resources, and the heightened susceptibility of crops and livestock to climate change. The study also analyzes the European Union's policies and strategies designed to address these challenges by promoting food security, sustainable resource management, and equitable territorial development.

The primary conclusions of the study suggest that while there is a persistent rise in the worldwide demand for food, the availability of food is constrained by various crucial factors. The factors encompassed in this context comprise of accelerated urbanization, escalating energy and fertilizer expenses, heightened strain on water resources, and augmented susceptibility of agriculture to climate change. Europe faces amplified challenges due to its aging population, impacting both the availability of agricultural workforce and the need for food.

This research contributes to the comprehension of the necessity for an all-encompassing and enduring approach in agricultural and rural development policy. The study emphasizes the intricate relationship among economic, environmental, human, and technological factors. It underscores the significance of a cohesive and flexible strategy to address long-term challenges and maintain a sustainable equilibrium between economic growth, environmental preservation, and human welfare.

*Keywords: agriculture, sustainable development, production, Romania*

## 1. Introduction

The main objective of sustainable development is to find a balance between four interconnected systems: economic, human, environmental and technological. This is achieved through a dynamic, adaptive process that ensures the harmonious

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functioning of these systems. (Irimie & Tulbure, 1996). The world is facing significant long-term challenges that demand immediate and resolute action. These challenges include a continuously growing global population, escalating strain on natural resources, and the pressing issue of global warming. These factors collectively shape a new context that necessitates proactive measures. The aging population in Europe poses an additional challenge. These changes will have significant ramifications for agriculture and rural areas. The growing global demand for food will be constrained by factors such as urbanization, escalating energy and fertilizer costs, water resource constraints, and the heightened susceptibility of crops and livestock to climate change. The EU has commenced a transformation process to confront these challenges, with the objective of addressing issues related to food security, sustainable management of natural resources, and balanced territorial development. Our connection to the natural environment is facilitated by rural locations. Occasionally, it conjures the notion of uncomplicatedness and tranquility, while other times it suggests seclusion, a bygone era. The countryside is a multifaceted entity that serves as a source of inspiration and cultural significance, while also being a tangible aspect of daily existence (Cloke, 2006). It is a dynamic and ever-present aspect of life. Ethnopolitical conflicts, economic interests, and political debates concerning issues such as food security, land fragmentation, the legitimacy of foreign land acquisition, and environmental degradation are all influenced by land (Holtslag-Broekhof et al., 2016; Petrescu-Mag, Petrescu & Azadi, 2022). Nevertheless, this contribution does not solely focus on land, but also explores the social and political dynamics influenced by changes that impact various issues related to land, such as restitution, the decline of rural areas, the inadequate rural infrastructure, and the attempt to revert to a pre-communist era in Romania (Basek & Kraus, 2011).

Some studies present a variety of obstacles that are associated with the rural terrain in Romania (Burlacu, Stoica et al., 2022). Others investigate the past to gain a deeper understanding of the future and gain insight into the present (Buzoianu, Pargaru, Chiotan, & Uta, 2024). The phrase "from scythe to smartphone" (Ciobanu et al., 2019) encapsulates this. Kijek et al. (2019) point out that land ownership is a critical component of this debate because of its substantial influence on our imagination.

On the other hand, the term "rurality" refers to the combination of physical spaces, with variable dimensions, together with population and specific forms of housing that are associated with different stages of development and are involved in the primary sector of economic activity. The presence of a rural environment is commonly believed to enhance food sovereignty (Meek et al., 2019) and foster strong social cohesion among community members.

Additionally, it plays a role in safeguarding customs, language, and overall national and personal identity, while relying on the natural environment (Dorneanu, 2017). Therefore, the notion of rurality is shaped and propelled by the prevailing establishment of agricultural terrain and community (Rădulescu, Bran et al., 2022).

According to Gkartzios and Scott (2014), a community is not only a collection of physical locations, but also a group of people who share common interests and are guided by agreed-upon rules and principles.

Rurality is defined as both a spatial concept and a social construct that is determined by an individual's access to different networks of relationships and the opportunities they provide (Feher & Handaric, 2016).

According to Huang *et al.*'s research from 2020, the process of contact amongst villagers is an essential component in understanding rural change. There are a variety of elements that contribute to the ongoing transition that rural communities experience. Barath and Ferto (2017) state that it is of the utmost importance to have a comprehensive understanding of the development of rural communities, which may be characterized as a transition from the use of traditional agricultural instruments to the utilization of contemporary technology such as cellphones.

Just as the study by Alramamneh, Saqr, and Areepattamannil (2023) highlights the critical role of parental attitudes and early literacy activities in shaping Arabic literacy among Emirati children, a similar focus on fundamentals—such as education, integration policies and the community involvement—is essential for promoting Romania's agricultural sustainability. By promoting an environment where these elements are synergistic, Romania can cultivate a resilient agricultural sector that supports both economic growth and environmental management.

#### *Sustainable development in Romania*

Agriculture, as a basic economic activity, represents a primary sector that involves extracting or harvesting products from nature. From an accounting perspective, an industry is defined as a specific sector of economic activity (Rădulescu, Gâf-Deac *et al.*, 2022). In this context, the term "agricultural industry" refers to the agricultural production sector, but its use does not imply the industrialization of agriculture or the orientation towards the processing of raw materials. In fact, the term "agricultural industry" is specifically used in this article to reflect specific accounting terminology, while the expression "agricultural sector" is used in other contexts (Gâf-Deac *et al.*, 2022).

The evaluation of the performance of the agricultural sector has traditionally been done through the lens of its efficiency in the provision of primary agricultural products and services. However, there is growing recognition of the environmental implications of agriculture, including its impact on water, air, and soil quality, land use diversity, ecology, wildlife, and climate change (Cejudo-García, Navarro-Valverde, & Cañete-Pérez, 2022). This complex approach emphasizes the need to evaluate agricultural performance not only in economic terms, but also in ecological terms, given the significant impact that agricultural activities have on the environment.

The importance of evaluating the performance of the agricultural sector derives from several essential reasons. First, agriculture is a fundamental pillar of rural communities, supporting numerous related industries such as food processing, packaging and transportation. Second, agriculture plays a crucial role in ensuring a steady flow of safe and high-quality food. Agriculture also contributes significantly to the conservation of landscapes and biodiversity. In addition to these aspects, agriculture has a critical role to play in combating climate change and requires a fair income for farmers to support these efforts. The economic impact on farmers directly influences their future business decisions, both in the agricultural field and in terms of their large-scale ecological and environmental behavior (Cárdenas Alonso & Nieto Masot, 2022).

A comprehensive assessment of the overall performance of the agricultural sector can be achieved by integrating data on quantitative and price changes of agricultural goods and services in an accounting framework (Orzan et al., 2020; Bran et al., 2023). The Economic Accounts for Agriculture (EAA) provides a set of comparable data that provides insight into various aspects of agriculture, including economic sustainability, farmer incomes, the structure and composition of agricultural production, and the relationship between prices and quantities of both outputs and of the inputs. The effectiveness of resources in the agricultural sector can be analyzed through the lens of the main objectives of the European Green Pact, thus emphasizing the commitment to sustainable and ecological agriculture (Staic & Vladu, 2020).

## **2.1. The contribution of the agricultural sector to economic growth**

A notably significant economic activity in the European Union (EU) is agricultural production, which is primarily conducted by millions of small farms. It is more than just a critical element in the downstream food and beverage processing industry; its significance extends beyond that. The agricultural sector made a cumulative contribution of 173.3 billion euros to the Gross Domestic Product (GDP) of the European Union in 2022. To provide context, the agricultural sector's contribution to the EU economy surpassed Greece's GDP in the same year, thereby qualifying it as the 16th greatest economy among the EU member states.

The contribution in question, known as gross value, added at production prices, is the difference between the value of agricultural production and the total costs of inputs incurred during the production process, considering taxes and subsidies on products. It can be compared to GDP at market prices. The structure and composition of the value of this agricultural production, as well as the numerous inputs used, are therefore enthralling to examine.

The gross added value of the agricultural industry in the EU was estimated to be 178.4 billion euros in 2022. This value is calculated as the difference between the total value of the output of the primary agricultural sector and the costs of inputs and services used in production. Therefore, 0.76 euros of added value were generated for each euro spent on intermediate consumption in the EU agricultural industry. Even though the relative value added in 2022 was lower than the 0.79 euro in 2020, it remained higher than most of the other years in 2019.

In 2022, the agricultural industry's overall production in the EU was estimated to be 414.1 billion euros. This figure encompasses the value of non-agricultural products and services, agricultural services, livestock, and produce that are not individually quantifiable. The agricultural industry in the European Union produced €219.8 billion in 2022, with crops accounting for approximately 54.0% of the total value. Vegetables and horticultural commodities, as well as cereals, were the most valuable crops, as illustrated in Figure 13. Animals and animal products accounted for approximately 38.4% of the total production, which amounted to €159.2 billion. Most of these contributions were produced by hogs and milk. The remaining 8.7% of the contribution was derived from inseparable non-agricultural activities (15.6 billion euros) and agricultural services (20.3 billion euros).

The contributions of the Member States exhibited significant variations, which were attributed to variations in the variety of crops produced, animals reared, animal products collected, and services provided, as well as the prices received and production volumes. The total value of EU agricultural industry production was 58.7% attributed to the "big four" countries: France, Germany, Italy, and Spain. Germany's production value was 57.6 billion euros, Italy's was 53.7 billion euros, and Spain's was 56.8 billion euros. France recorded a production value of 76.3 billion euros.

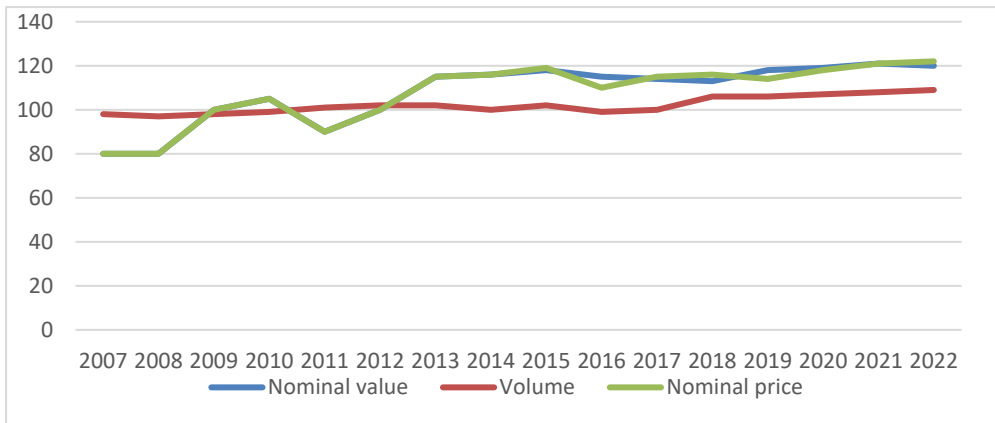


Figure 1. Developments in the production of the agricultural industry, EU 2007-2022.

Source: Own computation according to Eurostat data, 2024

## 2.2 Incomes from agriculture and rural areas

The EU's agricultural income in 2022 was approximately 0.8% lower than that of 2021, as defined by factor income deflated (real) per ATU and expressed as an index (known as Indicator A). This was indicative of a decrease (-3.6%) in the level of factor income in comparison to 2021, which was ostensibly attributed to a decrease in agricultural labor input (-2.8%).

Nevertheless, the EU's overall decline was reflected in the lower farm revenues of five of the 'big seven' agricultural producer Member States: Germany (-11.8%, the second largest rate of decline among Member States), Romania (-8.1%), Italy (-6.8%), the Netherlands (-6.1%), and France (-5.0%).

In 2020, the EU's agricultural income per TAU experienced a minor decline from its 2019 zenith. This was due to the ongoing contraction of the agricultural workforce, which was accompanied by a decline in factor incomes. Nevertheless, the EU's agricultural income per TAU remained 31.5% higher than it was in 2010. During the same period, factor income increased by 7.6%, while agricultural labor input decreased by 18.2%. There is a developing interest in the efficacy of resource utilization.

During the 2007-2022 period, the EU agricultural industry experienced a general increase in production volume, with a 12.3% trend. The volume of products and services consumed experienced relatively consistent growth (+8.0%), which in turn facilitated significantly higher output volumes (see Figure 1). These medium-term trends

suggest that there is minimal evidence of a decoupling of output growth from resource use at the EU level.

With a few notable exceptions, there was also little indication of an apparent decoupling of agricultural production growth from growth in intermediate consumption resources among member states. The volume of intermediate consumption goods and services utilized decreased by 30.5%, while the production of the agricultural industry in Belgium increased by 15.3% between 2007 and 2022.

Additionally, Slovenia and Finland experienced an increase in agricultural production (+8.9% and +4.7%, respectively) during the same period, while the consumption of intermediate consumption products and services decreased (-7.3% and -16.6%).

A much smaller decline (-18.2 %) in the volume of agricultural production was concurrent with a two-thirds reduction (-65.8%) in the consumption of products and services in Cyprus. Please be advised that these modifications may partially reflect modifications to the structure of agricultural industries in these Member States, as well as enhanced resource efficacy.

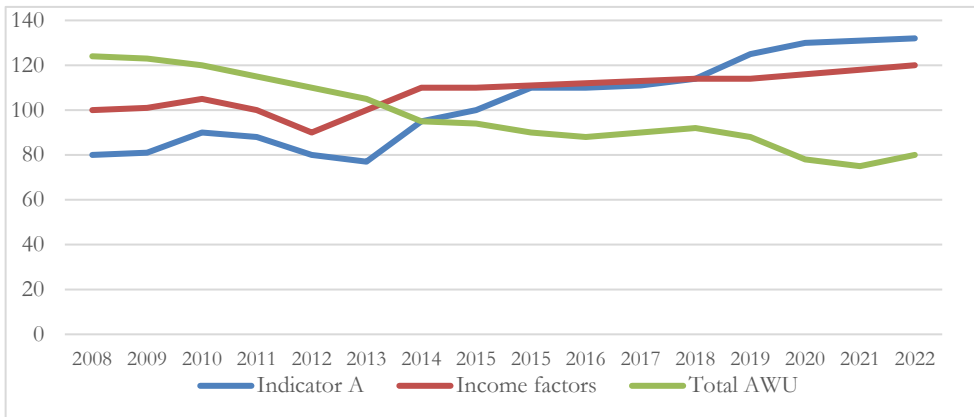


Figure 2. Agricultural income per annual labor unit and key components, 2007-2022.

Source: Own computation according to Eurostat data, 2024

### 3. The potential of the agricultural sector in Romania until 2040

The macroeconomic forecast for Romanian agriculture was derived from three critical indicators that indicate the degree of sectoral development: agricultural industry production, intermediate consumption, and gross added value (Feher et al, 2022). As defined by Eurostat, the agricultural industry's production includes the combined output of agricultural products (including crop and animal production), as well as the production of agricultural services and commodities and services (Buzoianu & Balu, 2016).

The indicators that were selected predominantly reflect the extent and patterns of the efficacy of economic operations in the agricultural sector. The research investigates the historical progression of three indicators over the past two decades and

offers an estimated forecast of their future development over the next two decades. The analysis was conducted at the national level of three countries—namely, Romania, France, and Germany—as well as at the average level of the European Union. The evaluation of the macroeconomic efficacy of agricultural activity in Romania has been conducted in light of the evolution of this sector over the past two decades, which includes Romania's accession to the European Union in 2007. An objective and logically sound representation can be established by employing regression functions to forecast the evolution of agricultural indicators. Nevertheless, this method may also result in economic inconsistencies that require resolution. The value of agricultural production cannot increase sustainably in the medium and long term without an adequate amount of input. Additionally, statistical data demonstrates a considerable degree of variability, with substantial variations in their rates of progression from year to year. The statement suggests the existence of a multitude of variables that are frequently unpredictable or difficult to manage (Ward, Atterton & Kim, 2005). In an area where the economic activities are influenced by the biological processes of vegetation and animals, this phenomenon is a defining feature of agriculture (Rusu, 2021).

The selected model effectively depicts the investigated phenomena, as evidenced by the high correlation coefficients acquired using the power function. As a method of characterizing the future evolution of the macroeconomic indicators under investigation, the utilization of power functions is justifiable (Staehr, 2015).

All the countries analyzed, including the European Union average, exhibit an increase in the value of agricultural production per unit of land area. Nevertheless, the rate of development varies across various states. The value of agricultural production in Romania nearly doubles. In the case of France, this indicator is considerably more significant, with a weight of 104.4%, followed by Germany at 109.3%. The increase is 106.6% at the average EU level. Concurrently, Romania is witnessing a substantially greater increase in gross added value per surface unit than other nations. The evolution of intermediate consumption exhibits an analogous trajectory, except for Romania, where the growth rate of intermediate consumption surpasses that of gross added value. The agricultural sector's expansion is influenced by a variety of factors, some of which are more difficult to quantify and manage, while others are more straightforward. The adoption of modern agricultural techniques is significantly impeded by the elderly demographic of farmers and their limited educational attainment. In Romania, less than 10% of producers participated in a training seminar. In France, the percentage exceeds 60%, while in Germany, it exceeds 69%. The efficacy of this sector is primarily influenced by investments in agriculture. The gross fixed capital formation in Romania is a mere €109 per hectare, while it is €396 per hectare in France, €572 per hectare in Germany, and €350 per hectare on average across the EU-28. The capitalization of agricultural enterprises is significantly influenced by the acquisition of bank loans to finance production and investments at the farm level. Romania continues to languish behind other European Union member states in this regard, despite the recent improvement in agricultural lending, which saw a 20.3-fold increase in the total volume of loans to €3.7 billion in 2019 compared to 2000 (National Bank of Romania, 2020). The average bank loan granted per hectare of agricultural land in Romania is €269.

France offers financing at a rate that is eight times higher than Germany, specifically €1718 per hectare. Conversely, German banks provide loans equivalent to €2994 per unit of land area.

The agricultural sector in Romania receives loans that are less than the average of the 28 member states of the European Union. Nevertheless, the interest rates for these loans are elevated. The agricultural sector is presently experiencing distortions in agricultural production and the market for agricultural products because of the financial aid provided through the mechanisms of the Common Agricultural Policy.

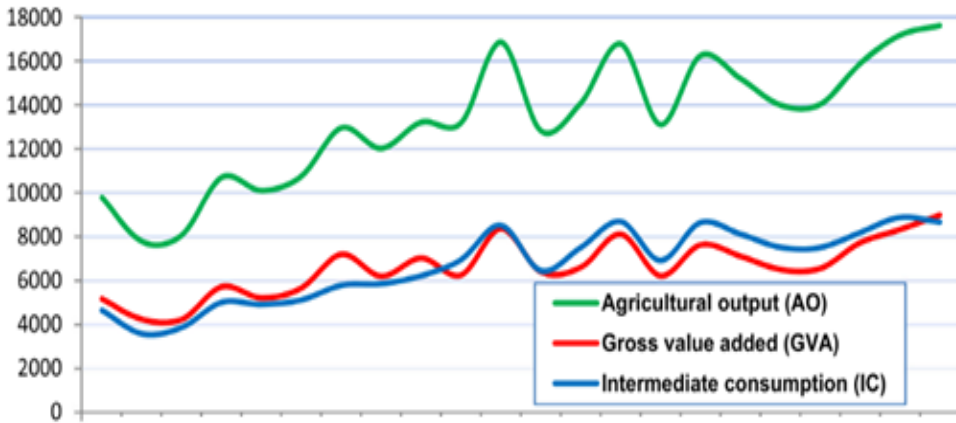


Figure 3. Evolution of agricultural production, gross value added and intermediate consumption in Romania, 2000-2022 (millions of euros).

Source: Own computation according to Eurostat data, 2024

This objective has not been entirely realized, despite the objective of achieving a balance between direct contributions and assistance among member states, as outlined in EU Regulation no. 1307, CE, 2013 and CE, 2018a. The mean quantity of direct payments for each hectare of utilized agricultural land was approximately €300 in Germany, €270 in France, and €140 in Romania during the financial years 2014-2020.

#### 4. Conclusion

In our research, the main hypotheses that have been developed for the future development of Romanian agriculture in the next 20 years, as well as its comparison with the agricultural performance of established European countries, are based on the different growth rates of the examined indicators.

The projection for Romania is that it will reach the average level of the European Union or other reference countries (such as France or Germany) by 2040, as indicated by the power regression function and the consistent historical rate of development observed in all evaluated countries. By 2040, the value of agricultural production per surface unit in Romania is estimated to be 1508 euros per hectare. In contrast, the European Union is expected to be worth €2,426 per hectare, France at €2,663 per hectare and Germany at €3,474 per hectare. Romania is expected to



experience an annual growth rate of 3%, as indicated by a working hypothesis. This growth rate is consistent with the historical growth rates of other countries. Romania's agricultural production is expected to reach EUR 2317 per hectare by 2040, as this projection indicates. This would bring Romania close to the average level of agricultural production of the European Union, but it would still be below the values observed in France or Germany.

According to the authors, the value of Romania's agricultural production per hectare would reach 2565 euros by 2040 if the hypothesis of a 3.5% increase in development is realized. This would position Romania at the average level of the European Union and near France in the years 2041-2042. This hypothesis provides that the gross added value per unit of land in Romanian agriculture will be equivalent to the average level recorded in the European Union in 2030 (1049 euros per hectare), France (1123 euros per hectare) in 2032 and Germany (1123 euros per hectare) . 1289 per hectare) in 2036. Romania is expected to reach a gross value added of 1479 euros per hectare in 2040, which is higher than the projected levels of the other countries that were analyzed, according to these forecasts.

It is anticipated that the value of intermediate consumption per unit of land in Romania will remain below that of the other countries analyzed during the forecast period, according to the forecast. This is the result of the extremely low level of this indicator in 2019, which was 527 euros per hectare. I believe that the assumption of an annual growth rate of 3.5% is a reasonable one.

It is essential to consider the allocation of additional financial resources to agricultural holdings with a higher gross value added per unit of land and a higher value of agricultural production. This can be achieved by increasing the share of livestock production and services in global agricultural production. It is imperative to implement a genuine restructuring of agricultural production to achieve the projected levels as mentioned earlier. The authors suggest a variety of strategies to improve the agricultural sector, such as increasing livestock production, reducing dependence on natural factors, providing additional financial resources for agriculture, expanding agricultural credit, renegotiating national limits for direct payments, and increasing self-financing capacity. of agricultural holdings. As previously mentioned, Romanian agricultural production can be successfully reorganized to reach projected levels, thus ensuring increased efficiency. The rapid establishment of compatible agricultural infrastructures is necessary, as this would allow Romanian producers to take advantage of EU aid and improve their competitiveness on the international market. The food security of the population depends on the effectiveness of agriculture, which is the primary source of food security.

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