

## **Bioeconomy related perspectives for boosting agriculture development in Romania**

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**Abstract.** *Situated at the crossroads between several sectors, from biology, biochemistry, agronomy, management and economy to technology, the bioeconomy represents all uses of bio-resources, whether they come from agricultural land, sea, forest or waste materials. The current bioeconomy strategy of European Union identifies agriculture as one of the sectors mainly supplying biomass. In the last decades, agriculture was constantly transforming towards a knowledge intensive sector. Being almost entirely the physical support for agriculture, the rural regions are expected to become a key player in the development of the bioeconomy activities of the near future. In the modern biobased economies, the rural regions represent more than just a source of raw materials to bioeconomy industries. Future opportunities for the development of the agricultural sector in Romania, thus boosting rural development were identified by conducting a SWOT analysis of the domain through agriculture development.*

**Keywords:** agriculture; biotechnology; trends; Romania; bioeconomy

### **Introduction**

The agri-food system is generally considered to be one of the main culprits in several problems that have arisen or are being discussed in the last decades: climate change (through CO<sub>2</sub> and methane emissions), biodiversity loss, intensive use of natural resources (leading to water depletion, soil fertility loss), increasing pollution (pesticide residues in drinking water and surplus nutrients ending in rivers, lakes and shallow coastal waters) and increased antibiotic resistance. In addition, other global challenges, such as increasing world population and changing consumption patterns in several parts of the world, are increasing the pressure on natural resources. It is therefore essential to enable more efficient use of resources and to minimize waste by unleashing the full potential of biological resources. This paper is an overview of challenges and opportunities for the development of the agricultural sector in Romania, related to the transition to bioeconomy.

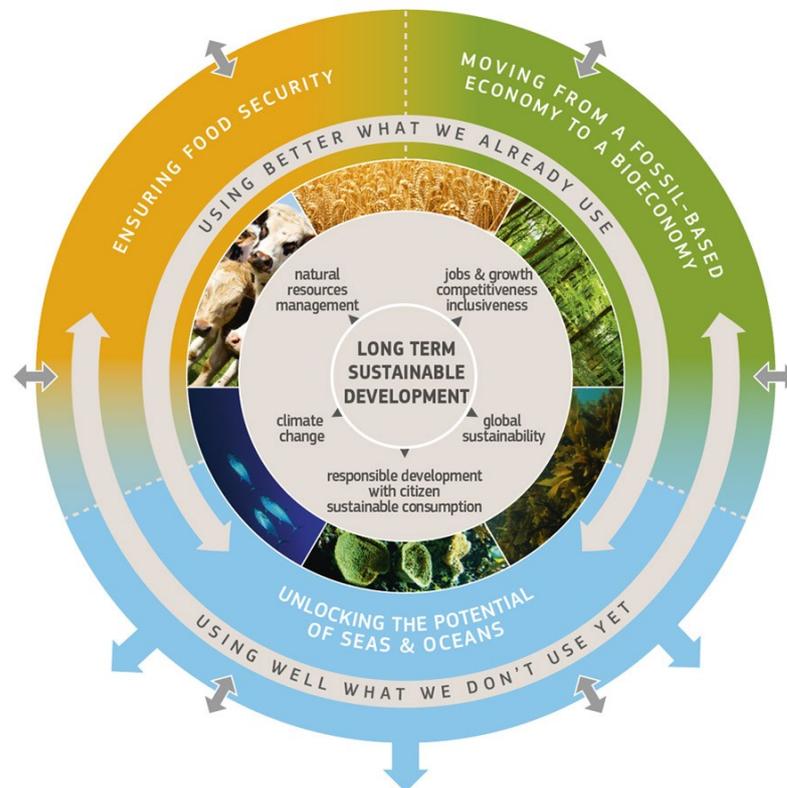
### **Literature review**

Bioeconomy sector is covering all activities related to the innovative production, use and conversion of biological resources (EC, 2012; EC, 2017; Paterman et al., 2018) EC. Situated at the crossroads between several sectors, from biology, biochemistry, agronomy, management

and economy to technology, the bioeconomy represents all uses of bio-resources, whether they come from agricultural land, sea, forest or waste materials (Bugge et al., 2016; Golembiewski et al., 2015; Biber - Freudenberger et al. 2018) for a long term sustainable development (Figure 1).

It is aimed at sustainably meeting the food, material and energetic needs of a growing population, while preserving natural resources and ensuring the production of good quality ecosystem services (EC, 2012; Székács, 2017; Scarlat et al., 2015). To accomplish all these, it is first and foremost necessary a thorough strategic projection, obtained by a large stakeholder's consultation, followed by a careful practical application tailored to the regional and local needs.

Across the world, most of the countries released bioeconomy related strategies based on biotechnological innovation (Birner, 2018; Parisi and Ronzon, 2016). Technological advances in biotechnology, with a particular emphasis on agricultural biotechnology represent an important component of the transition to a future sustainable bioeconomy (Scarlat et al., 2015; Birner, 2018; Bajpai, 2018).



**Figure 1. Bioeconomy illustration**

Source: [https://ec.europa.eu/research/bioeconomy/images/bioeconomy\\_graphic\\_full.jpg](https://ec.europa.eu/research/bioeconomy/images/bioeconomy_graphic_full.jpg)

## Methodology

The information provided in this paper is based on a review of recent literature, including reports and strategies released by international bodies and by national government organizations. Taking into consideration the rapid expansion of the literature on this topic, this review focuses on general aspects of bioeconomy with a specific highlight on agricultural biotechnology as a potential engine for rural development in Romania.

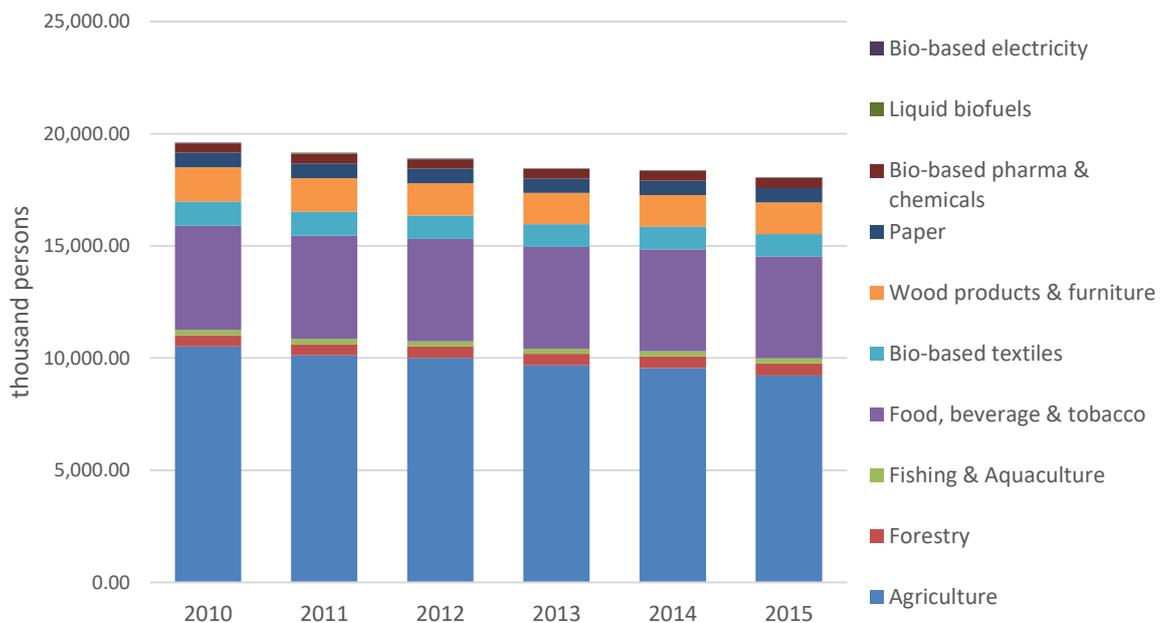
Official statistical data (both European and national, from Eurostat or National Statistics Institute), scientific publications in the area of bioeconomy, analytical studies, and EU commission reports served as an information ground for our research.

## Results and discussions

### European context

The current bioeconomy strategy of the European Union identifies agriculture as one of the sectors mainly supplying biomass. This is illustrated by the Commission communications such as: legislative proposals on the common agricultural policy (CAP) beyond 2020 (COM / 2018 / 392 final; COM / 2018 / 393 final; COM / 2018 / 394 final / 2) and ‘Thematic Strategy for Soil Protection’ (SEC (2006) 620). Almost half of European habitable land is represented by agricultural land and over 4% of EU-28 workforce is employed in agriculture (Eurostat data). In the same time, according to the official statistics, the labor force levels in bioeconomy sectors, and in agriculture (Figure 2), is getting lower, and it is expected that this trend to continue in the next years (Ronzon et al., 2018).

According to the above mentioned data, in total, 18.07 million people were employed in the EU in the bioeconomy sector. A high share of employees (51% of all) included in bioeconomy sector are working in agriculture. In the same time, a quarter of the employees in bioeconomy are working in food industry, and a much lower share (8%) in wood based industry.



**Figure 2. The EU labor force in bioeconomy sectors 2010-2015**

Source: Data adapted from Ronzon, 2018

The farmers are the cornerstone for rural development all over the world, while agriculture is the first provider of primary products for food industry. The challenge of bioeconomy related perspectives in agriculture is to keep up with the changes occurring across various sectors regarding demographic, environmental and economic conditions (Székács, 2017). To keep up with the current development needs the modern farmers need to innovate, to design strategies, and to continually adapt to the changing environment. Reaching the optimal productivity with the limited resources available involves the use of latest technology approaches regarding agricultural practices such as: digitalization and precision agriculture,

Conventional intensification, Conservation farming, Diversified farming and Agroforestry (Lewandowski et al., 2018).

According to the Organisation for Economic Co-operation and Development (OECD) data, the Earth population would reach 8.3 billion by 2030, and 9 – 10 billion by 2050. The agricultural production and implicitly food production should increase therefore, by at least 70 %. Taking into consideration that the increase of utilized agricultural area has limitations, the challenge is to produce more food using less land surface and less inputs (water, fertilizer, pesticides).

In an earlier study of 2009, the OECD estimated that by 2030 about half of agricultural production will be obtained with the use of biotechnology (OECD, 2009). However, in Europe there is little acceptance of genetically engineered organisms (Lucht, 2015; Zilberman et al., 2018).

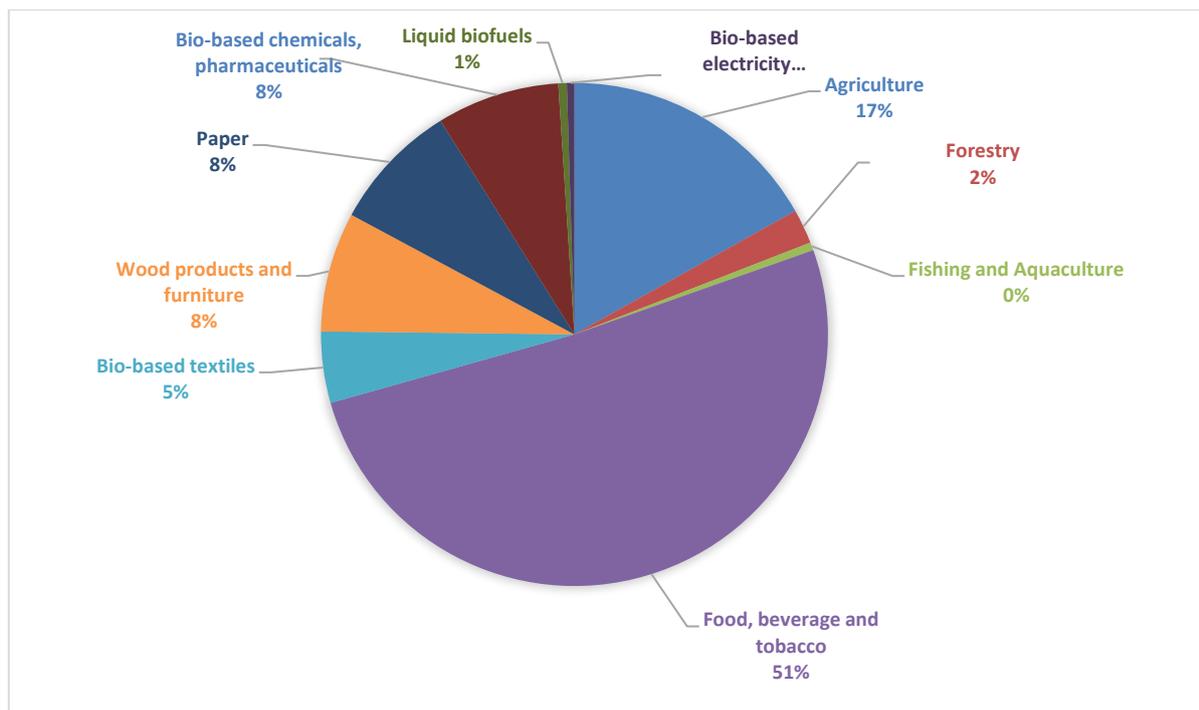
A part of the puzzled solution would be the development of innovative biotechnologies based on NBIC (nano-, bio-, info- and cogno-) technologies. In the broad sense, biotechnology represents more gene engineering. It can be applied for biodiversity preservation and genetic resource conservation (National Research Council- US, 2008)].

Another example are the Bioproducts based on microorganisms and vegetal sources used for plant protection, as a key element for organic agriculture. These could be seen as a pathway for bioeconomy transition in agriculture (Rengalakshmi et al., 2018). There are various reports on antimicrobial activity of plant based products (Rodino et al., 2015; Arsene et al., 2015) that could be commercially developed for use as adjuvant in plant disease management.

It is to be highlighted that based on their need for natural resources as raw materials, it is considered that the present economic models cannot be sustained in the future, if the consumption pattern is maintained unchanged. The human or social cost of the collateral damage produced (environmental pollution and its consequences on health) is not included in the Gross Domestic Product (GDP) formula (Leitão , 2016).

A quick view on European bioeconomy by sectors involved, for the timeframe 2010-2015, showed up that the largest turnover was brought up by food, beverages and tobacco industry, followed by agriculture sector (including fisheries and silviculture).

The data provided by the Joint Technical Committee (JTC) show that in 2015 the total EU bio-economy turnover amounts to 2, 259 billion Euros. Most of this was in the food and beverages sector (51%), less than a quarter went to agriculture (17%) and forestry (2%), and the rest came to bio-based industries such as: chemicals and plastics, pharmaceuticals, paper and paper products, forestry, textiles, biofuels and bioenergy (Figure 3). Nevertheless, it is to be observed, that despite the fact that most of the labor force was involved in agricultural activities (Figure 2), this sector does not return the highest turnover, given the low value added of the sector (Figure 3).



**Figure 3. Share of the bioeconomy sectors in EU turnover, 2015**

Source: Data adapted from Ronzon, 2018

### Romanian context

EU intention is to develop future production systems based on sustainable bioeconomy. A strategy on bioeconomy has not yet been released for Romania, but there are various policy initiatives towards bioeconomy. The first step towards a Romanian Bioeconomy strategy was done by including bioeconomy in several national strategies.

For example, Bioeconomy is one of the smart specialization areas in the Romanian National Strategy for Research Development and Innovation 2014 to 2020. It was considered that the bioeconomy sectors benefits from the huge potential of Romanian agriculture, in the context of an increasingly active local food industry with growing standards, successful applied research in the field and in the pharmaceutical industry, as well as in the context of global trends such as high food demand. Food safety and optimization, the development of the horticultural, forestry, animal husbandry and fisheries sectors or the capitalization of biomass and biofuels are subdomains with obvious potential.

According to the same strategy, Bioeconomy as a smart specialization related to agriculture is focusing on the following key concepts:

- Safe, accessible and nutritionally optimized food
- Development of new products, practices, processes and technologies in the horticultural sector.
- Adapting the sector of animal husbandry, veterinary medicine, fishing and aquaculture to the challenges of the twentieth century.
- Sustainable development of field crops adapted to the impact of global climate change
- Sustainable development of the forestry sector and wood products by increasing its competitiveness through the design of new products, processes and technologies, as well as innovative business models for traditional products;

- Bioenergy - biogas, biomass, biofuel (enhancing research and innovation to exploit the significant potential of wood and agricultural biomass, to obtain cheap and clean energy in various forms, including biogas, biofuels and the combined combustion of biomass and fossil fuels in cogeneration).
- Agri-food biotechnologies (plant genetics, technical crops, circular agriculture, advanced agri-food processing technologies, smart farming, safe food products, nutritionally optimized agri-food products)

Given the importance of agriculture in our economy, Romania can make important progress by placing the farmer at the heart of the transition process to bioeconomy.

Agriculture is the main employer in Romanian economy (25.8% of the total labor force employed at the end of 2015) (Eurostat data). Romania being the European country with the largest number of people employed in the field. The agricultural sector and the rural economy in general continue to have substantial growth potential, still underutilized. At national level, agriculture accounts for 6% of Gross Value Added (GVA) (NIS data).

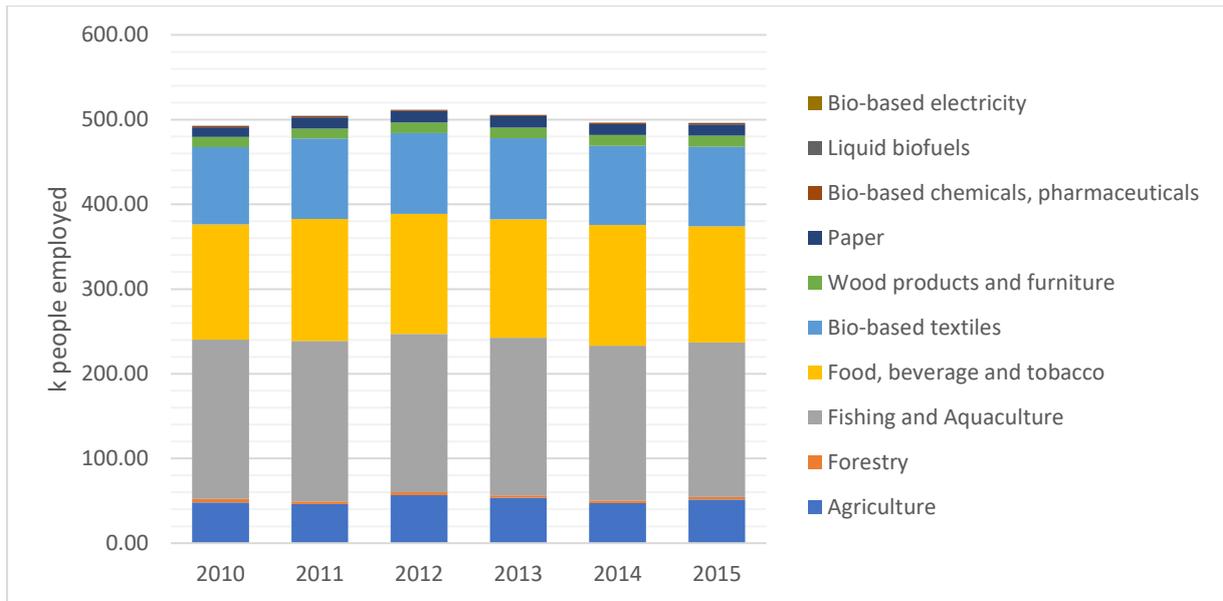
However, as added value Romania is far behind other European countries with much lower agricultural areas and a much lower number of employees. EU gross value added in agriculture was 188.5 billion euro in 2017, and Romania had 7.5 billion euro, ranking 9th, representing 1.6% in the EU, equal to almost quarter of Italy's GVA (Eurostat data). A coherent strategy should be projected, particularly in terms of boosting the value added. This, of course could be achieved by increasing crop productivity with application of latest technological knowledge, and by increasing focus on livestock, fruit and vegetables production.

Analyzing the statistical data, it can be observed that for Romania, the bioeconomy is practically the sector that is the most important in terms of share in the active population. However, the economic sector that produce primary bioresources (agriculture, forestry and fishing) and the industries that are processing these bioresources with relatively low added value predominate (for example the food industry).

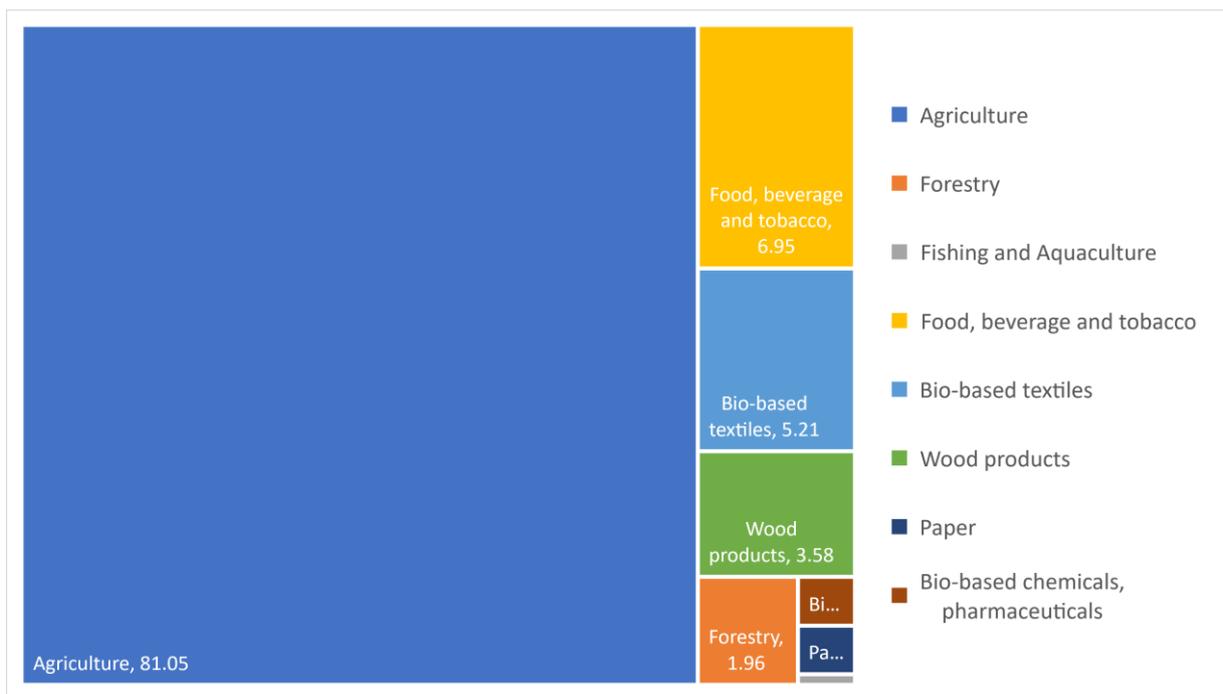
Step by step, the Romanian farmers are informed on the possible opportunities offered by the clever association of biology and technology, resulting in bioeconomy. For a smooth transition to a more efficient farming system, knowledge transfer should be enhanced, thus transforming innovative ideas into marketable products. As showed in the previous section, in the European Union, the bioeconomy generates a turnover of around 2,250 billion EUR of turnover, included in various sectors of activity such as agriculture, agri-food, biofuels and all bio-based activities.

In 2015, top five contributors to EU 28 turnover were: Germany (17%), France (15%), Italy (13%), UK (10%), Spain (9%). Romania accounted for 2%, weighs 36,971 million euros, and almost 40 percent was generated by agriculture (Ronzon et al., 2018).

Regarding the demographic data, according to Ronzon data (Ronzon et al., 2018; Ronzon and M'Barek, 2018), Romania's bioeconomy location quotient was 3.76, employed in bioeconomy sectors. The location quotient meaning is that in our country we have almost 4 times more people involved in bioeconomy sector than EU (Ronzon and M'Barek, 2018). Regarding the distribution across bioeconomy sectors (figure 4a), over 80% are employed in agriculture, and at a far distance is situated food industry with almost 7% (Figure 4b).



**Figure 4.a. Distribution of labor force across bioeconomy sectors in Romania**



**Figure 4b. The share of labor force by bioeconomy sectors in Romania, 2015**

Currently, the pathway on how to reach bioeconomy principles, and the practical implementation of Research-development-innovation (RDI) results is still hindered by the scarce collaboration between industrial actors (including agriculture stakeholders from both vegetal and livestock sectors) and RDI promoters (Orboi et al., 2017). The best good example of practical efficiency of exchange between science and practice are agro-forestry or agri-aqua farming systems. This is particularly relevant when taking into account that any innovative

solution must be locally adapted and an in-depth understanding of any complex solution is always needed (EC, Directorate-General for Research and Innovation, 2018).

Another issue hindering the progress is the fact that Romania owns the most divided EU agricultural structure (Feher et al., 2017). Our country includes a third of the agricultural holdings in the EU and 7.47% of its agricultural area (Eurostat data).

Therefore, innovation is the key to sustainable intensification of agriculture, and this can be achieved by a two-fold approach: structural perspective and improvement of production processes. The structural perspective is about strengthening and deepening the collaboration and cooperation in the agri-food sector. And the second one is about capacity building and increasing access to latest knowledge available on technology and innovation, while adapting to Romanian realities (Dovleac and Balasescu, 2016). According to recent data provided by United States Department of Agriculture (USDA) foreign agricultural services, in a public report, Romania is one of the most progressive European states when speaking of agricultural biotechnology. The national regulations allow biotechnology related field trials, still research is limited to genetically engineered plum trees (Johnson, 2017). The strict EU regulatory framework on agricultural biotechnology is partially understandable due to uncertainty that always comes together with new technologies (Zilberman et al., 2018) but maybe this situation should be reevaluated.

Capacity building opportunities for the development of the agricultural sector in Romania, thus boosting rural development can be identified by conducting a SWOT analysis of the domain (Table 1).

*Table 1. The SWOT Analysis of emerging bioeconomy agricultural sector in Romania*

<b>Strengths</b>	<b>Weaknesses</b>
<ul style="list-style-type: none"> <li>✓ increasing government commitment to Bioeconomy through its policies, strategies and funding</li> <li>✓ existing natural resources</li> <li>✓ large agricultural land available</li> <li>✓ well established academic environment through both organisations subordinated by Agriculture Ministry and Research and Innovation Ministry</li> <li>✓ emerging SMEs (small and medium enterprises) on bioeconomy related fields</li> </ul>	<ul style="list-style-type: none"> <li>✓ low public awareness for biobased products</li> <li>✓ decreasing skilled labor force availability due to negative demographic indicators</li> <li>✓ low degree of interaction between academic environment and private companies</li> <li>✓ low degree of innovation culture</li> <li>✓ the most fragmented agricultural structure from EU</li> <li>✓ polarized agricultural structure</li> </ul>
<b>Opportunities</b>	<b>Threats</b>
<ul style="list-style-type: none"> <li>✓ financing schemes through National Rural Development Programme</li> <li>✓ bio-entrepreneurship and agro-entrepreneurship good practice examples provided by International Research projects (especially H2020-RUR)</li> <li>✓ recent farmers and producers' associations involvement in the national financing schemes</li> <li>✓ policy makers availability and willingness to the development of the Bioeconomy</li> </ul>	<ul style="list-style-type: none"> <li>✓ population aging</li> <li>✓ population migration</li> <li>✓ extreme weather (drought, frost, rainfall) due to climate change</li> <li>✓ unstable political environment</li> </ul>

Innovation and capacity building are key elements of the development of agriculture in the context of bioeconomy. While innovation itself comes as a result of research, the innovative spirit of entrepreneurs is educated through the development of knowledge. This requires the translation of scientific knowledge and results on bioeconomy and bioproducts, so that concepts

are easily understandable outside the scientific circles. Examples of good practice from the countries in the region, which already have a coherent strategy on bioeconomy, are welcome, such as to make the transition to the bio-economy of Romanian agriculture easier.

Several of the perspectives to be approached for enhancing agriculture development in Romania could be digital agriculture; climate change adaptation methods and agroecology.

Through agriculture development, the rural regions are expected to become a key player in the development of the bioeconomy activities of the near future. Romania need to follow the western Europe examples, where in the modern economies, the rural regions represent more than just a source of raw materials to bioeconomy industries. However, both the industrial and agricultural sides of the bioeconomy must be developed in close synchronization. Although there is broad agreement on the need for expanding the bioeconomy there is less agreement on the pathways to get there (Johnson, 2017).

The historical and prospective trends in the development of the bioeconomy illustrated above suggest that the importance of the contribution of agriculture and the food industry to total employment in the bioeconomy could decrease in the future, even if this general trend can be offset, at least in part, by increases in employment in forestry and in the "blue bioeconomy".

## Conclusion

The premises for technological and scientific development towards transition to bioeconomy are already being created in theory, the challenge is now being to translate them into innovative ways of doing business in order to generate jobs and growth.

Bioeconomy perspectives for boosting agriculture and rural development in Romania should to concentrate on the following areas:

- a) promote the bioeconomy and its products to the general public to improve public perception and awareness of the concept;
- b) improve knowledge on biobased products and enhance technology transfer;
- c) build upon EU good practice for pilot and demonstration facilities;
- d) enhance qualification and skilled labor force;
- e) improve access to financing for agriculture investments;
- f) introduce a long-term policy and incentive framework to promote the bioeconomy in agricultural area.

A coherent bioeconomy strategy should be the result of collaborative work carried out by the decision makers in charge of agriculture, the environment, the economy and research, as well as contributions from all the stakeholders (economic actors upstream and downstream, public institutions, researchers, civil society). The implementation of bioeconomy is a process that involves the entire society, cannot be implemented by institutions or experts in economics, science or politics without the support of the general public and without knowing the needs and desires of the consumers.

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