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STUDY ON THE POSITION OF AGRICULTURE AMONG THE BIOECONOMY SECTORS IN THE EUROPEAN UNION

Daniela Nicoleta VOICILĂ, Cristina Maria STERIE, Steliana RODINO

Research Institute for Agricultural Economics and Rural Development, 61 Mărăști Blvd, District 1, Bucharest, Romania, E-mails: badan.daniela@iceadr.ro, sterie.cristina@iceadr.ro, steliana.rodino@yahoo.com

Corresponding author: steliana.rodino@yahoo.com

Abstract

This paper provides a detailed analysis of the position of agriculture among the bioeconomy sectors in the European Union and Romania, focusing on the recent period. It explores the National Competitiveness Strategy 2015-2020, which identified 10 economic sectors, including the 5 considered part of the bioeconomy. Using Eurostat statistical data and processing them through SPSS software, indicators such as minimum, maximum, mean and standard deviation were calculated to highlight the evolution of this sector. In the EU, the bioeconomy generated around 17.2 million jobs and €664 billion in value added in 2020, with an increasing trend in value-added and a decreasing trend in jobs. Sectors with high potential, such as food, agriculture and wood products, have seen significant added value. Romania is presented as having a high potential to develop the bioeconomy, based on the diversity of natural resources. The bioeconomy has been found to have a significant presence in primary sectors such as agriculture and the food industry and can contribute to sustainable growth and job creation in the private sector. Agriculture is considered an important pillar of the bioeconomy ecosystem, by providing added value and creating employment opportunities. As of 2020, across the EU-27, the agriculture sector represented a high share of the value added in the bioeconomy, supporting the efforts to sustainable development and the efficient utilization of biological resources on European scale.

Key words**:** *bioeconomy, added value, labour productivity, strategies, Romania*

INTRODUCTION

The bioeconomy is an innovative approach to economic development, encompassing fundamental principles such as sustainability, efficient resource use and circularity. In the European context, the bioeconomy is becoming increasingly present in scientific research as the impact of climate change becomes more evident and significant in terms of human activity. The bioeconomy is linked to concepts such as the green economy and the circular economy, and their interactions are particularly highlighted in the relationship between the bioeconomy and the circular economy [2, 12, 13].

The bioeconomy is based on the responsible use of biological resources and processes in the environment to create goods, energy and services [11]. It focuses on the sustainable use of resources such as plants, animals, micro-organisms and marine resources in various fields such as sustainable agriculture and forestry, food industry, renewable energy or medicine. The aim is to develop products and solutions that reduce environmental impacts and support economic development [14].

The concept of bioeconomy is closely connected to the objective of reducing the dependency on mineral resources, while providing value-added goods, including food, feed, fiber, industrial and health products, through the sustainable utilization of the locally available biological resources (Socaciu, 2014) [19] .

Bioeconomy is characterized as an environmentally friendly and sustainable economic sector, bringing positive benefits for economic development by creating new employment opportunities and expanding the business environment. It can be presented as a key element in the process of reducing the economic gap between the countries of Central and Eastern Europe and those of the Western continent.

Authors Bălan E.M. and Cismas L. (2022), have conducted a study on the analysis of the CEE grouping according to specific bioeconomy

indicators, highlighting similarities or discrepancies between these countries [3].

Research by Rozon T. (2020), highlights structural differences between EU national bioeconomies, accentuated over time, with reference to the apparent level of labour productivity [17].

The establishment of bioeconomy governance frameworks at both regional and national levels is an important step in the transformation of bioeconomy within those contexts [6, 15]. Participatory design of the financial support and regulatory mechanisms is helpful in overcoming bottlenecks that may arise during setting the scene for the bioeconomy sector. Employing the method of hierarchical cluster analysis, a group of researchers evaluated the progress towards bioeconomy of EU member states. Having in mind the sectors engaged in biomass production and conversion, the study has highlighted a visible progress in the bioeconomy, highlighting the performance of Belgium and Denmark [9].

The European Union aims for a circular bioeconomy, so that biological resources are used as efficiently as possible to reduce waste. This process involves transforming biological materials into different products [18]. The European Union's bioeconomy strategy includes several objectives, such as reducing dependence on finite resources, promoting high-performance technologies and innovation, creating jobs and sustainable economic growth. It also aims to protect the environment, and combat climate change through better management of natural resources [14, 1].

In agriculture, the bioeconomy involves the adoption of practices that can harness biological resources, and soil fertility, moving towards reducing the use of chemicals, thus ensuring efficient and sustainable production in the long term [5, 20]. Bioeconomy in agriculture also promotes the efficient use of resources such as water, energy and agricultural inputs to maximize production and reduce losses [7, 4]. Responsible waste management in agriculture involves recycling of nutrients to maintain a sustainable resource cycle [20].

This paper aimed to present the current state of the bioeconomy at European level and in Romania, as well as an evolution of this sector for the period 2008-2020.

MATERIALS AND METHODS

The data was analysed according to the economic sectors that fall under bioeconomy umbrella, that were previously identified in National Strategy for Research, Development, and Innovation 2014-2020, as follows: agriculture, forestry, fisheries and aquaculture, biopharmaceuticals, and biotechnologies.

The statistical data analysed were taken from the europa.eu database and regard the following indicators: number of persons employed, value-added and apparent labour productivity. For a more detailed study, descriptive indices such as minimum, maximum, period mean and standard deviation were calculated using SPSS. These calculated indicators highlighted the periods of growth and decline of this sector, thus providing an overview at European and national level.

RESULTS AND DISCUSSIONS

At European level, in 2020, the bioeconomy sector provided jobs for around 17.2 million people and added an estimated €664 billion in value, according to the latest estimates. For the year 2020, the European Commission reports showed that the bioeconomy sector provided a share of 8.72% of the total workforce employed in the EU-27. More than half of the employed individuals in bioeconomy, totalling 8.7 billion people, were engaged in agriculture. a share of 27% of the workforce (4.6 billion people), were employed in the food, beverage, and tobacco industries. At the bottom were the sectors of topical interest at European level, bioelectricity and liquid biofuels with 0.2% of total EU-27 employees.

Between 2008 and 2020, there was a decrease of 15.3% in the share of employees within the bioeconomy sector. This decline was evident across various sectors of the bioeconomy as follows: agriculture 23.4%, bio-based textiles 35.64%, fishing and Aquaculture 7.88%, forestry 2%, paper sector 5%, wood products and furniture sector 17.9%.

It is interesting to be noted that the bio-based electricity sector has experienced significant

expansion. During the analyzed period, the number of employees registered a substantial increase, being 3 times higher in 2020 (36.7 thousand people) than in 2008 (11.8 thousand people)

Table 1. Descriptive statistics on the number of persons employed in agriculture and other bioeconomy sectors in the period 2008-2020 at EU-27 level (thousands of persons)

Specification	Minimum	Maximum	Mean	Std. Deviation
Agriculture	8,703.00	11,358.00	9,973.8462	869.46898
Bio_based_chemicals_pharmaceuticals_plastics_and_rubber	365.00	473.00	400.6923	37.40184
Bio_based_electricity	12.00	37.00	22.4615	8.03757
Bio_based_textiles	724.00	1125.00	844.6923	103.84314
Fishing_aquaculture	156.00	190.00	170.3846	8.51017
Food_beverage_tobacco	4,137.00	4,657.00	4,324.3846	181.06837
Forestry	494.00	529.00	515.6154	9.81953
Liquid_biofuels	15.00	27.00	21.3846	3.84141
Paper	581.00	650.00	603.6923	21.27355
Wood_products_furniture	1,288.00	1,618.00	1,359.6154	92.50904
Total_employed_people	17,163.00	20,267.00	18,236.538	927.55005

Source: SPSS's own representation based on europa.eu data [8].

At Member State level, the number of people employed varied in the proportions of the population employed in the bioeconomy sector. Figure 1 shaows that the highest shares are observed in Poland (14.11%), Romania (12.72%), Germany (12.19%), Italy (10.88%), and France (10.10%). At the opposite side, Luxembourg, Malta, and Estonia have the lowest shares, each below 0.3%.

Several Member States stand out for some specific sectors within the bioeconomy:

-Romania, Italy and France lead in agriculture.

-Germany, France and Poland have a high number of employees in the food, beverage and tobacco sectors

-France, Germany and Poland in wood products and furniture.

These findings highlight the varying degrees of engagement in the bioeconomy across different Member States, reflecting diverse economic structures and priorities within the EU-27.

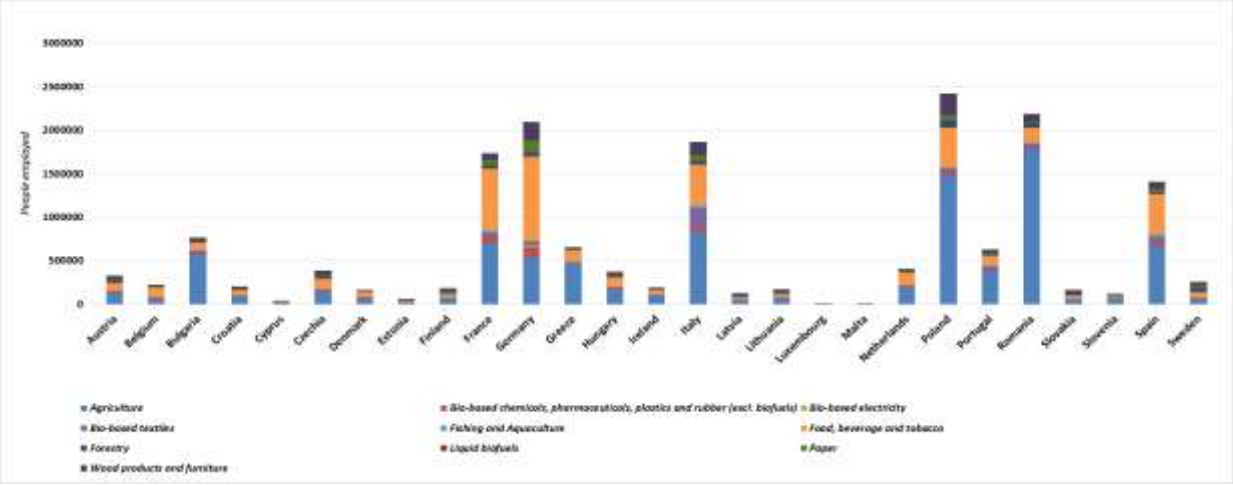

Fig.1. Number of persons employed in the bioeconomy sector, by EU-27 Member State, 2020
Source: Own processing based on europa.eu data [8].

Regarding the value added, it was found that during the period under study it increased by 29.53% in 2020 compared to 2008. The only sector that saw a decrease in value-added was Bio-based textiles, by 13.2% in 2020 compared to 2008. The largest increases were observed in the Liquid biofuels (by 161.33%) and Bio-based electricity (by 198.23%) sectors.

The minimum value added recorded at EU-27

level was €474.3 billion in 2009, the maximum was €667.23 billion in 2019, and the average for the period analysed was €566.10 billion. The highest values of value
added were seen in the following sectors of the bioeconomy: food,_beverage,_tobacco (with a maximum of 237.53 billion euros in 2019), agriculture (with a period maximum of 192 billion euros in 2019) and wood_products_furniture (with a maximum of 50.67 billion euros in 2020).

Table 2. Descriptive statistics on value added in agriculture and other bioeconomy sectors in the EU-27, 2008-2020 (€ billion)

Specification	Minimum	Maximum	Mean	Std. Deviation
Agriculture	**138.85**	**192.00**	**171.1377**	**15.62835**
Bio_based_chemicals_pharmaceuticals_plastics_and_rubber	42.60	79.30	53.7823	12.70180
Bio_based_electricity	2.22	6.63	4.1223	1.23210
Bio_based_textiles	20.01	25.65	22.4731	1.58715
Fishing_aquaculture	5.29	6.36	5.7446	.34650
Food_beverage_tobacco	174.78	237.53	199.9138	22.88892
Forestry	16.90	26.74	23.2608	2.83703
Liquid_biofuels	1.41	3.88	2.7185	.85228
Paper	33.89	48.15	40.3846	4.56845
Wood_products_furniture	37.71	50.67	42.5685	4.43280
Total_value_added	**474.30**	**667.23**	**566.1062**	**62.84825**

Source: SPSS's own representation based on europa.eu data [8].

At Member State level, in 2020, the highest value added was recorded by Germany, France, Italy and Spain with shares in total value added of 19.16% (€125.4 billion), 15.44% (€101.06 billion), 13.7% (€89.65 billion) and 10.47% (€68.51 billion) respectively. In 2020, the following countries with high value added values in the sectors with the highest shares of value added stood out:
-France, Italy and Spain in agriculture with values of 32.8 billion Euro, 30.5 billion Euro and 30.1 billion Euro.
-Germany, France and Italy, for the food, beverage and tobacco sectors with a value of EUR 53.3 billion, EUR 43.7 billion and EUR 27.9 billion, respectively.
-For bio-based chemicals, pharmaceuticals, plastics, and rubber (excluding biofuels), Germany holds the top position with a value of 16.8 billion Euros. France follows with 8.6 billion Euros, and Italy with 7.1 billion Euros.

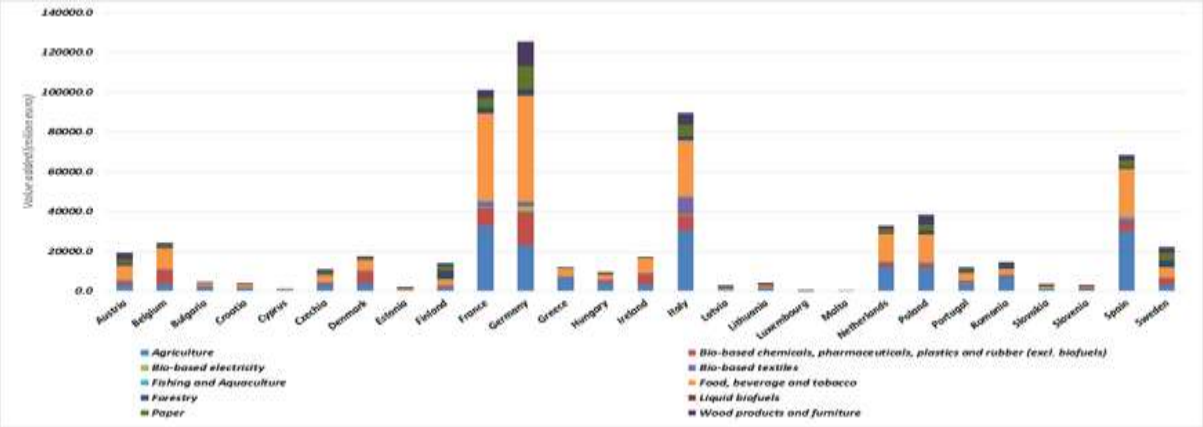

Fig. 2. Distribution of value added by country in the bioeconomy sector of the EU-27 in 2020
Source: Own processing based on europa.eu data [8].

The apparent productivity of the labour force in the bioeconomy sector, in 2020, at the EU-27 level, was EUR 38,100 per employee, representing an increase of 36.1% compared to the 2008 value (28 000 euros per employed person).
Within Figure 3 you can see a distribution of the apparent productivity of labour at the EU-

27 Member State level by the value recorded by each category of the business sector. Three distinct levels of apparent labour productivity can be highlighted: Less than 25,000 euros per employee, II. Between 25,001 and 50,000 euros for each employee and III. More than 50,001 euros per employed person. Apparent labour productivity in the Member States has shown significant variations, some of which are above the EU-27 average for each sector.

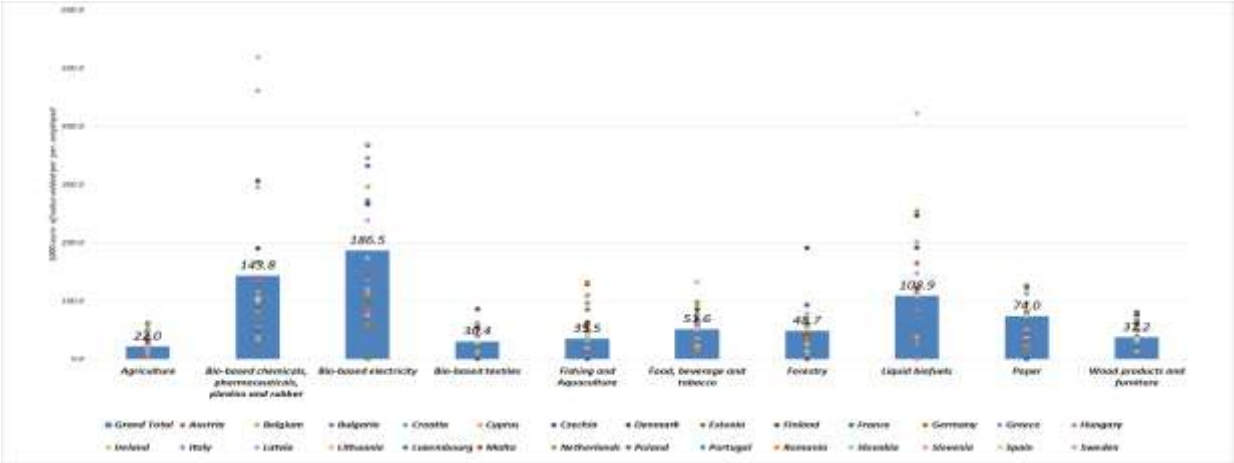

Fig. 3. Apparent Labour productivity in agriculture and other bioeconomy sectors in the EU-27 in 2020
Source: Own processing based on europa.eu data [8].

At the national level, in 2020, the bioeconomy sector provided more than 2 million jobs, representing 25.7% of the national labour force. The added value recorded was EUR 14.55 billion.

Statistics show that 81% of the employees in the bioeconomy sector were from agriculture (1.77 milions pers.). The food, beverage and tobacco industry accounting for 8.3% of the labor force in the bioeconomy sector in Romania (180 thousand pers.). The difference of 10% of the total employed persons was divided between the remaining sectors. The lowest shares were recorded in the bioelectricity and liquid biofuels sectors (below 0.04%) (Figure 3).

Table 3. Descriptive statistics on the number of persons employed in agriculture and other bioeconomy sectors in Romania, 2008-2020 (thousands of persons)

Specification	Minimum	Maximum	Mean	Std. Deviation
Agriculture	**1,772,600.00**	**2,844,400.00**	**2,325,076.92**	**383,279.3**
Forestry	42,900.00	61,800.00	52,092.31	5,686.455
Fishing and Aquaculture	1,600.00	4,700.00	2,530.77	817.9085
Food, beverage and tobacco	180,996.00	208,537.00	187,944.00	7,098.798
Bio-based textiles	60,827.48	132,630.06	91,786.66	17,621.47
Wood products and furniture	90,007.62	129,549.98	99,988.03	9,662.041
Paper	11,748.37	14,961.97	13,362.88	1,108.681
Bio-based chemicals, pharmaceuticals, plastics and rubber (excl. biofuels)	12,236.97	15,328.65	13,655.63	880.0555
Liquid biofuels	792.83	1,152.49	1,025.99	114.0385
Bio-based electricity	5.61	294.75	169.82	102.622
Total_employed_people	**2.189,092.86**	**3,407,238.51**	**2,787,633.01**	**409,051.2**

Source: SPSS's own representation based on europa.eu data [8].

In Table 3 can we see descriptive statistics on the number of employees in different sectors of the bioeconomy, the maximum, minimum and average value for the period 2008-2020. The data presented show a persistent decline in the number of people employed in the agricultural, food, beverage and tobacco sectors during the period under review.

The maximum number of employees being recorded in 2008 at 2.8 million persons, i.e.

208 thousand persons, and the minimum in 2020 at 1.77 million persons, i.e. 180 thousand persons. During the period under review, there was a significant increase in the number of employees in the biochemical, pharmaceutical, plastics and rubber sectors and the bioelectricity sector. Beginning with a minimum of 12.2 thousand individuals (equivalent to 6 pers.) in 2009, the workforce in these sectors reached a peak of 15.3 thousand people (or 254 individuals) in 2019.

In contrast, the value added in Romania's bioeconomy sector exhibited a fluctuating trajectory between 2008 and 2020. The minimum value added was recorded in 2010 (10.282 million euros) and the maximum in 2019 (15.37 million euros).

Regarding the distribution of added value by sectors of the bioeconomy, it could be noted that the highest weights were in agriculture, forestry and in the food, beverage and tobacco sectors, with weights of 48.3%, 12.9% and 18.8%, respectively. The lowest share was recorded by the paper, liquid biofuels and bio-bio-based electricity based electricity sectors.

Table 4. Descriptive statistics on value added in agriculture and other bioeconomy sectors in Romania, 2008-2020 (thousands of euros)

Specification	Minimum	Maximum	Mean	Std. Deviation
Agriculture	**5,668.00**	**8,771.00**	**6,976.4615**	**965.02725**
Forestry_	393.00	1,880.00	937.0000	428.40401
Fishing_and_aquaculture	12.00	304.00	126.6154	95.49567
Food_beverage_and_tabacco	1,581.00	2,848.00	2,234.0000	341.27799
Bio_based_textiles	541.00	754.00	630.5385	62.94126
Food_beverage_tobacco	746.00	1,233.00	952.6923	138.69053
Paper_	142.00	295.00	213.3077	57.75867
Bio_based_chemicals_pharmaceuticals_	213.00	474.00	339.5385	80.74715
Liquid_biofuels	4.00	29.00	15.0769	7.93160
Bio_based_electricity	.00	15.00	9.2308	5.71772
Total_value_added	**10,282.00**	**15,372.00**	**12,434.1538**	**1,623.48862**

Source: SPSS's own representation based on europa.eu data [8].

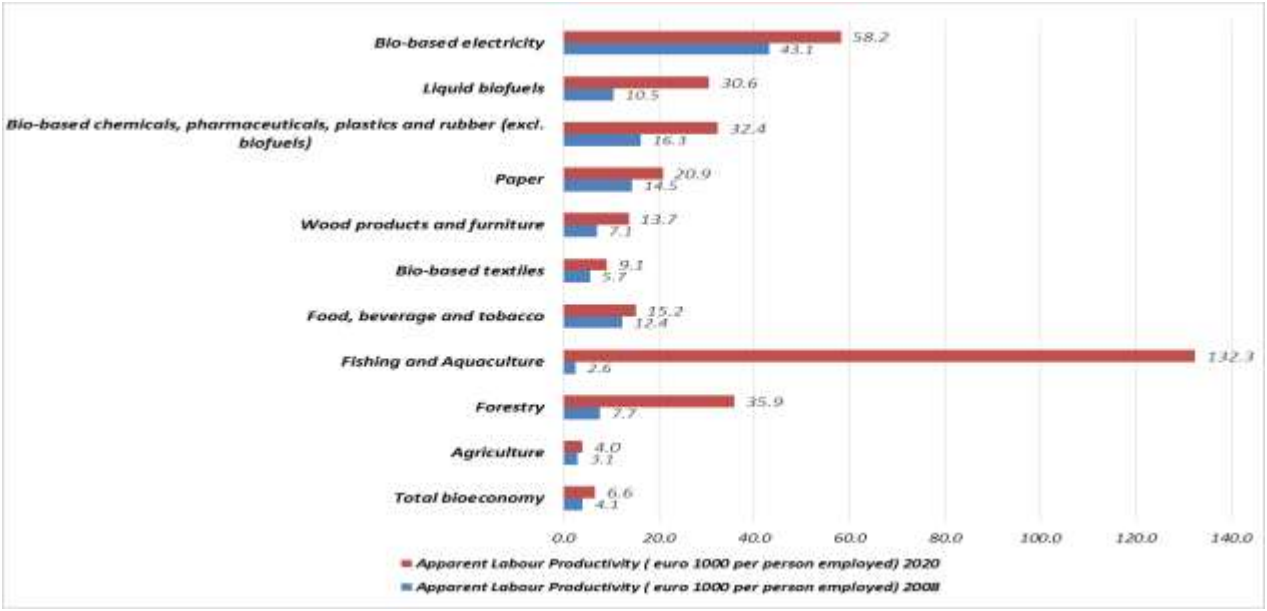

Fig. 4. Apparent Labour productivity in agriculture and other bioeconomy sectors in Romania in the period 2008-2020

Source: Own processing based on europa.eu data [8].

The highest values of value added were recorded in 2019 for most sectors of the bioeconomy, which showed low values during 2010-2012. The Bio-based electricity sector presented the lowest values of value added, with the maximum recorded being 15 thousand

euros two years in a row in 2019 and 2020. Apparent labour productivity recorded at national level followed an increasing trend, in 2020 it was 62.3% higher than in 2008. In 2020, the apparent productivity within the bio-based sector equated to only 30% of the average European level. When examining specific sectors, Figure 2 shows a number of significant increases in apparent productivity in areas such as fisheries and aquaculture, forestry, liquid biofuels and bio-based chemicals, pharmaceuticals, plastics and rubber (excluding biofuels).

For instance, the agricultural sector saw a considerable 28.6% increase in apparent productivity in 2020 compared to 2008.

Although Romania does not present a dedicated strategy for the bioeconomy, this concern is reflected in the National Strategy for Research, Development and Innovation 2014-2020. This Strategy highlights the potential of the bioeconomy at the national level by focusing on key sectors: agriculture, forestry, aquaculture and fisheries [16]. At regional level, a limited number of dedicated strategies have been identified, with regions planning for the period 2021-2027 to publish regional strategies and introduce specific measures on the bioeconomy [10].

CONCLUSIONS

Bioeconomy covers a wide range of traditional economic sectors. These sectors present a high potential in terms of innovation given the continuous development that has occurred in recent years. At European level, the bioeconomy generated around 17.2 million jobs and an estimated added value of €664 billion in 2020, with the trend over time being one of increasing added value and decreasing employment. A high potential in the bioeconomy is presented by the food_beverage_tobacco, agriculture and wood_products_furniture sectors with an added value of more than 50 billion Euro in 2020. Romania presents a high potential for the development of the bioeconomy due to the diversity of its natural resources. Primary sectors such as agriculture and food and tobacco are predominantly bioeconomic at the national level. These sectors can help to support sustainable growth through the transfer of knowledge and technology, and the generation of private sector labour.

In the period 2008-2020, the number of employees in the bioeconomy at the national level decreased, and the added value has increased. In 2020, in Romania were registered 2.2 million employees in the bioeconomy, representing 12.72% of the total employed population in the EU-27. The value added was EUR 14.55 billion. Apparent labor productivity increased from €4,100 per employee in 2008 to €6,600 in 2020.

A number of EU Member States have developed national bioeconomy strategies with the aim of achieving a coherent vision, appropriate policies and adequate financial instruments for the development of this sector. The bioeconomy is supported and promoted by the European Union through research and implementation of sustainable solutions, but also through the allocation of funds through the HORIZON 2020 (€3.8 billion) and Horizon Europe 2021-2027 (€10 billion) programs. Agriculture holds a central and crucial position within bioeconomic fields, representing an essential element in this global approach. The contribution to the added value in the economy at the level of the European Union in terms of agriculture, in 2020, was high, the share being 48.3% of the total value. As a key sector, agriculture not only ensures food security and creates employment opportunities, but also serves as an essential foundation for the development of other branches of the bioeconomy.

In contrast, sectors such as bioelectricity and liquid biofuels recorded lower proportions of value added compared to agriculture, indicating significant variation in their contribution to the bioeconomy. These data underline not only the relevance of agriculture at the local level in Romania, but also at the European level, highlighting the diversity and interconnectedness of the bioeconomic sectors.

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