EVOLUTION AND PROSPECTS OF AGRICULTURAL BIOMASS IN THE EUROPEAN UNION AND ROMANIA

VOICILA DANIELA NICOLETA[1*], GIUCA ANDREEA[1], ANCUTA MARIN[1], RODINO STELIANA[1]

[1] ***Research Institute for Agriculture Economy and Rural Development, Bucharest***

*Corresponding author's e-mail: badan.daniela@iceadr.ro

Abstract: *The purpose of the study is to analyze the evolution of agricultural biomass supply at the EU-27 level and in Romania, highlighting the main sources, distribution, and long-term trends. Statistical data for the research were extracted from Eurostat, with the study period being 2008-2020, depending on the available data. The applied research methods are descriptive analysis and linear forecasting to observe the trends and evolution of agricultural biomass, as well as its sources. At the European level, in 2020, agricultural biomass supply reached 714 million tons, mostly from agricultural crops (95%), with Romania contributing 4.9% of the total. The forecasts indicate an increase in agricultural biomass until 2025, followed by a decrease until 2030, attributed to climate change, agricultural technologies, and regulations. The adoption of sustainable agricultural practices and investment in ecological technologies are crucial for ensuring a constant and sustainable source of biomass in the long term.*

Key words*: biomass, agricultural sector, linear forecast, trends*

INTRODUCTION

The European Commission highlights that global consumption will triple in resource equivalents by 2050, and by 2060, the use of biomass, fossil fuels, metals and minerals will double, and the amount of waste will increase by 70% [11]. The expected changes will put particular pressure on the environment and natural resources, which makes it necessary to implement measures to create a sustainable and efficient economy. At the same time, the current energy crisis highlights that the transition to renewable energy sources is progressing slowly, and that rapid action is needed to replace fossil fuels with sustainable solutions [8].

Biomass is an important source of renewable energy, occupying an important place in the European and global energy market. The sector that contributes considerably to the supply of biomass is agriculture, being a key component in the transition to a more sustainable economy [5].

It is a key factor in the European Union's energy strategies, being a crucial element for achieving renewable energy objectives. According to research, the contribution of biomass to the total renewable energy resources at the European Union level varies between 50% and 60% [14].

Agricultural biomass includes materials resulting from agricultural activities (cereals, oilseeds, straw, animal residues). It is considered an important source of renewable energy, the benefits and advantages are multiple (management of agricultural waste, reduction of carbon emissions and diversification of use) [3]. It has a particularly important role in increasing regional energy security and contributes to job creation, the surplus of raw materials is a generator of additional income [4].

Agriculture is the main source of biomass, providing 68% of its total [6]. This share highlights how important agricultural biomass is in the EU strategy on the bioeconomy.

The European Union generated an average of approximately 924 million tonnes of agricultural biomass in dry matter (Mtdm) annually between 2016 and 2020. Of this amount, 54% comes from economic production and 46% from residues. The availability of agricultural biomass in the EU in the future will be largely determined by the impact of climate change on the agricultural sector [1, 2].

By 2031, the area of agricultural land in the European Union is expected to decrease to 160.5 million hectares due to declining yields and profitability. At the same time, the area of forests will increase, reaching 161.4 million hectares. The changes that have occurred could influence the availability of agricultural biomass, requiring new appropriate strategies for sustainable resource management [6]. Given all this information, agricultural land continues to be an essential resource for both food production and renewable energy [9].

A number of papers in the literature address the subject of agricultural biomass, analysing both its energy potential and its impact on the environment and the economy.

The paper by the author Arkadiusz Weremczuk aims to analyze the potential of agricultural biomass in the European Union for energy production, highlighting the various sources of biomass. It highlights the significant differences between EU countries, due to the diversity of agricultural practices, highlighting the need to adopt biomass strategies adapted to each country according to the necessary conditions. The author also underlines the key role of biomass in strengthening the energy independence of the European Union and reducing dependence on fossil fuels [6].

Researchers Marek Wieruszewski and Katarzyna Mydlarz analyse in a study the role of biomass and bioenergy in the energy strategy of the European Union. The article highlights the estimates of the growth in biomass demand and the main biomass sources: forest biomass, agricultural residues and energy crops. The research indicates a significant increase in biomass potential, both in the case of forest biomass and agricultural biomass, and highlights the impact of imports from non-EU business on biomass demand in EU Member States [7].

The paper by Dorota Janiszewska and Luiza Ossowska analyses the potential of agricultural biomass in the European Union for energy production. The research assesses resources such as cereal straw, hay, natural fertilizers and energy crops on unused land. According to Eurostat data from 2019, approximately 15% of the total potential of agricultural biomass can be used for energy. The study highlights regional differences in the efficient use of this resource [3].

There is a constant discussion among researchers and in the specialized literature about the importance of agricultural biomass as a main source of renewable energy, highlighting its role in reducing dependence on fossil fuels and supporting the transition to sustainable economies. The study presents the distribution and sources of biomass, as well as long-term trends, comparing data and information from the period 2008-2020. This research contributes to documenting this topic by highlighting regional differences in the EU regarding the supply of agricultural biomass.

MATERIALS AND METHODS

In the present study, the authors aimed to analyze the supply of agricultural biomass at the European level EU-27 and Romania. The analyzed statistical data were available for the period 2008-2020, from the Eurostat portals and the statistical sources of the European Commission. The following indicators were taken into consideration: the amount of agricultural biomass produced in each EU-27 member state, with details on the structure of biomass sources (agricultural crops, residues, grazing); the proportions of imported biomass and those generated from domestic resources.

The main research methods used in the study:

- Descriptive analysis - applied to examine the evolution of agricultural biomass production in the EU-27 and Romania and to produce graphs and charts.

- Comparison between EU-27 member states - making a comparison between EU-27 member states, taking into account the share of each state in agricultural biomass production, the structure of crops and domestic resources versus imports.
- Long-term forecast, carried out to estimate the future evolution of the available biomass supply. The linear forecast carried out assumes a continuity of historical trends, not taking into account unforeseen factors (climate and political changes, global economic crises or technological developments).

An important component of the study is also the analysis of the structure of agricultural crops in the EU-27 and Romania (cereals, oilseeds and fodder) being essential for the production of agricultural biomass. The paper aims to contribute to a better understanding of the dynamics of the supply of agricultural biomass at European and national level by providing relevant information for the development of agricultural and sustainable energy policies.

RESEARCH RESULTS

The total biomass supply from the agricultural sector at EU-27 level in 2020 was approximately 714.22 million tonnes of dry matter (Mtdm). The forestry and aquaculture sectors did not present any recorded value at the time of the analysis. Approximately 95% of the biomass was produced in the EU-27, while 5% was imported from countries outside the European Union. Compared to 2008, the biomass supply increased by 1% in 2020. The highest amount of agricultural biomass in the period under review was recorded in 2019, at 743.62 million tonnes (Figure 1).

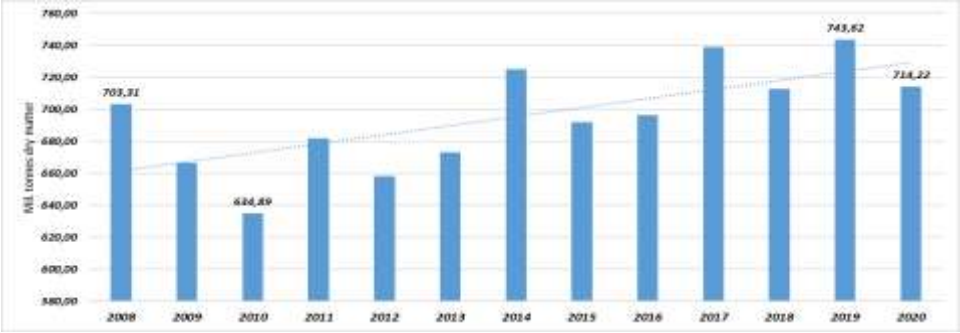

Figure 1. Evolution of agricultural biomass at EU-27, 2008-2020

Source: processing data, https://datam.jrc.ec.europa.eu/datam/mashup/BIOMASS_FLOWS/

The sources of biomass in the agricultural sector at EU-27 level, in 2020, were divided as follows:

- 70.04% of biomass, which comes from crop production, being used for biofuels, feed and food;
- 12.88% of biomass, coming from agricultural residues, these being used for energy, organic fertilization and ecological materials;
- 13.40% of biomass comes from grazing, used for animal husbandry and pasture management.
- around 4% of biomass is imported, indicating a partial dependence on external sources, such as feed and wood. (Figure 2).

The different sources of biomass suggest that the agricultural system is diversified and interconnected, presenting a particular potential in terms of renewable energy.

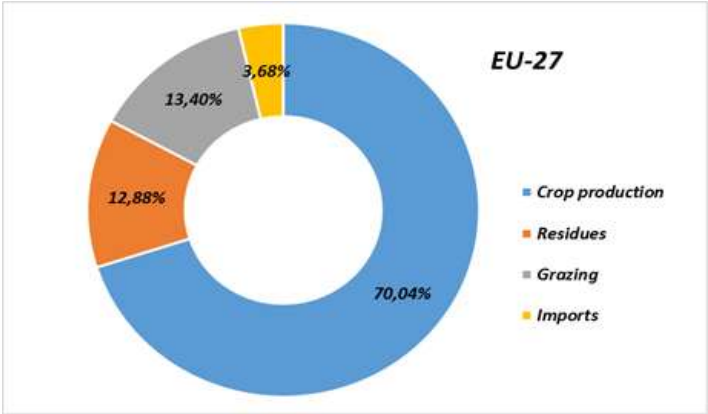

Figure 2. Sources of agricultural biomass, EU-27, 2020.

Source: processing data

Analyzing the amount of agricultural biomass at the level of the EU-27 Member States, in 2020, it is found that the highest quantities were recorded in Germany (15.59%), France (15.32%), Italy (12.05%), Spain (9.12%) and Poland (7.78%). Romania occupies the sixth position at the European level in terms of the amount of biomass originating from agriculture, with a share of 4.9% of the total.

Countries importing agricultural biomass are: Italy (5.02%), Germany (3.92%) and the Netherlands (3.33%), while Estonia (0.04%), Slovenia (0.08%) and Malta (0.07%), relied more on domestic resources. France (10.21%) and Germany (9.50%) are leaders in the production of crops for biomass due to their extensive agricultural areas, and Cyprus and Malta have a low production (Figure 3).

France (1.85%) and Spain (1.83%) have the highest use of grazing land, suggesting a strong livestock industry. Countries with low contributions of biomass from grazing are Finland (0.00%) and Slovenia (0.07%), indicating a lower dependence on this type of resource.

Poland and France use large amounts of residues for biomass, while Malta and Luxembourg have low contributions, due to limited agricultural areas. (Figure 3)

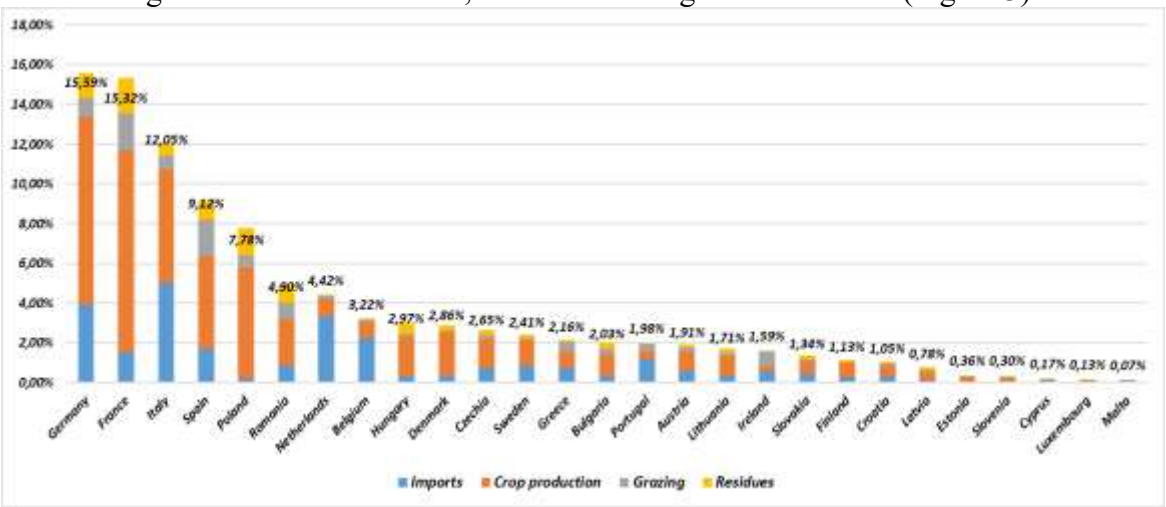

Figure 3. Biomass supply from agriculture,(%), 2020

Source: processing data

Biomass production in the European Union is dominated by cereals and feed, which accounted for almost 81% of the total in 2020. Cereals (48.8%) played an essential role in both food and biofuel production, while feed (32%) was fundamental for the livestock sector.

Root crops (7.2%) and oilseeds (5.1%) make an important contribution to the food industry and renewable energy production. Fruits and olives accounted for 4.6% of total agricultural biomass production, and other vegetables, although with a low share, could gain greater importance in the future, amid increasing sustainability requirements. (Figure 4)

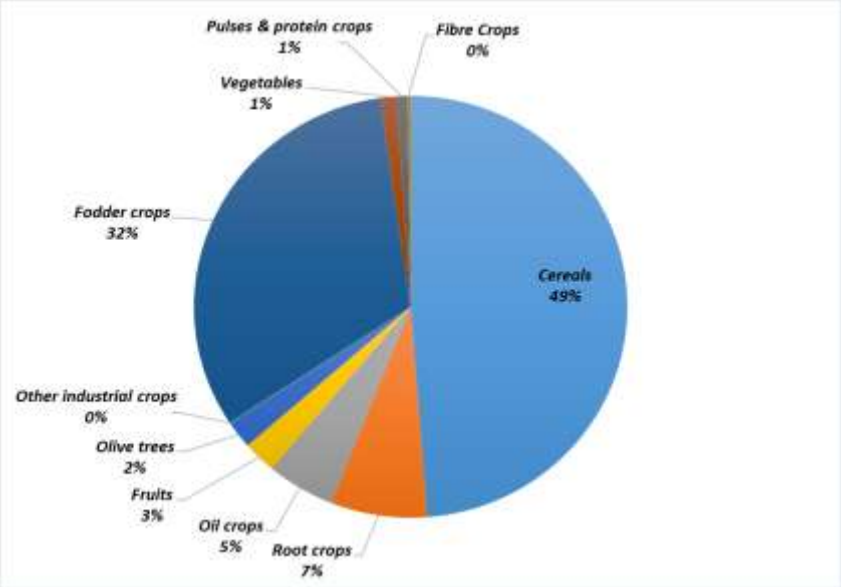

Figure 4. Crop production, EU-27, net trade, 2020

Source: processing data

The analysis of the supply of biomass from agriculture at the national level, in Romania, highlights an increase of 7% in 2020 compared to 2008. The highest quantity of biomass was recorded in 2018, at 65.08 million tonnes dry matter (Figure 5).

Regarding the own production of biomass from agriculture, the quantity increased in 2020, by 5% compared to 2008. Biomass imports increased during the analyzed period, reaching a maximum quantity of 8.12 million tonnes in 2020.

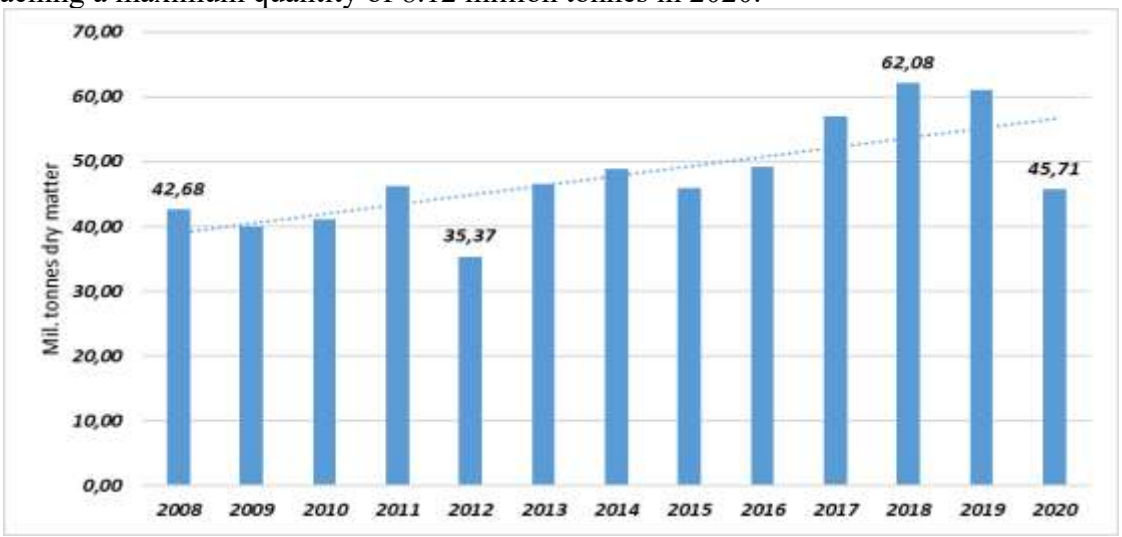

Figure 5. Evolution of biomass from agriculture in Romania, 2008-2020.

Source: processing data

Taking into account the sources of biomass in agriculture, in 2020, the following was found in Romania:

- 47.32% of agricultural biomass comes from crop production, highlighting the dependence on domestic agriculture;
- 18.15% is represented by residues, used for energy and organic fertilizers;
- 16.78% comes from grazing, reflecting a moderate use of resources for animal husbandry;
- approximately 18% of biomass is imported, indicating a significant dependence on external sources to complete the biomass requirement (Figure 6).

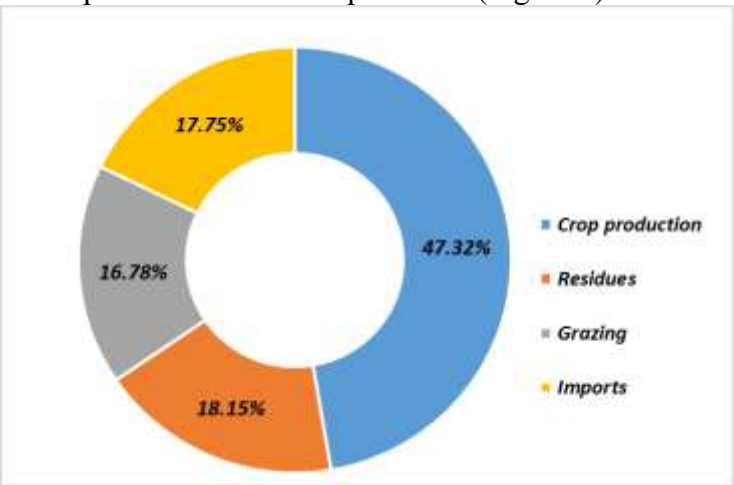

Figure 6. Agricultural biomass sources, Romania, 2020

Source: processed data

The structure of biomass at the level of Romania indicates a majority concentration on cereals (72.2%), followed by oilseed crops (13.5%) and fodder (8.0%). Root crops, fruits and protein crops are less represented, while other industrial crops and fibers have an extremely small share. National agriculture is thus dominated by the production of basic foods (cereals), vegetable oils and animal feed, with a reduced involvement in industrial or non-food crops (Figure 7).

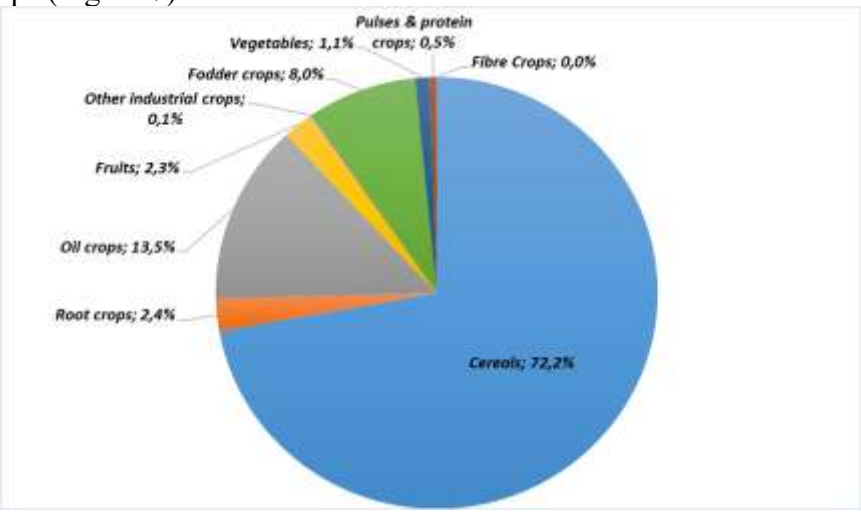

Figure 7. Crop production, Romania, net trade, 2020

Source: processed data

Making the forecast of the quantity of agricultural biomass at EU-27 level based on the available data, for the period 2021-2030, they indicate a moderate increase until 2025, with a maximum of 744.27 million tonnes, then a progressive decrease is recorded until 2030, to 716.56 million tonnes. The trend recorded may reflect a combined influence of

various factors such as climate change, technological development and changes in agricultural policies (Figure 8).

The generated forecast indicates an increase in the amount of initial agricultural biomass that can be attributed to investments in sustainable agricultural practices, but also to the increase in demand for biomass for renewable energy. After 2025, there was a decrease in the amount of agricultural biomass determined by the reduction of agricultural land, climatic variations and the imposition of stricter environmental regulations.

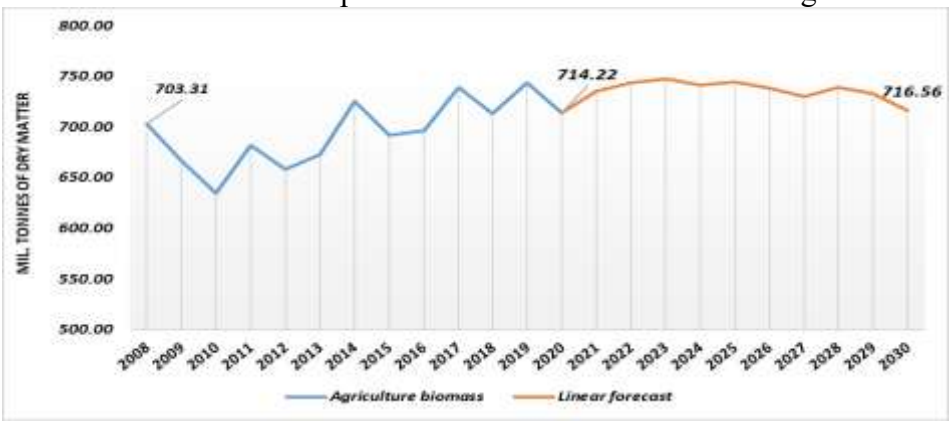

Figure 8. Forecast EU-27, supply agricultural biomass.

Source: processing data

In order to have a broader vision of the agricultural biomass supply in Romania, a forecast of the amount of agricultural biomass for the period 2021-2030 was made based on the available data and analyzed for the period 2008-2020 (Figure 9).

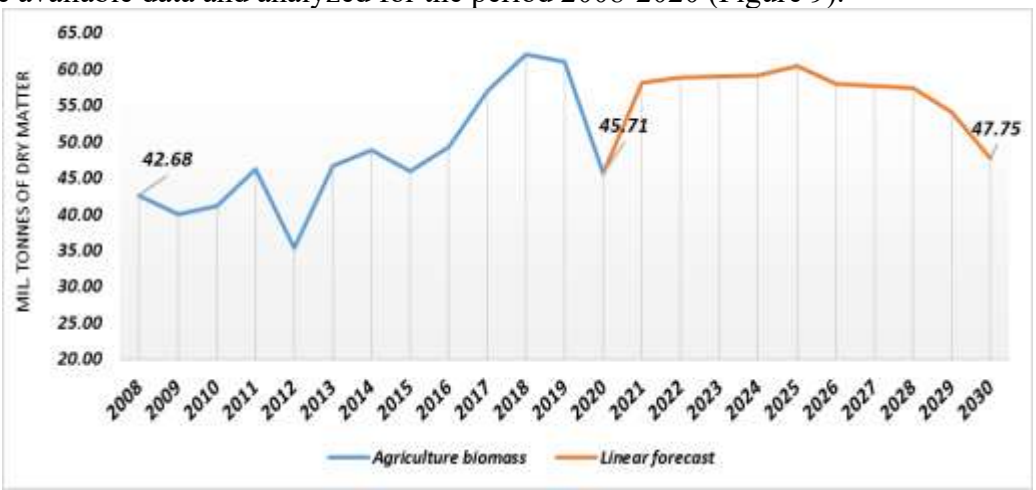

Figure 9. Forecast Romania, supply agricultural biomass

Source: processed data

According to the forecast made, it is estimated that the agricultural biomass at the country level, Romania, will register an increase by 2025, up to the amount of 60.41 million tons. According to the generated model, it indicates that there will be a gradual decrease in agricultural biomass, reaching 47.75 million tons in 2030 (Figure 8). This trend can be based on climate change, which can influence, as well as the reduction of agricultural areas, the evolution of technology and agricultural policies.

CONCLUSIONS

The analysis of agricultural biomass supply at EU-27 level and in Romania during the period 2008-2020 provides us with an overview of the evolution of this sector. The data taken for analysis suggest that a moderate increase in biomass production was recorded over the analyzed period, most of which came from the agricultural sector, with a significant share of crops, agricultural residues and grazing.

The dominant countries in agricultural biomass production are Germany, France, Italy, Spain and, while Italy and Germany stand out for significant biomass imports. Countries such as Estonia and Malta rely largely on domestic resources.

At European level, Romania ranks 6th, with a share of 4.9% of total agricultural biomass. Domestic production of agricultural biomass is based on cereals, oilseeds and fodder, and imports indicate the need to diversify and optimize domestic resources.

The variations recorded and observed indicate that there are differences between the strategies and capacities for using biomass within the EU, with a significant impact on European energy and agricultural policies.

Both at EU-27 and national level, the forecasts made indicate a moderate increase followed by a gradual decrease in agricultural biomass, until 2030. A decrease that can be attributed to climate change and changes in environmental regulations. In order to counteract this decrease, it is considered necessary to adopt sustainable agricultural practices and invest in ecological technologies, which can ensure a constant and sustainable supply of biomass in the long term.

ACKNOWLEDGEMENTS

The present research is part of the Project ADER 22.1.4 "Research on the development of technical-economic solutions for the creation of value chains in the agri-food sector in view of the transition to the circular bioeconomy" of the Research Institute for Agricultural Economy and Rural Development Bucharest.

REFERENCES

[1]. AVITABILE V., BALDONI E., BARUTH B., BAUSANO G., BOYSEN-URBAN K., CALDEIRA C., CAMIA A., CAZZANIGA N., CECCHERINI G., DE LAURENTIIS V., DOERNER H., GIUNTOLI J., GRAS M., GUILLEN GARCIA J., GURRIA P., HASSEGAWA M., JASINEVIČIUS G., JONSSON R., KONRAD C., KUPSCHUS S., LA NOTTE A., M`BAREK R., MANNINI A., MIGLIAVACCA M., MUBAREKA S., PATANI S., PILLI R., REBOURS C., RONCHETTI G., RONZON T., ROUGIEUX P., SALA S.,SANCHEZ LOPEZ J., SANYE MENGUAL E., SINKKO T., STURM V., VAN LEEUWEN M., VASILAKOPOULOS P., VERKERK P.J., VIRTANEN J., WINKER H. AND ZULIAN G., 2023, Biomass Supply And Uses In The Eu, Mubareka, S., Migliavacca, M. And Sanchez Lopez, J. editors, Publications Office of the European Union, Luxembourg, 2023, doi:10.2760/368529, JRC133505. (accessed on 20 March 2025)

[2]. GURRÍA P., GONZÁLEZ H., CAZZANIGA N., JASINEVICIUS G., MUBAREKA S., DE LAURENTIIS V., CALDEIRA C., SALA S., RONCHETTI G., GUILLÉN J., RONZON T., M'BAREK R., 2022, EU Biomass flows: update 2022, Publications Office of the European Union, Luxembourg, 2022, ISBN 978-92-76-49477-5, doi:10.2760/082220, JRC128384 (accessed on 20 March 2025)

[3]. JANISZEWSKA D., OSSOWSKA L., 2018, Diversification of European Union Member States due to the production of renewable energy from agriculture and forestry. Probl. World Agric. 2018, 18, 95–104 (accessed on 20 March 2025)

[4]. NAKICENOVIC N., ALCAMO J., DAVIS G., DE VRIES B., FENHAM J., GAFFIN S., GREGORY K., GRÜBLER A., JUNG T.Y., KRAM T., ET AL., 2018, Special Report on Emissions Scenarios. Intergovernmental Panel on Climate Change, Cambridge, UK. 2000. Available online: https://www.ipcc.ch/site/assets/uploads/2018/03/emissions_scenarios-1.pdf (accessed on 20 March 2025)
[5]. RODINO S., BUTU A., DRAGOMIR V., BUTU M., 2019, An Analysis Regarding The Biomass Production Sector In Romania - A Bioeconomy Point Of View, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development Vol. 19, Issue 1, 2019 PRINT ISSN 2284-7995, E-ISSN 2285-3952 (accessed on 17 March 2025)
[6]. WEREMCZUK A., 2023, The Energy Potential of Agricultural Biomass in the European Union. Problems of World Agriculture, 23(4), 44-60; DOI: 10.22630/PRS.2023.23.4.16 (accessed on 17 March 2025)
[7]. WIERUSZEWSKI M., MYDLARZ K., 2022, The Potential of the Bioenergy Market in the European Union—An Overview of Energy Biomass Resources. Energies 2022, 15, 9601. https://doi.org/10.3390/en15249601 (accessed on 15 March 2025)
[8]. ZUK P., ZUK P., 2022, National energy security or acceleration of transition? Energy policy after the war in Ukraine. Joule 2022, 6, 703–712. [CrossRef] (accessed on 5 March 2025)
[9]. ***, Agriculture, Forestry and Fishery Statistics—Statistical Books Eurostat; Luxemburg, European Union 2020. Corine cover 2018, European Environment Agency (EFA). Available online: https://ec.europa.eu/eurostat/documents/3217494/12069644/KS-FK-20-001-EN-N.pdf/a7439b01-671b-80ce-85e4-4d803c44340a?t=1608139005821 (accessed on 20 March 2025)
[10]. ***, European Commission. New EU Forest Strategy for 2030; COM (2021) 572 Final; European Commission: Brussels, Belgium, 2021.Available online: https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52021DC0572&from=EN (accessed on 15 March 2025)
[11]. ***, European Commision. A New Circural Economy Action Plan for a Cleaner and More Competitive Europe; COM (2020) 98 Final; European Commission: Brussels, Belgium, 2020. Available online: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2020%3A98%3AFIN (accessed on 10 March 2025).
[12]. ***, European Commission. The European Green Deal; COM , 2019, 640 Final; European Commission: Brussels, Belgium, 2019. Availableonline: https://eur-lex.europa.eu/legal-content/PL/TXT/?uri=CELEX%3A52019DC0640 (accessed on 18 March 2025)
[13]. ***, The Role of Agricultural Biomass as a Renewable Energy Source in European Union Countries. Energies 2022, 15, 6756. https://doi.org/10.3390/en15186756 (accessed on 20 March 2025)
[14]. ***, Report from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, State of the Energy Union Report 2023 https://energy.ec.europa.eu/news (accessed on 11 Feb 2025)
[15]. ***, https://datam.jrc.ec.europa.eu/datam/mashup/BIOMASS_FLOWS/ (accessed on 10 March 2025)
[16]. ***, https://data.europa.eu(accessed on 11 Feb 2025)
[17]. ***,https://ec.europa.eu/eurostat/databrowser/view/nrg_cb_bm/default/table?lang=en&category=nrg.nrg_quant.nrg_quanta.nrg_cb (accessed on 11 Feb 2025)
[18]. ***,https://energypost.eu/what-is-the-future-of-woody-biomass-in-the-eu-energymix/ (accessed on 11 Feb 2025)