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# RESEARCH ON BIOETHANOL PRODUCTION IN ROMANIA

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***Abstract***

*Biofuels have many advantages over traditional fuels as they are easier to be obtained, they are considered to be environmentally friendly, biodegradable and could be achieved through sustainable technologies. The aim of the paper is to identify the potential for bioethanol production in Romania, from the two main representative agricultural crops, namely: wheat and corn. For this purpose, the method of quantitative and qualitative analysis of data about the area, production, consumption, import and export was used. Unlike the United States or Brazil, the production of bioethanol in Romania and in the European Union remains an under-exploited branch despite the valuable potential of this renewable energy source. This can also be explained by the rather low demand for such a fuel.*

***Key words*****:** *bioethanol, production potential, import, export*

## INTRODUCTION

One of the most current problems facing human society at the present stage is the energy problem. Population growth, the fast development of industry and the demands of the social sphere, the accelerated depletion of fossil fuel resources, together with the process of global warming caused by the increase in greenhouse gas emissions have motivated the research towards finding other energy resources, a renewable type of energy resources [1, 2, 6].

Overexploitation of our planet's resources have irreparably affected the environment, which is now suffering more than ever from climate change. Increased gas emissions, the greenhouse effect and global warming have contributed to the search for renewable energy sources which are in harmony with the energy needs of the world.

Research to obtain new alternative and sustainable fuels has become increasingly important due to the accelerated depletion of fossil fuel resources but also the increasing level of $CO_2$ in the atmosphere that helps form the greenhouse effect and thus trigger global warming. More than 30% of the total energy needed by developing countries it is used on the transport sector [3, 4, 5].

Currently, the transport sector is totally dependent on fossil fuels and is responsible for 60% of global fuel consumption. As a result, 70% of the carbon monoxide released into the atmosphere worldwide is generated by this sector as well as 19% of global carbon dioxide emissions [4].

The dramatic increase in fuel prices from day to day, the reduction of fossil fuel reserves and their non-renewable nature, the growing impact of pollution on the environment especially greenhouse gas emissions have directed research in this area to new energy sources and the development of alternative methods of obtaining consumer goods, more efficient and more ecological [4].

Biofuels have many advantages over fossil fuels: they are much easier to obtain from common biomass resources, are considered environmentally friendly, are biodegradable and are obtained through sustainable technologies [7, 11].

Bioethanol is obtained by distillation and dehydration processes and is obtained by fermentation of energy sources. Typical materials used to obtain bioethanol include: wheat, corn, rye, rice or potatoes.

Among the steps in the process of obtaining bioethanol we mention, transformation into sludge, fermentation, distillation, rectification,

dehydration, CO2 recovery, treatment of distillation residues [13].

Table 1. Annual global ethanol production (million kilotons)

| Region | 2015 | 2016 | 2017 | 2018 | 2019 | % of world production |
|---|---|---|---|---|---|---|
| United States | 56.05 | 58.34 | 60.32 | 60.91 | 59.73 | 54% |
| Brazil | 27.25 | 25.55 | 25.17 | 30.25 | 32.52 | 30% |
| E.U. | 5.15 | 5.15 | 5.38 | 5.49 | 5.19 | 5% |
| China | 2.91 | 2.54 | 3.03 | 2.91 | 3.79 | 3% |
| Canada | 1.70 | 1.74 | 1.74 | 1.74 | 1.97 | 2% |
| India | 0.72 | 1.06 | 0.76 | 1.63 | 1.93 | 2% |
| Thailand | 1.17 | 1.29 | 1.48 | 1.48 | 1.63 | 1% |
| Argentine | 0.83 | 0.91 | 1.10 | 1.10 | 1.06 | 1% |
| The rest of the world | 1.49 | 1.84 | 1.72 | 2.00 | 1.98 | 2% |
| **Total** | **97.29** | **98.42** | **100.69** | **107.51** | **109.78** | **-** |

Source: https://ethanolrfa.org/statistics/annual-ethanol-production/, Accessed on 09.04.2021 [10].

The global trend in terms of obtaining bioethanol is increasing, so that if in 2015 a production of 97.29 million kiloliters was recorded, in 2019 it was 109.78 million kiloliters, representing an increase of 12.8% (Table 1).

The world leader in terms of obtaining bioethanol is the United States of America, which obtained in 2019, a production of 59.76 million kiloliters, with a share of 54% of total ethanol production (Table 1).

In the case of the European Union, the cumulative production of the 28 Member States was only 5%, being almost 12 times lower than the production recorded by the main ethanol producer worldwide (Table 1).

Of note, Brazil ranks second in terms of ethanol production, due to high domestic demand, used as an energy source for means of transport, with a share of 30% of world ethanol production (Table 1).

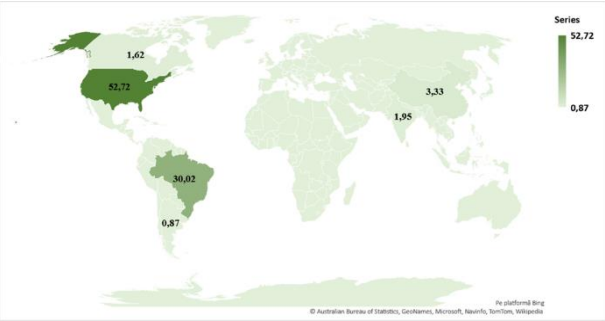


Fig. 1. World map of ethanol production, at the level of 2020

Source: data processing, https://ethanolrfa.org/statistics/annual-ethanol-production/, Accessed on 09.04.2021 [10].

At the level of 2020, the main producer of ethanol was the United States of America, producing 52.72 million kilotons, down 11.7% from the previous year, when a production of 59.72 million kilotons was obtained (Figure 1).

And in the case of the world's second largest producer of ethanol, there was a decrease in production in 2020, compared to 2019, of 7.7%, producing 30.02 million kilotons (Figure 1).

Regarding the production of ethanol in the European Union, there is a decrease of 8.8%, thus registering a production of 4.73 million kilotons. These declines in 2020 can be attributed to poor production, affected by weather conditions, as well as declining market demand for ethanol, caused by measures taken by Member States to combat the COVID-19 pandemic (Figure 1).

According to the work "Wheat as a promising substitute for maize for bioethanol production", by Neha Patni, Shibu Pillai and Ankur Dwivedi, there were made the following calculations on yield of bioethanol and also production costs from different crops [6].

The research conducted by the authors mentioned above proved that from 5 tons obtained per hectare, a quantity of 410 liters of bioethanol is obtained/ton, respectively 390 liters/ton, in the case of wheat (Table 2).

Table 2. Comparison between production costs and yield of bioethanol from different energy crops

| Culture type | Yield (t/ha/ year) | Conversion rate to sugar or starch (%) | Bioethanol conversion rate (l / t) |
|---|---|---|---|
| Sugarcane | 70 | 12.5 | 70 |
| Cassava | 40 | 25 | 150 |
| Sweet sorghum | 35 | 14 | 80 |
| Maize | 5 | 69 | 410 |
| Wheat | 4 | 66 | 390 |

Source: Patni et al., Wheat as a promising substitute for maize for bioethanol production [9].

At the level of Romania, the predominant crops are represented by those of corn and wheat.
In this sense, the purpose of the paper was to analyze the extent to which Romania could generate sufficient bioethanol production to cover consumption needs and whether this renewable energy source is a sustainable solution or not.

## MATERIALS AND METHODS

For identify the potential of bioethanol production for Romania, in this paper we used the method of quantitative analysis of data on the area cultivated with wheat and corn, production obtained for the two crops, consumption, import and export of wheat and corn, using data from the National Institute of Statistics, and the international basis Trademap.
Using the bioethanol conversion rate mentioned in Table 2, it was calculated the bioethanol production potential for the two crops taken into analysis.

## RESULTS AND DISCUSSIONS

Romania benefits from a significant agricultural area. In the study, the main agricultural crops that could be used to obtain bioethanol and which have the highest share of area were analyzed. At the level of 2019, Romania used an agricultural area of 8.74 million hectares, increasing by 11.9% compared to 2010, the trend being one of growth.
Of this total area, 63.74% was cultivated with grain cereals, accumulating an area of 5.57 million hectares, increasing by 10.5% compared to the area recorded in 2010 (5.04 million ha).
Romania cultivated, in 2019, an area of 2.17 million hectares of wheat, increasing by 0.3% compared to 2010 (2.16 million ha). These oscillations can be attributed to the demand registered in previous years, the variations being significant, from one year to another, registering a maximum in 2019 (2.17 million ha) and a minimum in 2011. The share of cultivated area with wheat, out of the total cultivated area in Romania, was 24.8% (1.95 million ha) (Figure 2).
In the case of maize cultivation, in 2019 an area of 2.69 million hectares was used, increasing by 27.6% compared to the area used in 2010, respectively 2.1 million hectares. The share of the area cultivated with corn, out of the total area cultivated in Romania, was 30.65% (Figure 2).

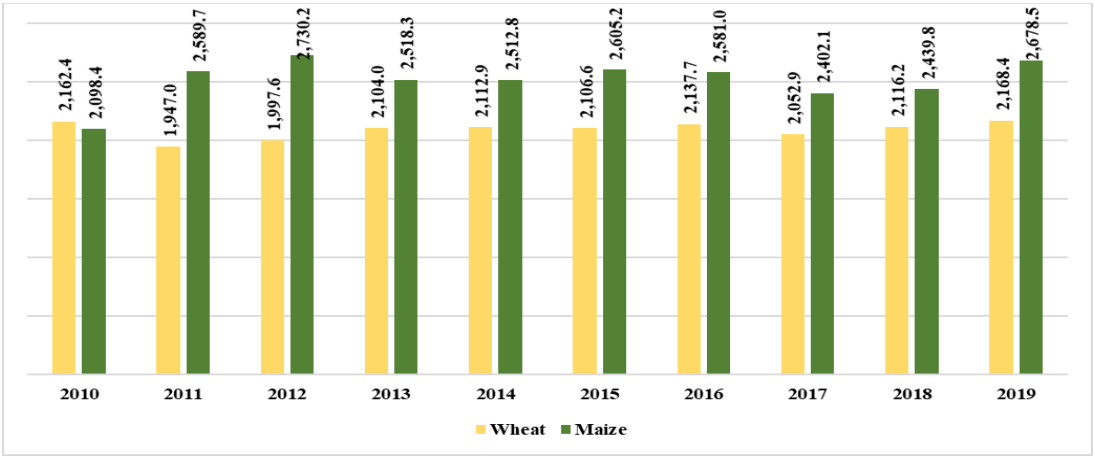


Fig. 2. Evolution of the cultivated area with wheat and corn, in the period 2010-2019 (thousand ha)
Source: NIS statistical data processing, Accessed on 09.04.2021 [8].

The total wheat production registered a substantial increase, during the analyzed period, of 77.2%, aspect determined by the increase of the surface, but also by the new technological machines used in agricultural farms, which led to the increase of the yield per hectare, so if in 2010, the registered production was 5.8 million tons, in 2019 it was 10.3 million tons (Figure 3).

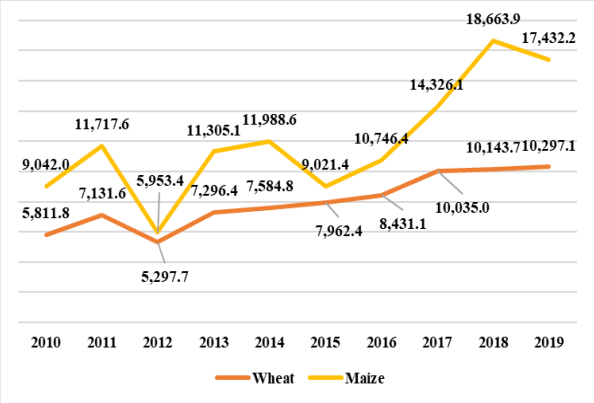


Fig. 3. Evolution of wheat and corn production, in the period 2010-2019 (thousand tons)
Source: NIS statistical data processing, Accessed on 09.04.2021 [8].

During the analyzed period, the total production of corn registered an important increase, of 92.8%, aspect generated by the increase of the cultivated areas with corn, but also by investments in technology and equipment. At the level of 2010 the registered corn production was 9.04 million tons, in 2019 the production reached the value of 17.4 million tons (Figure 3).

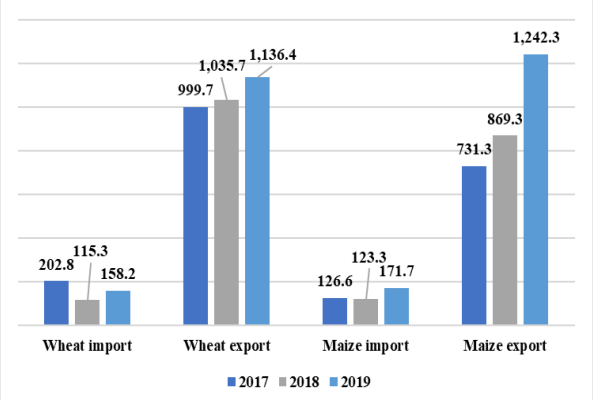


Fig. 4. Evolution of wheat and maize imports and exports, in terms of value (million EUR)
Source: Trademap statistical data processing, Accessed on 09.04.2021 [12].

In 2019, Romania imported wheat worth 158.2 million euros, but exported 1.14 billion euros. Also, in the case of corn, Romania imported 171.7 million euros, and exported 1.24 billion euros (Figure 4).

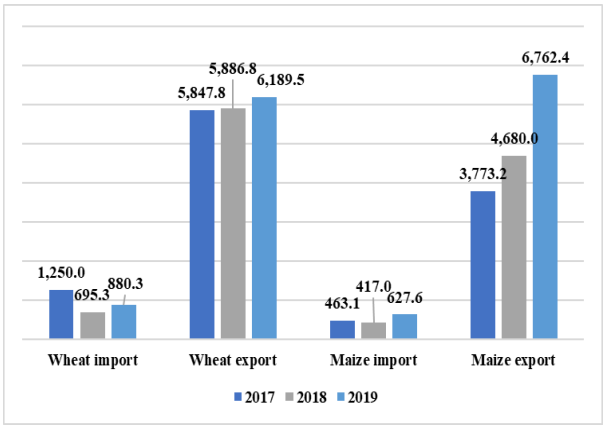


Fig. 5. Evolution of wheat and maize imports and exports, in quantitative terms (thousand tons)
Source: Trademap statistical data processing, Accessed on 09.04.2021 [12].

From a quantitative point of view, in 2019, Romania imported a quantity of 880.3 thousand tons, and exported a quantity of 6.19 million tons, while in the case of corn Romania imported 627.6 thousand tons, and exported a quantity of 6.8 million tons (Figure 5.).

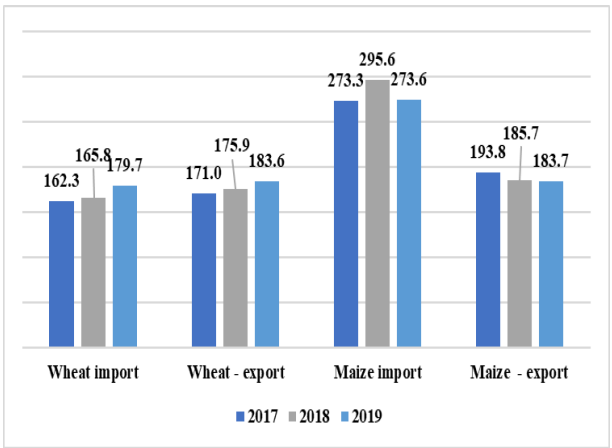


Fig. 6. Evolution of the import/export price for wheat and corn, in the period 2017-2019 (euro/ton)
Source: Trademap statistical data processing, Accessed on 09.04.2021 [12].

At the level of 2019, we noted the fact that wheat purchase was 179.7 euro/ton, lower than the sale price of 183.6 euro/ton. This can be explained by Romania's geographical position with an exit to the Black Sea, which

favors trade with the Middle East countries. In the case of maize, the purchase price is 273.6 euro/ton, being by 50% higher than the export price, because the imported maize has a higher quality (Figure 6).

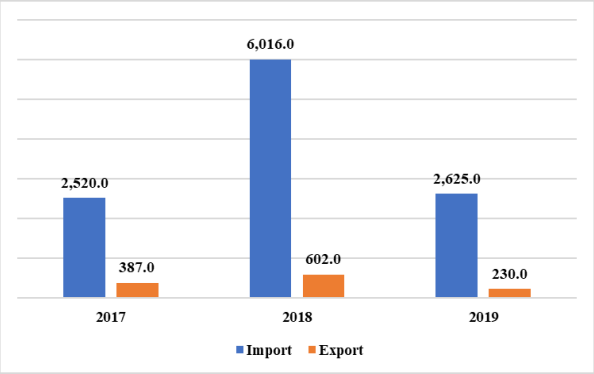


Fig. 7. Import and export (value) of ethanol worldwide in the period 2017-2019 (thousand euros)
Source: Trademap statistical data processing, Accessed on 09.04.2021 [12].

Regarding the import of ethanol worldwide, it shows oscillating values, so that in 2019 it was 2.62 million euros, while the export value was 230 thousand euros. These differences between the value of the import and the value of the export can be attributed to the purchase of ethanol, which is resold (Figure 7).

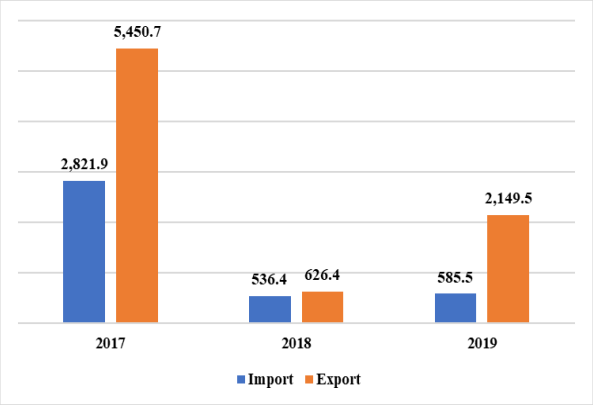


Fig. 8. Evolution of import/export price for ethanol worldwide during 2017-2019 (euro/tons)
Source: Trademap statistical data processing, Accessed on 09.04.2021 [12].

Analyzing the average import price of ethanol, in 2019 it was 585.5 euro/ton, being approximately 5 times lower than the import price recorded in 2017.
Also, the export price of ethanol in 2019 was of 2149.5 euro/ton, being 2 times lower than the price registered in 2017, when it was 5,450.7 euro/ton (Figure 8.).

Table 3. Bioethanol production potential in Romania

| Specification | 2017 | 2018 | 2019 |
|---|---|---|---|
| Wheat surplus (million tons) | 4.60 | 5.19 | 5.31 |
| Maize surplus (mil. Tons) | 3.31 | 4.26 | 6.13 |
| Wheat bioethanol production potential (mil. Kilotons) | 1.8 | 2.0 | 2.1 |
| Bioethanol production potential of maize (mil. Kilotons) | 1.4 | 1.7 | 2.5 |
| Total bioethanol production (wheat + maize) | 3.2 | 3.8 | 4.6 |

Source: own calculation.

At the level of 2019, the surplus of wheat registered by Romania was 5.31 million tons, which means that the production potential of bioethanol would be 2.1 million kilotons.
In the case of maize surplus, in 2019 it was 6.13 million tons, so that the production potential of bioethanol would be 2.5 million kilotons (Table 3).

## CONCLUSIONS

At present, at the level of the European Union, the demand for bioethanol is quite low, an aspect highlighted by the transactions that take place between the Member States of the European Union.
Also, countries that need bioethanol are provided in most of their own production.
At least for the time being, both the countries of the European Union, among them Romania, do not consider an opportunity in this field, leaving the United States and Brazil to dominate this market.
The total production of bioethanol, from the two analyzed productions, at the level of 2019, would be 4.6 million kilotons, which would rank Romania, close to the total production registered at the level of the European Union, which in 2019 was 5.4 million kilotons of bioethanol.

## ACKNOWLEDGEMENTS

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