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AGRICULTURAL BIOMASS POTENTIAL IN BULGARIA

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Abstract

Fuel dependency and uncertainty about their prices, coupled with increasing concerns about climate change and other environmental issues, are among the major global challenges on the agenda. They are key drivers for the development of biomass production, considered as the core of the bioeconomy and a main alternative for energy production. The aim of the study is to analyse the contribution of Bulgarian agriculture to the bioeconomy development and the potential of the sector for biomass production. The research is based on the definition and classification of the bioeconomy proposed by the European Commission. The results show a tendency of diminishing importance of Bulgarian agriculture in the national economy after accession to the EU. On the other hand, the sector remains a major source of employment in rural areas. In terms of the potential of Bulgarian agriculture for biomass production, crops of wheat, sunflower and maize play an important role. Based on the data, the other crops analysed cannot be considered as a key source of biomass. Among the major challenges facing Bulgaria are the attitudes in society about the benefits of using biomass, including economic, social and environmental. Therefore, the entrepreneurial activity should be stimulated in order to guarantee sustainable production and efficient use of biomass in the conditions of imbalance between North and South Bulgaria.

Key words**:** *bioeconomy, agricultural biomass, sustainability*

INTRODUCTION

The agricultural sector faces a number of challenges -a growing global population, demand for food and biomass, as well as environmental issues such as climate change and resource scarcity. As an emerging concept, the bioeconomy si an opportunity to takle multidimensional problems and to ensure sustainability [12].

A number of countries are developing bioeconomy strategies orientated to the economic and environmental benefits, while ensuring food security and supply of biomass [12, 32, 5].

There are high expectations that bioeconomy can enhance sustainable development [21, 22, 5].

Although some aspects and elements of the bioeconomy have been long established, the concept has attracted attention in recent decades based on the new technological innovations, changes in consumers' perception and the necessity of oil and fossil fuels dependency reduction.

The European Union's Europe 2020 Strategy considers a bioeconomy as a key element for green growth, maintaining competitiveness and creating jobs, which presents opportunities for the agriculture [8, 28, 33].

Changes in the biomass demand and supply, as well as the entire value chain, place the agricultural sector in the centre of bioeconomy. The aim of the study is to analyse the contribution of Bulgarian agriculture to the bioeconomy development and the potential of the sector for biomass production.

The paper is structured as follows: First, the materials and methods are presented. Second, an analysis of the potential of agriculture in terms of gross value added and employment levels has been carried out. Third, the agricultural production potential of key crops for the bioeconomy is revealed. The potential of biomass is calculated and analysed. On this basis, conclusions and recommendations are formulated.

MATERIALS AND METHODS

There are many definitions of bioeconomy. It should be noted that the term is evolving and

nowadays is shifting toward sustainability. The "greening" of bioeconomy is linked to the concepts of green and circular economics [2, 27]. As there is no uniform definition of the term, national strategies emphasise different sectors [22]. Therefore, it is important how countries determine bioeconomy in their strategies, in order to understand policy implications and the role of the agricultural sector.

Different surveys and reports [20, 19, 4, 16] analysed bioeconomy sectors and their contribution. However, these studies are not fully comparable due the variation of sectors among them.

According to the European Bioeconomy Strategy 2018 "…bioeconomy includes and interlinks: land and marine ecosystems and the services they provide; all primary production sectors that use and produce biological resources (agriculture, forestry, fisheries and aquaculture); and all economic and industrial sectors that use biological resources and processes to produce food, feed, bio-based products, energy and services (biomedicines and health biotechnology are excluded)"[18].

Based on the EU definition, a study conducted by the European Commission divides the bioeconomy sectors as core bioeconomy, partial and indirect sectors [17].

This paper is based on the definition and classification of the European Commission.

The monitoring and survey of bioeconomy potential and contribution for fostering sustainable development is an object of a global discussion [13].

There are different approaches for measuring the bioeconomy potential and contribution to a country's economy. Based on [13] classification, they could be defined as: the value added/GDP approach; Input-Output (I-O) and Social Accounting Matrix (SAM) analysis; Computable General Equilibrium (CGE) Model; Partial Equilibrium (PE).

Some countries measure the potential and contribution of bioeconomy by disaggregated indicators. Based on [26] methodology, the main indicators are: 1) Turnover of the bioeconomy; 2) GDP/Value added of the total bioeconomy and its sectors, and the contribution of the bioeconomy to total country/region GDP; 3) Employment in the bioeconomy and its sectors and the contribution of the bioeconomy to total employment; 4) Resource use of the bioeconomy; 5) Primary production of biomass in the country.

The document focuses on gross value added and employment indicators to determine the agricultural potential for biomass production.

The methodology is based on approaches applied by [24, 25] and adapted to agricultural sector.

The first part of the study focuses on the analysis of the regional potential of Bulgarian agriculture in terms of gross value added and employment levels. The survey is based on [23] of the European Parliament and of the Council of 26 May 2003 on the establishment of a common classification of territorial units for statistics (NUTS). The study covers NUTS 2 regions in Bulgaria.

The second part compares the potential of Bulgarian agriculture for the production of crops important for the bioeconomy with several other countries at EU-28 level. The biomass production potential in these countries is calculated on the basis of crop residues.

According to [15] the concepts for biomass potential evaluation do not follow the necessary consistency. A number of authors provide information on the calculation of biomass potential [3, 30, 31].

[31, 30] distinguish three levels of biomass potential: theoretical, technical and bioeconomic.

The theoretical potential of residues is calculated by the residue-to-crop ratio (R: C ratio) based on the literature study of [29]. According to the authors, the R: C ratio is inflenced by a number of factors and this causes difficulties in the assessment. It is also mentioned that the harvesting index (HI), defined as a share of primary product in relation to total biomass above ground, is linked to the residue-to-crop ratio as follows:

$$\text{R: C ratio} = \frac{residue\ (\frac{t}{ha})}{yield\ (\frac{t}{ha})} = \frac{1}{HI} - 1 \quad (1)$$

This study is based on data provided by National Statistical Institute, Eurostat, FAO

and Ministry of Agriculture, Food and Forestry.

RESULTS AND DISCUSSIONS

The share of agriculture in Gross Value Added (GVA) shows the potential for bioeconomy development and biomass production. Agriculture is considered as core sector of bioeconomy [8]. Therefore, the data of this part of the study is based on National agricultural economic accounts. The regional variation in the indicator can define the potential and contribution of each planning region to the bioeconomy (Fig. 1).

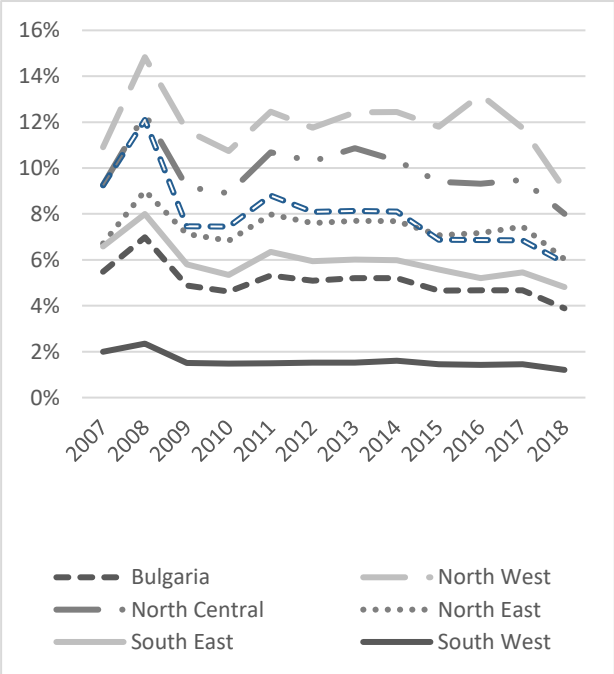

Fig. 1. Share of agriculture in the GVA (%) – regional level NUTS 2, 2007-2018
Source: Own calculation based on National Statistical Institute [17].

A number of significant structural changes have taken place during the Bulgarian transition period [1]. At the beginning of the transition period the relative share of agriculture in the GVA is increased. Deindustrialization and high unemployment in the industrial sectors can be cited as the main reason. The transition in the agricultural sector, however led to various challenges. The land reform, privatization and other policy instruments applied by the government haven't helped the sector to overcome the main issues. The problems during the transition period predetermine the difficult recovery of the agriculture. All this affects the share of agriculture in the in GVA. The data show downward trends in the agricultural potential and contribution to the bioeconomy. In the last few years of the research period, the sector's share of the national economy has been below 5%. The observed negative trends are related to substantial structural and sectoral challenges in Bulgarian agriculture. These issues can hinder the potential for biomass production in the country.

Regional dimensions of the indicator lead to several conclusions. After the accession to the EU, there has been a significant change in the role and importance of agriculture, with a serious decline in the relative share of the agricultural sector in total generated GVA in all planning regions. Nonetheless, there is no major variation for the analyzed period.

The agricultural sector has the highest relative share in the economy of North-West region. However, it is characterized by depopulation and lower economic development. In this area the agriculture is considered as a main source of income and employment.

By contrast, South-West region has the lowest potential and contribution. The agricultural sector does not play an important role in these territories. The negligible share is impressive and is associated to the higher level of urbanization.

Based on the data, the country can be divided into two: Northern and Southern Bulgaria. The leading role of Northern Bulgaria is related to the specialization in cereals and industrial crops production [1]. The larger arable land and the natural characteristics of the northern parts of the country determine their greater potential for biomass production. Based on NSI data it can be concluded that the southern parts of Bulgaria are specialized in vegetable and fruit production. Their potential for biomass is lower and hindered by the negative trends in these subsectors.

Another important indicator related to agriculture's potential for bioeconomic development is the share of agriculture in total employment (Fig. 2).

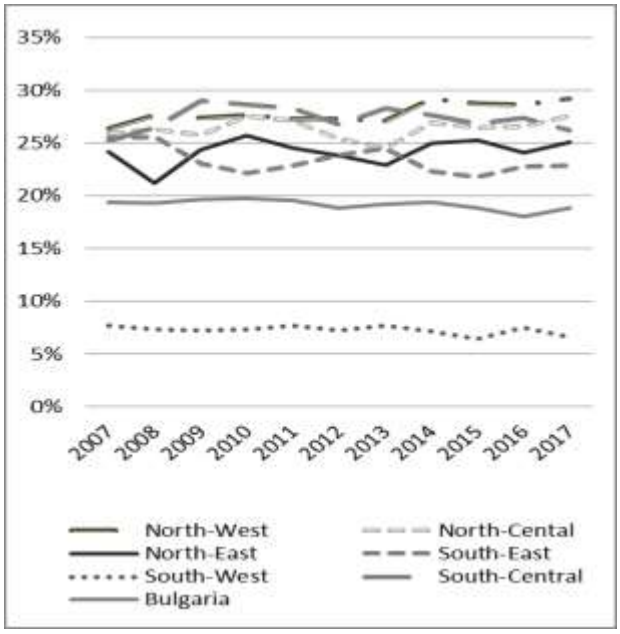

Fig. 2. Share of agricultural employment in total employment (%), regional level NUTS 2, 2007-2017
Source: National Statistical Institute [18].

Based on [10], agriculture provides 4.2 % of total employment in the EU (to 9.7 million). The highest values were recorded in Romania (23%), as well as in Bulgaria (18%), Greece (10.7%) and Poland (10.1%). On the other hand, in Luxemburg (0.8%), Belgium (1.2%) and Malta (1.2%) were registered the lowest shares of agriculture in employment [10].

It should be emphasized that many people can help in the farming activities without being employed. This EU's regular agricultural labor force is much higher, at 20.5 million people in 2016 [11]. However, farming is just an additional source of income for many people in the EU.

Based on the data, it can be concluded that agriculture plays an important role in generating income and employment in the rural areas of Bulgaria.

On regional level, there are not many changes and variation. The highest share of agricultural employment in registered in North-West, North-Central and South-Central planning regions. South West region is lagging behind. The trends are in parallel with the potential and contribution of the areas in generated GVA.

The role and importance of the northern regions determine their higher potential for biomass production and bioeconomic development.

Despite these regional differences, natural characteristics, traditions and knowledge are a prerequisite for the widespread cultivation of crops, which are a major source of biomass, including wheat, rye, barley, oats, triticale, rapeseed and sunflower seed, as well as grain maize.

The assessment of biomass production potential of the main crops is based on data for a 5-year period (2014-2018). The analysis includes comparisons with the neighbouring countries Greece and Serbia, which have similar agriculture structure based on UAA, Romania and Poland, as former central planned economies, and Germany and France, as leaders in agricultural production in Europe.

Wheat is one of the main agricultural crops, both for the agriculture of Bulgaria and for the production of biomass. Its areas cover nearly 1/4 of the UAA in the country, which is almost two times more compared to those in Greece and Serbia. Wheat and spelt areas in Bulgaria occupy 4.5% of the cultivated area with these crops in the EU-28. However, compared to the relative share of Romania (8%), Poland (9%), Germany (12%) and France (20.5%), the country is rather in the group of small producers. In terms of production, Bulgaria accounts for 4.2% of wheat and spelt production in the EU-28. It should be noted that the share of spelt is negligible.

Regarding average yield, it can be stated that Bulgaria is characterized by relatively good levels of this indicator. The average yield during the period under consideration is about 4.87 t/ha. This value is higher than the average values of Serbia, Romania and Poland, and compared to Greece the excess is about 75% in favour of Bulgaria. It should be noted that in terms of leaders France and Germany, the country is lagging behind. The average production of Bulgaria during the period is about 75% of the average French production and 63% of the achieved results in Germany. Bulgaria reports lower average yields compared to the European Union aggregated data - about 93% of the EU-28 average.

The role of other cereals in Bulgarian agriculture is much more limited. The latter also concerns the potential for biomass production.

Compared to wheat, barley is a relatively under-represented crop in Bulgarian agriculture, although the natural and climatic conditions are favourable for its cultivation.

During the 2014-2018 period, barley accounts for about 3.13% of UAA in Bulgaria and only 1.28% of the area with this crop at EU-28 level. The country provides 1.13% of the annual production of barley in the EU-28.

In terms of average yield, the trends in Bulgaria are similar to the findings about the wheat, namely: for the 2014-2018 period only two of the countries included in the analysis - France and Germany - reported a higher average yield, 6.3 t/ha and 6.78 t/ ha respectively, versus 4.37 t/ha for Bulgaria. In Greece, Poland, Romania and Serbia, the registered average yield is ranging from 2.68 t/ ha for Greece to 3.83 t/ ha for Romania. However, the values of the indicator for Bulgaria are below the EU-28 average. Bulgarian yield per hectare is about 90% of that of EU-28.

Triticale is not a widespread crop in Bulgarian agriculture. The areas with triticale are 0.33% of the UAA in the country. During the period, the country reported fewer areas from all analysed countries - an average of 16,310 ha per year. The indicator in the other countries is ranging from 18,450 ha in Greece to 1,367,140 ha in Poland.

The triticale yield for Bulgaria varies from 2.66 t/ha in 2018 to 3.19 t/ha in 2014. The average yield per hectare for the 2014-2018 period is 3.02 t/ha, and the highest values are recorded in Germany (6.20 t/ha).

In the 2014-2018 period, oats account for 0.27% of UAA in the country and 0.37% of areas with oats in the EU-28. Bulgaria provides 0.26% of the EU-28 average annual production of oats.

The lower relative share of production compared to the relative share of the area is due the negative trends in the average yield per ha. The indicator ranges from 1.88 t/ ha in 2014 to 2.54 t/ha in 2017, with the average for the period - 2.15 t/ha. Of the countries concerned, only Greece has lower average yield (1.08 t/ha). In all other countries the values of the indicator are higher, and in France and Germany they reach 4.21 t/ ha and 4.53 t/ha, respectively. The average yield at EU-28 level is also higher and varies around 2.94 t / ha.

For the analysed period the rye occupied only 0.18% of the UAA in Bulgaria and about 0.42% of the area with rye in the EU-28. The country provides 0.22% of rye production in the EU-28. The latter, given the size of the cultivated area, is a prerequisite for a relatively low level of average yield.

Indeed, the data show an average yield of 1.97 t/ha for Bulgaria. Only Greece is characterized by lower values of the indicator (1.77 t/ha). The other five countries included in the analysis report higher averages, with Germany and France reaching 5.33 t/ha and 4.47 t/ha, respectively. Regarding the aggregate data, it can be noted that the average rye yield in Bulgaria is 52.81% of the yield per 1 ha in EU-28.

Rapeseed is a relatively new crop in the agricultural production structure of Bulgaria. Areas occupied by this crop have varied significantly over the years, but a slight upward trend has been observed.

During the period under consideration, rapeseed annually covers 3.5% of the UAA in Bulgaria. The relative share of rapeseed areas at EU-28 level is 2.61% lower, while the average annual production is 481,860 tons.

In terms of average yield, Bulgaria is characterized with lower yield, as only in Romania from all analysed countries is registered lower results. The data show that the value of the indicator for Bulgaria is 2.76 t/ha compared to 2.66 t/ha for Romania. Greece has the highest yield, ranging from 3.33 t/ha in 2017 to 4.85 t/ha in 2018.

As opposite to rapeseed, sunflower is an agricultural crop in the production of which Bulgaria has competitive advantages. Based on average data, sunflower area is 16.6% of UAA, however, Bulgaria provides over 20% of the sunflower fields in the EU-28. The average annual production of sunflower seeds during the study period is 1,913,520 tons. Only Romania of all the countries included in the analysis has a higher volume of production - 2,396,570 tons, cultivating almost 24.5% of the area with sunflower in the EU-28 (Fig. 3).

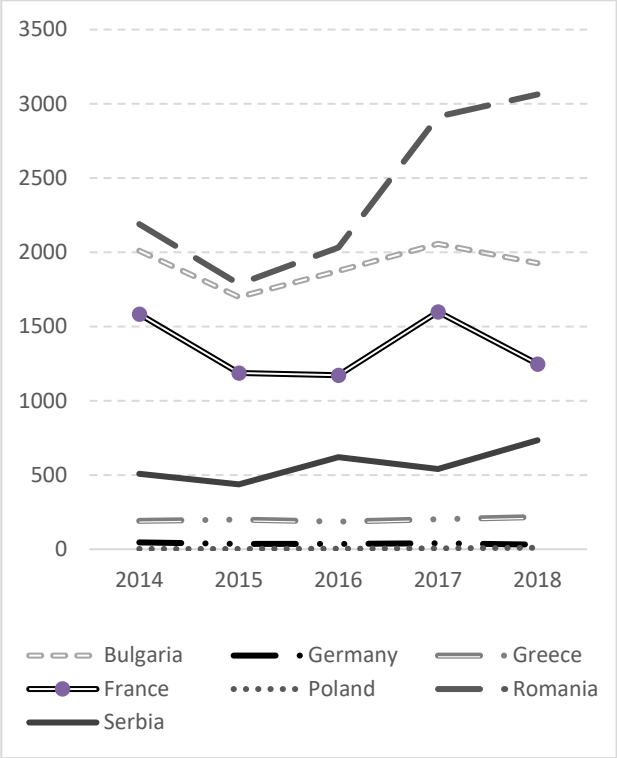

Fig. 3. Sunflower seed - harvested production in EU standard humidity (1,000 t)
Source: FAO stat [14].

In terms of average yields, Bulgaria reports competitive levels of 2.3 t/ha, which corresponds to an average annual yield in France, while Serbia and Romania have better results of 2.83 t/ha and 2.37 t/ha respectively.

Grain maize is the third most widely distributed crop in Bulgaria and accounts for nearly 9% of UAA in the country. Compared to Member States' average values, Bulgaria cultivates 4.9% of the EU-28 grain maize areas and produces over 4.3% of the total EU-28. It is also important to note that of the countries included in the analysis, only Greece has a smaller absolute production volume and a smaller size of the cultivated area with this crop than Bulgaria.

In terms of average yield, Bulgaria has higher results than Poland, Romania and Serbia. The average annual yield for the period is 6.64 t/ ha. In this respect Bulgaria is significantly lagging behind France (9.02 t/ha), Germany (9.54 t/ ha) and the leader of Greece (10.77 t/ha).

The crops that are sources of biomass have not only a different relative share in the agricultural structure, but also have different productivity in terms of the biomass produced. According to Thorenz et al. (2018), the coefficients for determining the theoretical level of residual biomass (R:C ratio) for the crops under consideration are: wheat - 1.00, rye - 1.10, barley - 0.93, oats - 1.13, triticale - 0.95, rape - 1.70 and sunflower seed - 2.70 and grain maize - 1.13.

The coefficients applied cannot change the ranking of a country vis-à-vis other countries with respect to the biomass of a particular crop, as well as in relation to the aggregated EU-28 data. As a result, Bulgaria has competitive positions in the production of wheat, barley, sunflower and corn biomass, taking into account the limited areas of barley. A lower potential for biomass production based on average yields per hectare is reported for rye, oats, triticale and rapeseed.

However, this finding should not be interpreted as a recommendation to limit or ignore the production of rye, oats, triticale and rapeseed.

Therefore there are two directions of analysis. On the one hand, the cultivation of these crops is linked to the autonomy, food security and food safety of Bulgaria, with rapeseed being used primarily as biomass and less for food production. On the other hand, the application of the different crop coefficients changes the ratio between them regarding the production per unit area.

Comparison of the data in absolute terms shows that the largest aggregate production is generated by the wheat crop, with an average annual amount of 5,762,900 tons during the study period. The second is grain maize with a production of 2,852,240 tons, and the production of sunflower is in third place with a result of 1,913,520 tons. The fourth place of production is taken by barley, whose production is 676,460 tons, rapeseed is in the fifth place with an amount of 481,860 tons.

After applying the coefficients for calculating the theoretical level of biomass, while maintaining the same size of the crop areas, there is a significant shift in the ranking of the crops producing the highest total production - biomass. Wheat, with a theoretical level of biomass production of 5,762,900 tons, remains first. Sunflower with biomass production of 5,166,500 tons, however, ranks second. The third is grain maize, which would generate biomass of 3,223,030 tons, and rapeseed is in

the fourth place with a potential biomass volume of 819,150 tons.

The potential for biomass production of individual crops can be most clearly estimated by comparing the average theoretical yield measured in tons per 1 ha (Fig. 4).

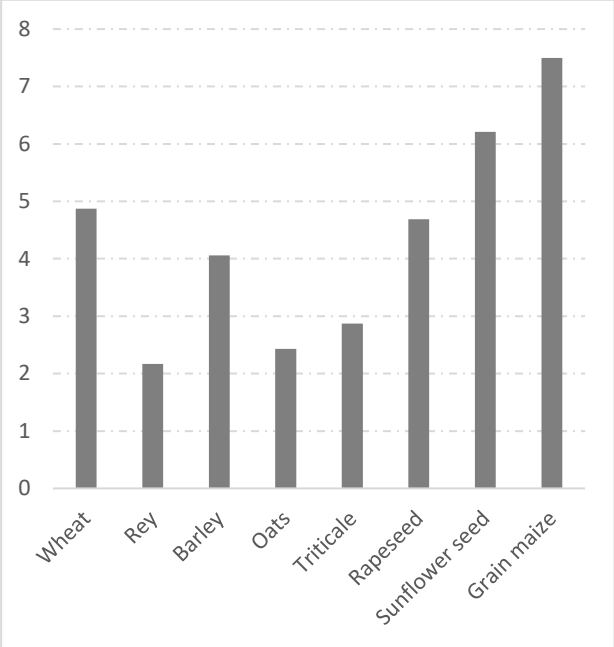

Fig. 4. Average biomass yield, t/ha
Source: Own calculation based on data from [9, 12, 29].

The highest average yield is reported for grain maize - 7.5 t/ha. In terms of average yield, the second in the ranking is sunflower with values of 6.21 t/ha. Wheat is ranked third with an average yield of 4.87 t/ha, followed by rapeseed and barley - with 4.69 t/ha and 4.06 t/ha respectively.

The presented data show, primarily, that the most widely used crops in the production structure of Bulgarian agriculture have the highest theoretical values for biomass production. The latter reveals the significant potential for biomass production in the country.

Second, some policy recommendations can be formulated on the basis of analysed data, including which crops should be targeted by government policy measures and policies to stimulate biomass production, as well as to support entrepreneurs seeking to invest in the production and processing of biomass.

CONCLUSIONS

Based on the analysis some conclusions and recommendation could be highlighted:

The data show that agricultural crops, which are the main source of biomass, occupy over 57% of Bulgaria's UAA. This, combined with the competitive levels of biomass production per ha, gives reason to claim that Bulgaria, by its scale, has good potential for biomass production.

Generalizing the conclusions of the analyses, it can be noted that wheat, sunflower and maize crops have significant potential for biomass production in Bulgaria. Other crops also have their place, both in the production structure of agriculture and as sources of biomass, but due to their limited area and constraints in climatic and economic conditions, there are no prerequisites for becoming a key source of biomass.

One of the main challenges facing Bulgaria is to change attitudes in society about the benefits of using biomass, including economic, social and environmental. The latter will stimulate entrepreneurial activity and guarantee sustainable production and efficient use of biomass in the conditions of imbalance between North and South Bulgaria.

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