

NELLY BENCHEVA  
Agricultural University  
Plovdiv  
MILENA TEPAVICHAROVA  
Higher School of Security and Economy  
Plovdiv

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## OPPORTUNITIES AND ATTITUDES OF FARMERS TO THE PRODUCTION OF BIOGAS AND BIO-BASED FERTILISERS IN BULGARIA

### Abstract

*The investments in biogas and bio-based fertilisers are an important tool for improving competitiveness and potential to increase production and economic performance of companies. The process of restructuring of the agricultural sector in Bulgaria, which is characterised by a large number of limited-capacity small farms, can be stimulated to diversify business by promoting development of biogas and bio-based fertilisers. This helps to increase the viability of the economy of rural Bulgaria which is currently heavily dependent on agriculture.*

*The purpose of this article is to present and analyse the capabilities and attitudes of farmers to produce biogas and bio-based fertilisers as a pre-condition for improving competitiveness, achieving higher production and economic performance of farms in the agricultural sector and enhancing viability of rural areas in Bulgaria.*

**Keywords:** biogas, bio-based fertilisers, rural areas, organic waste, Bulgaria.

**JEL codes:** O13; Q42; Q53; Q01.

### Introduction

The process of restructuring of the agricultural sector in Bulgaria, which is characterised by a large number of limited-capacity small farms, can be stimulated to diversify business by promoting the development of biogas and bio-based fertilisers. At present, a relatively small share of the farmers develop

profitable activities outside agriculture. This is mainly due to the lack of initial capital, managerial knowledge and skills to develop non-agricultural business.

The investment in biogas and bio-based fertilisers is an important tool for improving competitiveness and potential to increase production and economic performance of companies. This helps to increase the viability of the economy of rural Bulgaria, which is currently heavily dependent on agriculture. The prevailing microenterprises have limited financial resources for growth and modernisation. The small business has a low rate of investment, which in turn limits its contribution to employment opportunities.

Helping farmers to develop biogas and bio-based fertilisers will facilitate the entry and expansion of activities with potential for market growth. This implies additional income for the farmers and the shifting of labour to new employment.

**The purpose of this article is to present and analyse the capabilities and attitudes of the farmers to produce biogas and bio-based fertilisers as a precondition for improving competitiveness, achieving higher production and economic performance of farms in the agricultural sector and enhancing viability of the rural areas in Bulgaria.**

### **Materials and methods**

The study of the possibilities and attitudes of biogas and bio-based fertilisers as a precondition for improving competitiveness, achieving higher production and economic performance of farms in the agricultural sector and enhancing viability of rural areas in Bulgaria, takes place in two parts. The first part analyses the situation and considers the development of biogas and bio-based fertilisers in Bulgaria. The study is based on data from the National Statistical Institute (NSI), bulletins of the Agrarian Statistics Directorate at the Ministry of Health for 2011-2014, as well as theoretical works of different authors on the subject. For processing and analysing the data, we used the methods of descriptive statistics.

The second part analyses the opinions of farmers about their attitude to production and application of bio-based fertilisers as an alternative to replace synthetic fertilisers. The study was carried out in the framework of the international research project INEMAD. The main objective of the project is to explore the opportunities provided by livestock and crop production through the exchange of energy and nutrients to develop innovative strategies for their development. For the purpose of this study we used a previously developed questionnaire. The total number of respondents covered by the interview method is 150. Based on their responses, we presented a general estimation of the attitudes and willingness of the respondents to implement bio-based fertilisers as an alternative to replace synthetic fertilisers on the farms. The study was carried out during the period from January to March 2015.

## Results and discussion

### *Research on the opportunities for the development of biogas and bio-based fertilisers production in rural Bulgaria*

One of the biggest advantages of biogas and bio-based fertilisers production is the possibility to convert waste biomass into a valuable resource by using it as a substrate. Many European countries, including Bulgaria, have a problem with overproduction of organic waste from agriculture, industry and households. Bioenergy production is an excellent way to utilize organic waste to produce biogas and fertiliser as a byproduct. The technology for biogas production contributes to reducing the volume of waste and cost for waste disposal.

Many and varied types of materials can be used for biogas and bio-based fertilisers production: solid and liquid manure, crop residues, energy crops, organic waste from the food industry and agriculture, sewage sludge and municipal organic waste.

According to the European Biomass Association (AEBIOM), energy production in Europe, based on the use of biomass, can be increased from 72 million tonnes in 2004 to 220 million tonnes in 2020. The biggest growth potential lies in biomass originating from farms in the agricultural sector. According to AEBIOM, 20 to 40 million hectares of land can be used for energy production within the EU, without affecting production output to feed the population. In this aspect, the production of bioenergy plays an important role and has a very high potential for development. Different types of biomass residues, wastes and byproducts from agriculture and households are suitable for conversion into biogas through anaerobic digestion.

Bulgaria has a good infrastructure for waste management. However, the system of separate waste collection and recycling is not yet functioning well enough, which is why the majority of biodegradable waste goes to waste disposal sites. About 85% of generated waste is transported to landfills, and 52% of the total waste is biodegradable.

Opportunities for biogas and bio-based fertilisers production in Bulgaria are large (Table 1). The holdings in the agricultural sector are sufficient and suitable for construction on their premises plants for production of bioenergy. This is a prerequisite for the development not only of a biogas market but also of a secondary market for organic products (compost and liquid organic fertiliser). Non-centralised biogas plants are more suitable because they can be tailored to specific sites and raw material, and transportation costs can be minimized.

Table 1

*Potential to produce biogas and bio-based fertilisers in Bulgaria*

	Biogas plants for processing of waste from large farms	Biogas plants for processing of waste from small farms or municipalities	Municipal biogas installations for the treatment of domestic industrial waste	Plants for extraction of landfill gas	Biogas plants in industrial businesses	Biogas installations for processing of sludge WWTP
Bulgaria	Limited resources	yes	yes	yes	yes	yes

Source: adapted from *Biogas Handbook* (2009).

Despite the substantial opportunities for biogas and bio-based fertilisers production in Bulgaria, it is difficult to determine the exact amount of raw materials available. In assessing the potential of biomass, first the amount of material generated by agricultural activities is assessed.

The methodology used to estimate the potential for biogas and bio-based fertilisers is selected by Eurostat – Europharm. It includes standard sizes of farms, their productivity and the distribution of farms across the country. In Bulgaria, between 2011 and 2014, the cropland grew by nearly 10%, as in the last year it occupied 3 462 126 ha or 69.3% of the utilized agricultural area (UAA) (Table 2). Increase is mainly due to the increase in the area planted with wheat and sunflower. About 65% of arable land is concentrated in three regions: North, North Central and South Central.

The majority of the total utilized agricultural area (about 80%) is processed by farms, managing more than 100 hectares (but they are only 3.8% of farms) (Table 3). Less than 3.6% of the UAA is processed in 78.6% of the farms which occupy an area less than one hectare each. There is a trend of consolidation of farms. In 2011, Bulgaria had 77 133 farms, and in 2014 – 76 340. This is due to land consolidation into larger farms and reducing those of semi-market type.

Of particular importance for biogas and bio-based fertilisers production are waste products from livestock keeping. At the end of 2014, the number of livestock farms in the country increased by 11% compared to 3 years earlier. The most significant increase is on pig farms – a total of 91.6%. Less pronounced is the increase of farms with cattle, buffalo and goats – by between 2.2% and 6.6%. Only sheep-keeping farms decreased by 2.3%. Measured by the number of farms, pig, poultry and dairy farms have great potential for bioenergy production.

Table 2

*Arable land between 2011 and 2014 (ha)*

Crops	2011	2012	2013	2014
Wheat	1 095 703	1 152 999	1 194 141	1 328 062
Barley	250 640	174 010	176 556	182 457
Rye and triticale	16 116	17 841	24 303	31 506
Oats	24 627	17 163	16 814	20 835
Corn	360 046	430 914	525 412	518 475
Other cereals	9 259	12 006	16 046	22 938
Sunflower	734 314	795 319	854 738	928 781
Tobacco	31 652	21 710	24 857	19 265
Other oilseeds	209 347	233 934	144 457	123 549
Other industrial crops	74 738	54 458	40 989	29 795
Potatoes	13 824	16 852	17 465	10 634
Peas, beans, broad beans, lentils, chickpeas and other pulses	5 839	8 076	9 395	8 263
Green vegetables	29 420	27 227	24 778	26 846
Nurseries	3 014	-	-	-
Annual forage crops	7 462	3 804	11 035	4 685
Meadows planted with legumes and grasses	88 909	84 804	83 489	83 237
Fallow	207 616	174 110	128 097	121 289
Greenhouses	-	2 010	2 113	1 509
<b>ARABLE LAND:</b>	<b>3 162 526</b>	<b>3 227 237</b>	<b>3 294 685</b>	<b>3 462 126</b>

Source: MAF, Department of Agrostatistics.

Table 3

*Distribution of farms by size of the utilized agricultural area (UAA)*

Size of farms (ha)	Number of farms (%)	UAA (%)
0-1.99	78.6	3.6
2-4.99	7.9	2.3
5-9.99	3.6	2.7
10-49.99	4.4	6.5
50-99.99	1.7	5.3
more than 100	3.8	79.6
<b>Total</b>	<b>100</b>	<b>100</b>

Source: MAF, Department of Agrostatistics.

The number of most livestock species also increased compared to the previous year (Table 4). The highest growth is observed in the number of pigs in total – 10.4%, total cattle – by 9.4% and total buffaloes – 8.2%. Slight increase was registered in the total number of sheep – by 0.6%, with a significant increase in that of ewes – by 6.2%. The total number of goats decreased by 1.5% compared with 2013, but at the same time mother goats increased by 3.6%. At the end of 2014, the total number of birds decreased by 13.4% compared to the previous year, mainly due to a significant decrease in chickens for meat 32.3%, while the number of laying hens and adolescent hens went up by 4%.

Table 4

*Number of animals in 2011 and 2014 and a forecast for 2015*

Number of animals	01.11.2011	01.11.2014	Change 2014/2011, %	01.11.2015 forecast
Cattle – total, incl.:	526 112	575 584	9.4	585 000
Cows – total	317 295	346 767	9.3	350 000
– cows for meat	28 546	39 670	39.0	42 000
Buffalo – total, incl.:	9 212	9 964	8.2	10 500
Buffaloes	5 740	6 154	7.2	6 800
Sheep – total, incl.:	1 361 545	1 369 578	0.6	1 369 000
Ewes – general	1 085 175	1 152 902	6.2	1 100 000
– high yield meat sheep	85 648	89 303	4.3	90 000
Goats – total, incl.:	293 639	289 308	-1.5	289 000
goats	236 056	244 559	3.6	250 000
Pigs – total, incl.:	530 945	586 418	10.4	600 000
total breeding female pigs over 50 kg	58 406	55 386	-5.2	58 000
Birds total <sup>a</sup> thousand pieces, incl.:	15 260	13 213	-13.4	14 285
hens and pullets	6 338	6 592	4.0	6 700
chickens for meat	7 499	5 074	-32.4	6 000
waterfowl	1 323	1 463	10.6	1 500
other birds	100	85	-15.0	85
Equidae (horses, donkeys, mules)	131 463	121 649	-7.5	121 000
Colonies <sup>b</sup>	529 117	541 564	2.4	560 000
Rabbits	95 148	95 000	-0.2	95 000

<sup>a</sup> Data to December 31<sup>st</sup>; <sup>b</sup> data as of May 1<sup>st</sup>.

Source: MAF, Department of Agrostatics, NVS – for equines and rabbits; forecast for 2014 – the breeding of MAF.

The highest average number of animals per farm for grazing animals is located in the Southeast region (242 heads per farm with more than 10 ha of own land), followed by North-East (193 heads per farm with more than 10 ha of own land). The smallest number of animals is in the Southwest region (73 heads per farm with more than 10 hectares of own land).

It can be concluded that the structures of holdings in the agricultural sector and their development in time are favourable for the production of biogas and bio-based fertilisers. The most promising regions for planning installations for biogas production in Bulgaria are North-East, North Central and South Central. There is a wide variety in terms of size, distribution and potential of biomass on various farms.

The potential for biogas and fertilisers is theoretically evaluated on the basis of the total production of biomass. All residual products from the farms in the agricultural sector are potential energy sources and are presented in total volume of energy sources. The resulting value is not precise, but this approach can help to identify potential sites for the construction of biogas plants and fertilisers. Agricultural production generates a significant amount of organic materials, both from plant and animal breeding.

Table 5 assesses the overall potential for biogas production from organic waste from agriculture, food industry and sewage sludge in different regions of Bulgaria.

Table 5

*Total potential for biogas and bio-based fertilisers production from organic waste from agriculture, food industry and sewage sludge*

Region	Area ha <sup>3</sup>	Bioenergy, m <sup>3</sup> .10 <sup>4</sup>				
		Waste plant growing	Livestock waste	Solid organic waste	Sewage sludge	Waste from food processing industry
Northwest	1 029	360	27 561	4 491	156	465
North Central	1 827	720	50 188	10 422	363	1 079
North-East	1 997	990	77 135	12 511	428	1 274
Southwestern	2 031	420	40 706	19 430	676	2 011
South Central	2 752	760	93 947	17 610	613	1 823
Southeast	1 465	510	39 785	7 859	673	814
<b>Total</b>	<b>11 101</b>	<b>3 760</b>	<b>329 322</b>	<b>72 323</b>	<b>2 509</b>	<b>7 466</b>

Source: adapted from *Biogas Handbook* (2009).

As seen in Table 5, in Bulgaria the greatest potential for production of biogas and waste fertilisers from plant and animal waste is in the Northeast and South Central regions. Their use for the production of biogas is appropriate and advisable. In terms of solid waste and wastewater, the greatest potential for biogas

is in the Southwestern part of Bulgaria, where the population density is higher. There is great potential for the production of biogas from sludge from wastewater treatment plants (sewage sludge) from municipal solid waste and waste from food industries.

In Bulgaria there are 50 million ha of agricultural land, of which between 20 and 35 per cent are still not used. Annually, plant production of the main crops, after harvest, gives about 4.8-5.2 million tonnes of residual biomass, the highest share of crop residues belongs to straw – about 3 million tonnes. Manure is stored in open facilities and is underused on farms. To limit the negative consequences of open storage of manure, it is recommended to use it as feedstock for biogas production. The secondary product (processed biomass) has a higher content of nutrients, which makes it suitable for application to soils poor in nutrients and microorganisms.

Despite the above, at present, the production of biogas and fertiliser in Bulgaria encounters a number of difficulties. In the Act adopted in June 2007, Renewable and Alternative Energy Sources and Biofuels, there are no regulations pertaining to biogas. Also, Bulgarian regulations do not provide for special support mechanisms for the production of bioenergy, such as a system of preferential prices, certificate mechanisms, tax incentives, investments, subsidies and / or other financial resources. Without these financing mechanisms, the construction of biogas processing plants is not within the reach of most farmers. The future development of the bioenergy sector is highly dependent on the will of politicians and political leaders who will need to formulate relevant policies and introduce adequate legislations.

### **A study on the attitudes of farmers on the application of bio-based fertilisers as an alternative to replace synthetic fertilisers in the rural regions of Bulgaria**

The opinion of 150 surveyed farmers about their attitude to the application of bio-based fertilisers as an alternative to replace synthetic fertiliser is of interest. All respondent farms, at the time of the study, practice conventional (traditional) farming. Most of them (88.7%) periodically import synthetic fertilisers during tillage. For this purpose, most farmers possess appropriate agricultural machinery for fertilisation. These are mainly field crop sprayers, stout fertiliser spreaders and distributors of granular fertilisers. As a major advantage of the synthetic fertilisers most of the respondents highlight the fact that they provide security for the nutritional content. As a second important advantage farmers, name the capability of the synthetic fertilisers to secure production of agricultural crops. At the same time, they are clearly aware of the disadvantages of synthetic fertilisation. As such, they point out the conditions of proper and accurate dosing, the observance of safety rules when handling them, the proper storage, their incompatibility with the rules of organic farming, etc.

About 40% of the farmers surveyed say they regularly use manure. These are mainly holders of livestock farms. At the time of the study, none of the farms has equipment for processing manure. After removal from the breeding premises for the animals, the manure is left to dry on pre-prepared areas without any special treatment.

Despite the well-established system for cultivation with synthetic fertilisers, 98.7% of the surveyed farmers are willing to replace them with bio-based fertilisers. This is probably due to the fact that more than 80% of the respondents are aware of or have heard of some types of bio-based fertilisers.

Meanwhile, over 60% of respondents believe that the application of synthetic fertilisers and untreated manure provides enough nutrients to the soil. Approximately the same number of farm producers argue that the rest of nitrate in the soil of their farm is within permissible limits. This is one of the main reasons why conventional farming is being practiced on the majority of farms in Bulgaria so far. The process of switching from synthetic to bio-based fertiliser is slow due to the fact that the majority of the farmers consider them more expensive and more difficult to supply.

### **Conclusions**

The production and use of biogas and bio-based fertilisers from organic waste lead to a number of socio-economic benefits for the society, the environment and the farmers. The development of a national sector for bioenergy will stimulate the creation of new enterprises with significant economic potential, boost rural incomes and lead to the creation of new jobs. This leads to improved living standards and contributes to the economic and social development.

One of the main contributions of biogas production is anaerobic biological treatment of waste from the crop production and livestock farming, there is an opportunity to reduce the amount of individual nitrogen and thus limit soil pollution with nitrates. This fact has a positive impact on the quality of soil, groundwater and on biodiversity as a whole.

The promotion of biogas and bio-based fertilisers production as a safe and sustainable source of clean energy, together with its benefits will promote the future development of the sector in Bulgaria.

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NELLY BENCHEVA

Uniwersytet Rolniczy

Płowdiw

MILENA TEPAVICHAROVA

Wyższa Szkoła Bezpieczeństwa i Gospodarki

Płowdiw

## MOŻLIWOŚCI I POSTAWY ROLNIKÓW W ZAKRESIE PRODUKCJI BIOGAZU I NAWOZÓW BIOLOGICZNYCH W BUŁGARII

### Abstrakt

*Inwestycje w biogaz i nawozy biologiczne są ważnym narzędziem podnoszącym konkurencyjność i potencjał produkcji i wyników ekonomicznych przedsiębiorstw. Proces restrukturyzacji sektora rolniczego w Bułgarii, który charakteryzuje się dużą liczbą małych gospodarstw o niewielkich możliwościach, może przyczynić się do dywersyfikacji działalności przez promowanie rozwoju produkcji biogazu i nawozów biologicznych. Przyczyni się to do zwiększenia rentowności gospodarki bułgarskiej wsi, która obecnie w znacznym stopniu jest zależna od rolnictwa.*

*Artykuł ma na celu zaprezentowanie i analizę możliwości i postaw rolników w zakresie produkcji biogazu i nawozów biologicznych jako warunku koniecznego poprawy konkurencyjności, osiągnięcia wyższej produkcji i efektywności ekonomicznej gospodarstw w sektorze rolnym oraz podniesienia rentowności obszarów wiejskich w Bułgarii.*

**Słowa kluczowe:** biogaz, nawozy biologiczne, obszary wiejskie, odpady organiczne, Bułgaria.

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