ECONOMICAL ENVIRONMENTAL IMPACT OF BIOGAS PRODUCTION FROM ANIMALS WASTE IN LIVESTOCK FARMS IN ALBANIA

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Abstract: *The introduction of biofuels, and its supply chain, is seen as a possible solution contributing to the establishment of a more secure and stable energy supply and the development of rural agricultural while enabling Albania meet its international commitments on greenhouse gas emissions, clean air, combating desertification, etc. Nowadays trend of agricultural farms in Albania is increasing of their size, numbers of animals and agricultural livestock production. Utilization of organic waste from animals and crop residue have stimulate the Albanians farmers' interest not only for potentially increasing organic fertilizer use efficiency, but also for biogas production. On farm biogas production facilities typically utilize manure as the main substrate, but other materials as crop residue can be added to increase biogas production. Biogas production secure positive impact in utilization of energy from Albanian farmer families. Depending on the type of energy production the biogas would normally utilized to produce renewable electricity or heat. The biogas process also generates other environmental benefits as is reducing of potential risk from environmental pollution (soil, water, air), so creating organic farm. Developing the biodiesel production chain could alleviate the main environmental and socio-economic problems in Albania today, that is, heavy dependence on imported oil, air pollution, land depletation, high unemployment rate and the poverty. It will also help Albania in their harmonization process to joining the EU (2003/30/EC Directive) and support the government's commitments and policies towards energy security, rural development, employment creation, socio-economic development, stability and mitigating global warming. In this study there are analyzed three typical livestock farms, located in three different geographical and climacteric areas in Albania. {north, (Shkodra district), west (Fieri district) and south-east (Korca district). This paper aims to investigate the value chain of biodiesel production and balance feedstock supplies, processing technology, and market penetration in an integrated system in Albania.*

Key words : *biogas, livestock, organic waste*

INTRODUCTION

Livestock production in Albania accounts about 50% of agriculture production. The sustainable development of rural zones and farms is increasing the needs for electric energy.

The growing need for power as a result of the industrial development and the growth of world population has led to the reduction of global energy reserves. For these reasons, the developing countries along with the developed countries are seeking alternative energy sources to meet their needs. Albania is also working to combine power generated from renewable sources (solar, wind, hydro, biomass and geothermal), making them part of a whole strategy for energy, based on the directives of the European Union (2001/77, 2003/54/EC, 2003/55/EC, etc.) Currently, the National Energy Strategy (2007-2020) has involved not only the development of classical sources (fossil), but also the strategies for the development of renewable energy resources.

Economical use of renewable energy resources for the realization of sustainable supply of energy and minimizing the harmful impact on the environment as a support for the

sustainable development of rural areas requires the application of schemes for the use of biomass and biogas production from plant and animal remains.

Bio-Gas is mostly methane (around 60%) with carbon dioxide (around 40%) and a little hydrogen and hydrogen sulphide. Biogas has an energy content of about 5.720 kcal/m³, compared to 8.380 kcal/m³ for mashed methane gas, because carbon dioxide is present in the biogas. [4], [8]

Based on the growing trend of development dairy farms in our country 1.7% in the year 2007 [7] ,this study is focused on the evaluation of potential for biogas production from animal waste in three farms in different geographical regions of Albaia. This study also aimed at identifying the most effective system for the production of biogas for small family holdings.

MATERIAL AND METHOD

The analysis of this study focused on three farms of aveage sizes in three different regions of Albania:

- Northen zone, Dajc- Bregu i Bunes - Commune, Shkoder
- Lowland zone, Levan - Commune, Fier
- Southern- Eastern zone, Maliq Commune, Korça

It analysed the productive activity and evaluated the quantity of animal waste that might be collected from these farms. This was done with questionaires filled in by the respondents.

Based on the animal waste in the farms, the waste from the fodder, and the organic waste of the farming families, the potential for biogas production and the quantity theoretical of energy produced was calculated on the basis of the following formula:

Total waste (kg/day) = No animals unit waste (kg/day)/AU *collection factor.* [1] .[6]

Biogas potential capacity was estimated in m^3/day and m^3/ year. For this purpose, the study used the data from [8]

1 t animal waste = 20-35m³ biogas

1 t organic family waste = 60 m³ biogas

1 m³ biogas = 5.0-7.5kWh total= 0.5 l oil= 1.3 kg wood

Based on the theoretical potential for biogas, the study determined the potential for energy generation from a concentration of I CH4, on an average of 55-60%, [8]

- Theoretical Yield- Energy Potential (Energy gross relieved from the cremation of $1m^3$ biogas) [8]
- Technical Yield -Energy potential (Energy produced in: thermo engine: η = 30-40%; electric engine: η = 20-30%; Combined used: η =60-70%)
- Achievable Energy potential (Exploit energy – direct dependence from technology and efficiency of the equipment to be used)

All account [calculations made] done according to:

ASAE D384.1 FEB03; Manure Production and Characteristics; [1]

NRCS 1998; Manure Characteristics [2]

Based on these calculations we managed to determine also the economic value of the biogas production systems and the cost of utilization of 1kW yielded from such waste.

RESULTS AND DISCUSSIONS

Table 1 shows the structure and size of liverstock farms in Albania and the numerical growth of livestock in the last four years.

From the analysis of the data on the farm holdings, livestock accounts for about 60 % of the overall agricultural production in Albania. But, on the other hand, the farms are of small,

"family type" sizes, engaging in breeding different kinds of animals to ensure their livelihood and also market small amounts of seasonal produce. The analyses we conducted and the data we got from the MBUMK indicate that the number of farms in Albania is approximately 370 000. They have different sizes varying from 0.9-1.2 ha and breed an average of 3-7 heads of cattle, 10-15 sheep, or goats; 1-2 pigs and 20-25 chickens. The small family-type farms constitute on an average 75% of all the farms in the country. However, from the table it can be seen that this tendency is declining, since both the number of heads of cattle or sheep and the size of farms is growing, with the tendency being to have more average-size farms and some large-size farms. The average-size farms in 2009 accounted for about 20% of all the livestock farms.

Table1

Size disttribution of Albanian farms

Number of head	**2006**	**2007**	**2008**	**2009**
Farms with cattle	**1042**	**1233**	**2499**	**3995**
10-Qer	793	897	1955	3035
11-50	225	311	512	848
50-100	24	21	20	76
0ver 100	0	4	12	32
Farms with sheep	**5403**	**5616**	**7771**	**8953**
51-100	3630	3963	4566	4979
101-200	1243	1159	2419	3004
0ver 200	530	494	786	970
Farms with goats	**3218**	**2938**	**3109**	**3278**
51-100	2372	1898	1947	1855
101-200	672	676	922	973
over 200	174	164	240	450
Farms with pigs	**234**	**251**	**506**	**702**
10-Qer	126	142	322	412
11-50	102	97	163	234
50 - 100	6	12	16	35
over 100	0	0	5	21
Egg poultry farms	**25**	**22**	**22**	**37**
1000-5000	10	5	7	1
5000-10000	1	3	1	6
10000-50 000	10	8	7	9
over 50 000	4	6	7	11
Poultry meat farms	**23**	**20**	**29**	**39**
5000 - 10 000	11	8	7	0
10 000 - 20 000	3	3	6	11
20 000 - 50 000	8	7	2	7
over 50 000	1	2	12	21
Turkey meat farms	**3083**	**3946**	**3850**	**4127**
21-50	2398	3032	3205	3416
51 -100	576	749	522	539
over 100	109	165	123	172

(Source: [7] and personal interview)

From the analysis of the data on the farm holdings, livestock accounts for about 60 % of the overall agricultural production in Albania. But, on the other hand, the farms are of small, "family type" sizes, engaging in breeding different kinds of animals to ensure their livelihood and also market small amounts of seasonal produce. The analyses we conducted and the data we got from the MBUMK indicate that the number of farms in Albania is approximately 370 000. They have different sizes varying from 0.9-1.2 ha and breed an average of 3-7 heads of cattle, 10-15 sheep, or goats; 1-2 pigs and 20-25 chickens. The small family-type farms constitute on an average 75% of all the farms in the country. However, from the table it can be seen that this tendency is declining, since both the number of heads of cattle or sheep and the size of farms is growing, with the tendency being to have more average-size farms and some large-size farms. The average-size farms in 2009 accounted for about 20% of all the livestock farms.

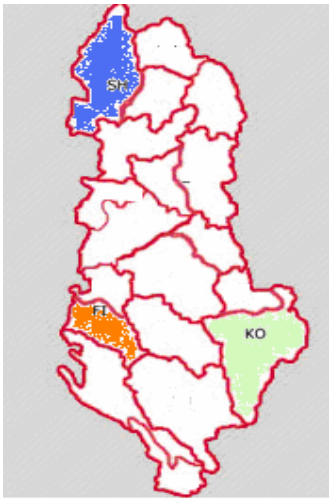

Fig 1 shows the map of Albania with the three regions in different geographical locations where the farms we analysed are found.

Farm A, Dajc-Bregu i Bunes Commune, Shkodra Region.

Shkodra represents the northernmost region and location of Albania, that belongs to the northern lowland mediterranean zone. The average air temperatures vary between 15-16˚C and the average annual rainfalls are 1500-1800mm.

The farm was selected at random, being of a small to averge size, a typical farm for this zone. It is run only by the four family members and breeds 42 heads of livestock and six horses. Table 2 shows the theoretical and practical amounts of waste that can be collected in this farm..

The total quantities of animal waste were calculated based on the above mentioned features. In order to have a fair trial it is also done their uniformity by using indicator animal unit [3].

In order to calculate the real quantity of waste, we used the waste collection coefficient Sh.Karaj[6] proposes for our farms

The amount of biogas generated and the amount of energy released from it.

The amount of biogas produced by these wastes will be:

9246 m^3/year or 25.3 m^3/day.

Theoretical Energy Potential (Used 100% of calorific value): 25.3 m^3 biogas = 542MJ/day =152 kwh/day

Technical Yield -Energy potential:

The energy produced in a thermo engine $\eta = 30 \div 40\%$; 190 MJ/day

The energy produced in an electric engine $\eta = 20 \div 30\%$; 135.5 MJ/day

The combined used ($E_{thermo} + E_{electric}$) $\eta = 60 \div 70\%$; 352MJ/day

Table 2

The theoretical and practical quantity of animal waste per day and year in the farm A

	Number of animals	Factor per Animal Unit[1]	Number of Animal Units	Animal waste per AU in Tons [2]	Total (Tons)	Collection factor [3]	Total animal Waste (Tons/D.)	Total animal waste (Tons/a)
Cattle	**33**							
Milk Cow with 5000 kg productivity	15	1.0	15	11.50	172.5	80	0.38	138
Calf (6-12 month old)	11	0.56	6.16	10.57	65.1	80	0.14	52
Heifers	7	0.75	5.25	12.50	65.62	80	0.14	52.5
Equidae	**6**							
Horses	6	1.1	6.6	16.5	109	60	0.18	65
Organic waste from family farms							0.002	0.7
TOTAL	**39**		**33**				**0.842**	**308.2**

[1] Animal Unit - An animal unit (AU) is one mature cow of approximately 1000 pounds and a calf up to weaning, usually 6 months of age, or their equivalent [3]

[2] [2]

[3] [6]

Farm B, Levan Commune, Fier Region

Fier represents the most typical region belonging to the most loweland area in Albania. It belongs to the central lowland mediterranean zone. The average air temperatures vary between 6-18˚C and rainfalls are 1600-1800mm per year.

Table 3

The theoretical and practical quantity of animal waste per day and year in the farm B

	Number of animals	Animal Unit Factor	Number of Animal Unit	Tons animal waste per AU	Total (Tons)	Collection factor*	Total animal Waste (Tons/D.)	Total animal waste (Tons/a)
Cattle	**167**							
Cow of milk productiviy of 3000 kg	12	0.73	8.76	10.59	**92.8**	**80**	**0.2**	**74.2**
Cow of milk productiviy of 5000 kg	44	1.0	44	11.50	506	80	1.1	404.8
Calf (6-12 month old)	39	0.56	21.8	10.57	230.4	80	0.5	184.3
Heifers	45	0.75	33.8	12.50	422.5	80	0.92	338
Fatling cattle (18-21 month old)	27	0.68	18.4	10.59	194.4	80	0.43	155.5
Organic waste from family farms							0.002	0.7
TOTAL	**167**		**132**				**3.15**	**1157.2**

The farm was selected at random of average size. In this zone, we noted a tendency of enlarging the farms and creating farms over 100 AU. It was run only by four family members and bred 167 heads of cattle. The average productivity of milk was 6200 l. It has in its use 52 ha of land. Table 3 shows the theoretical and practical of the amounts of collected in this farm.

The amount of biogas produced and the energy released from it.

The amount of biogas produced by these wastes will be:

34716 **m^3/year or 95 m^3/day.**

Theoretical Energy Potential (Used 100% of calorific value):

95 m^3 biogas = 2033MJ/day =570 kwh/day

Technical Yield -Energy potential:

The energy produced in a thermo engine $\eta = 30 \div 40\%$; 712 MJ/day

The energy produced in a electric engine $\eta = 20 \div 30\%$; 508 MJ/day

The combined used ($E_{thermo} + E_{electric}$) $\eta = 60 \div 70\%$; 1321MJ/day

Farm C, Maliq Commune, Korça Region

Korça is one of the regions of the south eastern part of Albania. It belongs to the premountainous mediterranean zone. The average air temperature vary from 8-11˚C. In January, they vary from -4 – 5 ˚C. It is a zone with frosts and snow which last for two to three months. The rainfalls are on an average 650-750 mm a year.

The farm was selected at random and was of an average size. It is run by two families and breeds 83 heads of cattle and 1500 layer hens. The average milk productivity is 5700 l. It has in its use 75 ha of land. Table 4 shows the theoretical and practical amount of the waste collected in this farm.

Table 4.

The theoretical and practical quantity of animal waste per day and year in the farm C

	Number of animals	Animal Unit Factor	Numer of Animal Unit	Tons animal waste per AU	Total (Tons)	Collection factor*	Total animal Waste (Tons/D.)	Total animal waste (Tons/a)
Cattle	**83**							
Cow of milk productiviy of 3000 kg	10	0.73	7.3	10.59	**77.3**	**80**	**0.17**	**61.8**
Cow of milk productiviy of 5000 kg	23	1.0	23	11.50	264.5	80	0.58	211.6
Calf (6-12 month old)	27	0.56	15.1	10.57	160	80	0.35	127.9
Heifers	12	0.75	9	12.50	112.5	80	0.25	90
Fatling cattle (18-21 month old)	11	0.68	7.5	10.59	79.2	80	0.17	63.3
Poultry								
Chicken	1500	0.004	6	11.47	68.8	75	0.14	51.6
Organic waste of family farms							0.004	1.4
TOTAL			**68**				**1.664**	**607.6**

Quantity of biogas generated and the quantity of energy released from it.

The amount of biogas produced by these wastes will be:

18228 m^3/year or 50 m^3/day**.**

Theoretical Energy Potential (Used 100% of calorific value):

50m³ biogas = 1070 MJ/day =300 kwh/day

Technical Yield -Energy potential:

The energy produced in a thermo engine $\eta = 30 \div 40\%$; 374 MJ/day

The energy produced in a electric engine $\eta = 20 \div 30\%$; 267 MJ/day

The combined used ($E_{thermo} + E_{electric}$) $\eta = 60 \div 70\%$; 696MJ/day

The most important problem both from the prospect of development and the economy is the selection of the best model of biogas production systems. The analysis of these three farms of small up to average sizes, typical of our country, shows that in the conditions of our country, in order to ensure a sustainable rural development, the most suitable type would be the family system of biogas generation. Such systems may generate 10 m3 biogas a day. It is possible to build a digest or 2-5 in series. The cooperation among farmers may make possible to build average systems with a capacity of up to 100 m3 biogas production with a lower cost and higher utilization capacity. In these conditions, 1 kWh may be released from the processing of wastes of 5-6 AU.

The calculation of the utilization cost of the energy generated by biogas from a family system.

In order to estimate this system, we selected farm C and an average fixed cost, provided by Puxin company for family systems of 1500 $/kW.

1. According to our calculations, farm C might generate per day:

50m3 biogas = 1070 MJ/day =300 kwh/day or 12.5 kW

2. Total cost for the plant:

12.5 kW x1500$ =18 750$

3. Total amount of energy generated shall be:

300kWh/day x 365 day x 0.7 = 76650 kWh/year

4. Minimal cost of plant utilization shall be:

18750$ /5 years/ 76650 kWh/year = 0.0 49 $ /kWh = 5 cent /kWh

Thus, based on such calculations, this type of plant shall repay its costs in five years and furthermore shall produce green energy, which is very profitable for the environment.

CONCLUSSIONS

1. Albania's sustainable development in general, and of the rural areas, in particular, is making it clear that there is a need for alternative energy resources. One of these resources that might be implemented in our country is biogas yielded from biomethanization of the farm animal waste.

2. Average sized farms that breed over 30 Au may serve as starting point for the implementation of the family systems for biogas generation. In the meantime, boosting of cooperation among farmers will lead to the construction of average systems with a capacity of over 100m^3 biogas per day.

3. The study showed that in the conditions of our country, given the type of breeding used and the yield of biogas achieved, one kW may be generated from wastes of 4- 6 AU.

4. The amount of energy manufactured in the farms of the size we analyzed may cover up to 30 – 40 % of the needs for cooking and 80 % of the needs for electric lighting for 1-2-3 farming families.

5. For family systems, the utilization cost for one kWH is calculated to be 0. 049 $/ kWh.

6. Today, biogas usage in rural areas is not only a renewable energy resource, but it also has a positive impact on environment, as well as on Albania's economic development.

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