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## **THE POTENTIAL OF SWINE BREEDING IN BIOGAS PRODUCTION AT FARM ENTERPRISES**

**Problem definition.** Swine production as a branch of agriculture provides population with required foodstuff and at present it remains one of the most promising branches in the agrarian sector of the national economy of Ukraine. However, its state in recent years has not answered a real potential and it requires the introduction of innovative technologies at farm enterprises of swine production. One of the most efficient ways to make farm production more competitive and efficient is to diversify swine breeding, in particular, the production of biogas from pork substrates.

The solution of the outlined issues will facilitate the development of fodder, meat and alternative fuel production. Besides, it will ensure food and power safety of the state, and population will receive domestic high-quality foodstuff. Social problems in the rural areas will be solved as well.

The issues of farm enterprise functioning in swine production are discussed in the works of V.H. Andriychuk, V.I. Boiko, V.P. Rybalko, I.V. Svytnous and others. The issues of production and consumption of alternative kinds of fuel are discussed in the works of H.M. Kaletnik, M.Yu. Kodenska, V.Ya. Mesel-Veseliak, M.V. Royik, P.T. Sabluk, O.M. Shpychak, V.S. Bondar and others. However, the problem of biogas production at farm enterprises in swine breeding needs additional studying.

**The purpose of the research** is to evaluate the potential of biogas production and consumption at farm enterprises in swine breeding, taking into account its effect on business economic efficiency.

**Research methodology.** The system analysis and logical generalization were used in the process of research to study preconditions of negative changes in swine production; economic-mathematic modeling – to work out a polynomial model which describes biogas production potential at swine breeding enterprises

in terms of natural gas; settlement-constructive – to determine the indicators of economic efficiency in swine farming; induction and deduction – to generalize the research results; abstract-logic – to make conclusions and suggestions.

**Results of the research.** Swine production is a priority branch of livestock production; the demand for its output is high which is confirmed by general world tendencies. Despite the fact that in some countries pork is not consumed due to religious and other considerations, in general world meat production its share is 40 %. The priority of swine production is explained by its important biological-economic peculiarities: high prolificacy, early maturity, economic fodder consumption, omnivorous feature, usefulness of slaughter products for cookery to be used every day and for lasting storage [1].

In Ukraine in the early 90ties of the XX century during the transition to market relations, the conditions for free pricing were created for all branches of the economy, and approximate prices were introduced for agriculture; the prices of farm products grew much slower than those of goods and services consumed in agriculture which resulted in price disparity. This, in turn, affected the farm enterprises in swine production: they were in crisis condition and experienced negative changes.

An important indicator of the branch development is the output volume. Unfortunately, the latter decreased considerably in Ukraine. In 1990 1576.3 th. t of pork were produced, and in 2013 – only 748.4 th., the decrease was by 52.5%. This is mostly due to the stock reduction – from 19.43 mln head in 1990 to 7.92 mln head in 2013, i.e., – by 59.2%. During this period the pig stock decreased by 72.4% – to 3.88 mln in 2013 (Table 1).

**Table 1. Indicators of swine production development in Ukraine (farms of all categories)**

Indicator	Year					2013 in % to	
	1990	2000	2010	2012	2013	1990	2012
Pig stock, mln	19,43	7,65	7,96	7,58	7,92	40,8	104,5
Including at farm enterprises:							
Mln of head	14,07	2,41	3,62	3,56	3,88	27,6	109,0
in % to total	72,4	31,5	45,5	47,0	49,0	-	-
Pork production (in slaughter weight), th t	1576,3	675,9	631,2	700,8	748,3	47,5	109,0
y % to meat of all kinds	36,2	40,6	30,6	31,7	31,3	-	-
Pork production (in slaughter weight) per person, kg	30,4	13,8	13,8	15,4	16,5	54,3	109,0

**Source:** calculation according to the data of the State statistics committee of Ukraine [2, 3]

Back in the years, pork consumption in Ukraine was over 30 kg per capita, today this indicator is lower. According to the State statistics committee of

Ukraine pork consumption per capita was 21.5 kg in 2013 and in 2012 – 21.1 kg [4, c. 37]. Ukraine lags behind other countries in this respect. Thus, pork consumption per capita in some countries is as follows: Denmark - 77 kg, Hungary – 62 g, Germany – 57 kg, Poland – 42 kg, the Netherland - 44 kg, China – 34 kg [5].

Hence, the output volume of pork which is produced in Ukraine does not meet the requirements of the internal market and the country is to import it. One of the reasons of such negative condition is its structural changes. In 1990, 72.4% of pig stock was kept at farm enterprises, and presently it is only 49%. As pigs are mostly kept at individual farms (homesteads) pork quality does not always meet the requirements of processing companies, the deficit of pork resulting in price increase at the internal market.

The analysis of pork production efficiency in Ukraine shows positive dynamics seen in recent years (Table 2) [6–11]. If in 2010 damage level of pig marketing for meat was 7.8%, in 2014 the production was profitable – 5.8%. However, during this period efficiency level decreased compared with the year of 2009 when it was 12.1%.

**Table 2. Economic efficiency from pig marketing for meat in Ukraine in 2009-2014 (farm enterprises)**

Indicator	Year						2014 in % to	
	2009	2010	2011	2012	2013	2014	2009	2013
Sold products, th. t	248,2	312,4	372,1	354,6	409,5	433,1	174,5	105,8
Total cost 1 t, UAH	12540,4	13237	14176	15626	15497	17477	139,4	112,8
Average selling price 1 t, UAH	14054,4	12204	13648	15941	15526	18459	131,3	118,9
Rate of return (damage), %	12,1	-7,8	-3,7	2,0	0,2	5,6	-	-

**Source:** calculation according to the data of the State statistics committee of Ukraine [6–11]

In 2009-2014 the amount of output sold by farm enterprises increased by 74.5% – up to 433.1 th. t, price playing a very important role in pork market regulation. During this period average selling price of 1 t of pig meat increased by 31.3% – up to 18459 UAH/t in 2014, production cost increased by 39.4% – up to 17477 UAH/t, respectively. Selling prices of pork were increasing at a lower rate than its production cost. The year of 2010 was especially notable: because of the price increase of combined fodder, cost production of pork increased by 5.6% and selling price of 1 t of pig meat decreased by 13.1% which resulted from high pork import at the market.

Thus, the main reasons which caused problems in the branch of swine production are: considerable decrease of pig stock; unstable price situation provoked by increased import of cheap, low-quality meat raw material; high production cost

due to outdated operational technologies, unbalanced fattening; lack of consistent state support and regulatory policy aimed at stimulating the branch development.

Taking into account an obvious fact that the sound efficiency of farm enterprises in swine production has serious risky deviation and is quite challenging, it becomes quite expedient to diversify the output, namely, to use it for biogas production.

Agricultural substrates such as liquid and stable manure or energy crops (sugar and fodder beets, corn, sugar sorghum, miscanthus, etc.) are raw materials for biogas units. The most promising agricultural crops which can be used as raw materials for biogas production are sugar sorghum (gas output – 17.6 th m<sup>3</sup>/ha), corn for silage (16.0 th m<sup>3</sup>/ha), sugar beets (10.9 th m<sup>3</sup>/ha), fodder beets (10.8 th m<sup>3</sup>/ha) [12, p. 6].

However, the use of food crops with the aim of power production may lead to the reduction of foodstuff and fodder, which is why it is necessary to use corn for grain to feed pigs. In this case both pork and gas production is ensured.

To calculate pork and biogas production from manure, we take average yield of corn for grain at farm enterprises in 2014 – 6.7 t/ha, then 1188 kg of pig meat per 1 ha will be produced (Table 3).

**Table 3. Efficiency of pork and biogas production from substrates at farm enterprises, 2014/2015 marketing year**

Indicators	Average meaning 2014/2015 MP
Yield of corn for grain, t/ha	6.7
Produced pig meat per 1 ha, kg	1188
Costs for meat production, UAH/ha	20766
Revenue from meat sale, UAH/ha	21930
Income from meat sale, UAH/ha	1164
Production cost of 1 kg of meat, UAH	17.48
Selling price of 1 kg of meat, UAH	18.46
Income from sale of 1 kg of meat, UAH	0.98
Rate of return of meat production, %	5.6
Amount of biogas per 1 ha, m <sup>3</sup>	594
Costs for biogas production, UAH/ha	1723
Amount of biogas in terms of methane per 1 ha, m <sup>3</sup>	327
Revenue from biogas sale per 1 ha, UAH	2158
Income from biogas sale, UAH/ha	435
Production cost of biogas in terms of methane 1 m <sup>3</sup> , UAH	5.3
Biogas price in terms of 1 m <sup>3</sup> , UAH	6.6
Income from sale 1 m <sup>3</sup> , UAH	.3
Rate of return of biogas production, %	24.5

**Source:** our calculations and the data of the State statistics committee of Ukraine [11]

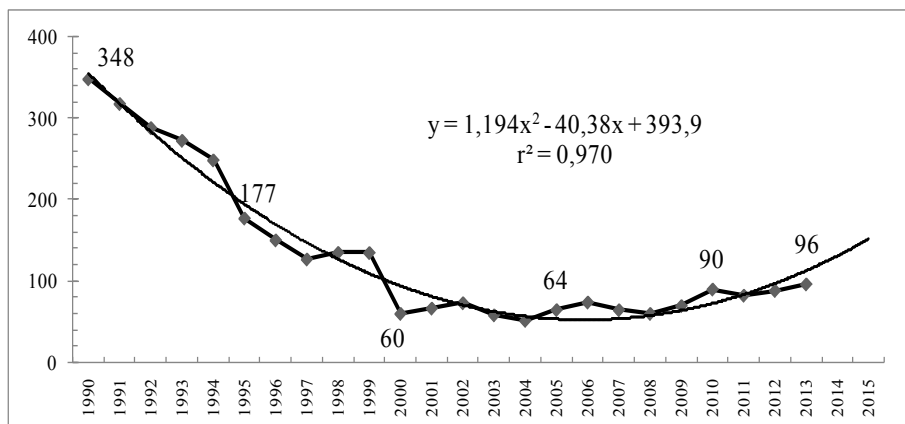
In compliance with departmental standards of technological design **BHTII -AIIK-09.06** “Systems of extraction, processing, preparation and use of manure” [13] biogas is a combustible gas, which consists of 55-70% of methane and 30-45% of carbon dioxide, which is why the amount of biogas in terms of methane is 327 m<sup>3</sup> per 1 ha, when yield of corn for grain is 6.7 t/ha.

In addition, by the decision of the National board which exercises public regulation in the spheres of power engineering and municipal services № 1886 of June 30, 2015, price ceiling of natural gas for industrial consumers and other business entities was fixed from July 1, 2015 – UAH 6600 per 1000 [14]. Under such conditions, income from biogas sale is 435 UAH/ha, rate of return of biogas production is 24.5%.

Thus, biogas production from pig substrates at farm enterprises will guarantee not only efficient pork production but also sources of renewable energy, which can reduce producers’ dependence on expensive energy carriers, and in turn will facilitate the rebirth of swine farming in Ukraine.

Despite the pig stock decrease at farm enterprises in 1990-2013, the potential of biogas production from pig substrates can reach 348 million cubic meters in terms of natural gas which constitutes 31% of natural gas consumption in Ukraine in 2013 [15] (Fig.)

**Fig. Potential of biogas production at farm enterprises in swine farming of Ukraine in terms of natural gas in various years, mln of cubic meters**



Source: our calculations

According to the statistics of 2013, the potential of biogas production from pig substrates at farm enterprises in terms of natural gas is 96 mln cubic meters, which in terms of standard fuel is 110 th. t. Provided average price of 1000 cubic meters of natural gas is UAH 6600, the industry will get additional UAH 633.6 million.

Thus, a considerable amount of biogas will be used to satisfy the needs of farm enterprises, however, when proper equipment is used, the rest of the energy

can be marketed to other consumers. It is possible to use units for simultaneous production of energy and heat, and special equipment will be used to clean biogas and consume it as ordinary fuel for vehicles and other agricultural machines.

**Conclusions.** Biogas production at pig breeding farms solves several problems of agrarian business:

- environmental pollution with dangerous substances including liquid and solid wastes of livestock farms decreases, as well as methane emission into the atmosphere;
- new conditions for farm enterprises to get additional profits which will enhance production efficiency of pork output are created;
- needs of farm producers in bio fuel at a lower price are satisfied which favors competitive power of agrarian businesses;
- food and energy security of the country due to the increase of pork and biogas production and the decrease of farm producers' dependence on import fuel are guaranteed;
- social problems in rural area are solved by creating new and saving existing jobs.

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### **Summary**

The factors which caused problems in swine production of Ukraine were identified. The trends in biogas production and consumption at farm enterprises in swine farming were studied. The evaluation of the production efficiency of both pork and alternative fuel – biogas – was made. A polynomial model, which describes potential of biogas production at farm enterprises in swine breeding in terms of natural gas in the years of 1990-2013 and envisages further increase of this indicator, was developed. It has been established that biogas production and consumption from swine substrates at farm enterprises will allow producing ecologically clean alternative fuel, ensuring food safety, creating new jobs, increasing business profits, reducing import fuel dependence. The research results can help solve practical problems of farm enterprises in swine production and in agrarian business in general.

**Key words:** swine production, production diversification, pork, biogas, food safety, production cost, price, efficiency, competitiveness, farm enterprises, bioengineering.