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## **ENERGY COSTS IN DAIRY FARMS – ASSESSMENT IN THE YEARS 2005-2016**

Key words: dairy farms, energy costs, diesel fuel subsidies, Poland, European Union

**ABSTRACT.** The main aims of the article are: 1) defining the changes of energy costs in farms focused on milk production and further divided according to their economic size in Poland and other selected EU countries between 2005 and 2016; 2) analysis of electricity and fuel (diesel) costs in Polish dairy farms between 2005 and 2016; 3) characterisation and evaluation of the current Polish subsidy system for fuel used for agricultural production purposes. The subject of research was dairy farms from selected EU countries participating in the FADN system. The implementation of the third objective boiled down to a critical analysis of the amendment to the Act introduced in Poland: “On the refund of excise duty included in the price of diesel used for agricultural production”. The research shows that in farms focused on cattle breeding and milk production in seven analysed EU countries, the average share of “energy” costs in the structure of total costs fluctuated (in 2005, 2010, 2016) from 2.72% in the largest Danish farms in 2016 to 13.08% in the smallest Polish farms in 2005. Regardless of the country, an increase in the economic size of farms focused on milk production, resulted in energy cost savings in relation to 100 kg of milk produced. The analysis of legal solutions implemented in Poland shows that dairy farms are able to potentially obtain higher subsidies for diesel oil used for agricultural production. This is very debatable from an economic point of view.

## **INTRODUCTION**

As a result of the process of continuously striving to increase productivity (profitability) of work in a free market economy, one of the activities undertaken in farms is replacing human work with machinery or replacing machine work with even more efficient machines and robots, which results in increasing energy consumption [Parzonko 2018, p. 203]. The report “World Energy Outlook 2018”, published by the International Energy Agency, shows that the demand for energy in the world is gradually increasing and will continue to grow in upcoming years, but the degree of this increase may differ due to a range of policies being implemented in the field of energy [IEA 2018]. In scenarios of changes published in the “New Policies Scenario”, Authors suggest that rising incomes together with an estimated additional 1.7 billion people in the world – who will mostly live in urban areas in developing countries – will increase global energy demand by 25% by 2040. According to the Authors [IEA 2018], this increase could be twice as large without continuous improve-

ments in energy efficiency, which is a powerful tool in the framework of energy policies to prevent problems related to energy security and sustainable development. The „Current Policies Scenario” presented in the report „World Energy Outlook 2018” is less optimistic and its implementation may lead to a much higher demand for energy, which will result in greater tension in almost all areas of energy security [IEA 2018]. Although, according to the published forecasts, the entire increase in energy demand by 2040 will come mainly from developing countries (with India in the lead), the effects of these changes will be spilled over to other countries around the world, including Poland. Undoubtedly, one of the effects will be related to an increase in prices of energy resources. The rate of change is quite difficult to predict due to the continuously changing political situation in the world and technological progress in the process of extraction and processing of various energy sources. According to a report published by the Polish Institute for Renewable Energy in January 2018, the weighted average price of electricity under BASE-Y<sub>19</sub> forward contracts in Poland amounted to 179.37 PLN/MWh (42.15 euro/MWh<sup>1</sup>). In May 2018, it was 210.86 PLN/MWh (49.54 euro/MWh), which constitutes an increase of 17.5% over a period of 5 months. It is estimated that as a result of maintenance and development of coal generation strategies in Poland, by the end of 2030, the average price of electricity for final consumers will exceed PLN 350 PLN/MWh (82.24 EUR/MWh). According to statements of the Polish Ministry of Energy, the rapid and large-scale introduction of nuclear power into the system will shape the energy mix. As a result of this measure, further increases in electricity prices should be expected (by approximately 22% in the 2031-2050 perspective) [IEO 2018]. Rising prices of electricity and diesel generate the need to determine the state of energy consumption in specific groups of farms and search for ways on how to reduce energy costs.

Farmers are being pushed for further reductions in costs and efficiency improvements as milk production is becoming more liberal after the quota elimination production of fresh products increased. As they are predominantly produced for internal EU consumption, increased production absorbed on the European market has resulted in a slump of milk prices [Mach et al. 2017]. Any elimination of costs is relevant since efficiency shall increase as the efficiency of milk processors is growing [Špička 2015] and the negotiating power of the single dairy farmer is minor.

As energy costs of dairy farmers has not been widely discussed, the main objectives of the article are: 1) defining the changes of energy costs in farms oriented towards milk production and further divided according to their economic size in Poland and other selected EU countries between 2005 and 2016; 2) the analysis of electricity and fuel (diesel) costs in Polish dairy farms between 2005 and 2016; 3) a characterisation and evaluation of the current Polish subsidy system for fuel used for agricultural production purposes.

## MATERIAL AND METHODS

The solution to the first defined objective was based on data from the European and Polish Farm Accountancy Data Network (FADN). The study selected farms from seven countries with the highest increase in milk processing between 2005 and 2015. The high-

<sup>1</sup> Euro exchange rate = 4.256 acc. FADN [2018],

est increase was observed in the following countries: Germany (3.16 million tonnes), Poland (2.16 million tonnes), the Netherlands (1.39 million tonnes), France (1.2 million tonnes), Ireland (0.6 million tonnes), Great Britain (0.53 million tonnes) and Denmark (0.48 million tonnes<sup>2</sup>). Then, farms focused on dairy cattle breeding and milk production (so-called “Specialist dairying” production type in the FADN system) were selected among separate countries. Those were additionally divided according to economic size, the determinant of which is the value of standard output (SO) after 2010. Next, it was necessary to determine the average energy costs in separate groups of farms. It should be emphasized that in the reports published from the FADN system, all energy costs are included in one item “SE345: Energy”. This includes motor fuels and lubricating oils, electricity as well as costs related to heating fuels. The aggregation of all energy costs into one value makes it difficult to analyse and draw conclusions as it is not possible to specify costs of individual energy carriers precisely.

In order to realize the second defined objective, unpublished data from the Polish FADN System were obtained regarding the exact information on diesel fuel consumption (in terms of quantity and value) and electricity (in terms of value) on Polish farms focused on dairy cattle breeding and milk production (FADN type “Specialist dairying”) in 2005-2016. Next, indicators presenting the status and changes in the area of energy-consumption and energy-costs related to production in separate groups of farms were selected.

The implementation of the third separate objective includes the presentation and analyses of new Polish policy solutions functioning since 2019 and aiming at refunding excise tax for diesel used for agricultural production (amendment of the Act of March 10, 2006 “On the refund of excise tax included in the price of diesel used for agricultural production”; Journal of Laws, 2015.1340 and 2018.2244), also known as “Agricultural Fuel”.

## RESULTS

When assessing the cost of milk production in agricultural farms focused on breeding dairy cows and milk production in selected EU countries, it is firstly necessary to emphasize their large variation in the scale of production (cow population and milk production level), which is closely related to the different production technology and assets involved, mainly assets of permanent character (machines, devices, buildings, etc.), which undoubtedly relates to various energy needs [Parzonko 2013]. This situation, on the one hand, hinders economic analysis, and on the other, illustrates the problem of farms functioning on the single European market.

As can be seen from the data presented in Table 1, the average share of energy costs in the total cost structure fluctuated in separate years (2005, 2010, 2016) from 2.72% (the largest Danish farms in 2016) to 13.08% (the smallest Polish farms in 2005). The presented summary also shows that the share of energy costs, irrespective of the period or country, in the structure of total costs of the examined farms, decreased as their economic size increased. It should also be emphasised that, in the analysed years, the share of energy costs in the structure of total costs did not change significantly among separate farm groups.

<sup>2</sup> Increased milk purchased by dairies between 2005 and 2015.

Table 1. Average share of energy costs in total costs of dairy farms diversified by economic size from selected EU countries in 2005, 2010 and 2016

Year	Economic size of farms [thoss. EUR]	Farms focused on milk production from selected EU countries*						
		DE	PL	NL	FR	IE	GB	DK
		Average share of energy costs [%]						
2005	2-8	-	13.08	-	-	-	-	-
	8-25	-	11.22	-	-	-	-	-
	25-50	10.26	10.65	-	5.77	4.96	-	-
	50-100	9.96	10.49	5.96	5.20	4.76	6.41	-
	100-500	8.57	9.99	5.06	4.90	4.47	4.67	3.47
	above 500	7.81	-	4.61	-	-	4.16	3.60
2010	2-8	-	12.60	-	-	-	-	-
	8-25	-	11.80	-	-	-	-	-
	25-50	11.67	10.90	-	6.06	6.77	-	-
	50-100	10.71	10.63	5.61	5.26	5.55	6.83	-
	100-500	8.45	11.15	4.77	4.91	4.82	5.07	2.99
	above 500	7.84	-	4.50	-	-	4.49	2.86
2016	8-25	-	10.41	-	-	-	-	-
	25-50	11.16	9.62	-	5.70	-	-	-
	50-100	10.13	9.30	-	5.61	4.93	6.04	-
	100-500	8.20	8.97	4.45	5.19	3.87	4.31	3.05
	above 500	6.76	-	3.95	5.41	-	4.03	2.72

\* De – Germany, PL – Poland, NL – Holland, FR – France, IE – Ireland, GB – Great Britain, DK – Denmark

Source: own collaboration based on [INLB 2018]

When comparing the average share of energy costs in total costs among dairy farms of all sizes from selected countries, it should be noted that in Poland the average was the highest. It amounted to 11.4% in 2005, 11.22% in 2010 and 9.48% in 2016. At the other side were farms from Denmark with a ratio ranging from 2.78 to 3.5%. An important element in the analysis of energy intensity of production in farms oriented towards cattle breeding and milk production is the nominal amount of energy costs. The data presented in Table 2 shows that the level of energy costs was determined by the economic size of the surveyed farms, which is related to the value of production. On average, the highest energy costs were generated in the largest farms from Germany. In 2010, they amounted to EUR 125,968 and in 2016 it was EUR 88,383. In comparison to other countries and farms of the same economic size (above EUR 500,000), it is clear that German farms are much larger than farms in the NL, GB or DK.

Referring to the total energy costs, as defined in the FADN system, in relation to the milk produced, the benefits of economies of scale (production scale) can be noticed. Regardless of the country, an increase in economic size of farms focused on milk production, led to a decrease in energy costs in relation to 100 kg of milk production (Table 3).

Table 2. Average annual energy costs in dairy farms with differentiated economic size from selected EU countries in 2005, 2010 and 2016

Year	Economic size of farms [thous. EUR]	Farms focused on milk production from selected EU countries*						
		DE	PL	NL	DE	IE	GB	DK
		Average annual energy costs [EUR]						
2005	2-8	-	603	-	-	-	-	-
	8-25	-	1,143	-	-	-	-	-
	25-50	4,063	2,422	-	2,503	1,458	-	-
	50-100	6,269	4,733	3,481	4,098	2,848	4,221	-
	100-500	13,653	15,997	8,192	8,540	5,756	10,387	9,562
	above 500	70,943	-	24,260	-	-	28,502	24,915
2010	2-8	-	608	-	-	-	-	-
	8-25	-	1,327	-	-	-	-	-
	25-50	4,362	2,738	-	2,633	2,713	-	-
	50-100	7,366	5,600	3,933	4,548	4,203	5,230	-
	100-500	17,892	14,007	11,072	9,824	8,541	12,845	11,705
	above 500	125,968	-	28,753	-	-	34,153	32,085
2016	8-25	-	1,191	-	-	-	-	-
	25-50	4,263	2,344	-	2,701	-	-	-
	50-100	6,872	4,701	-	4,923	3,543	4,660	-
	100-500	17,278	11,268	11,445	11,814	7,006	12,328	11,224
	above 500	88,383	-	26,577	33,752	-	30,728	31,214

\* De – Germany, PL – Poland, NL – Holland, FR – France, IE – Ireland, GB – Great Britain, DK – Denmark

Source: own processing based on [INLB 2018]

As can be seen from the data presented in Table 4, the diesel fuel consumption in the examined Polish farms focused on dairy cattle increased on average by 3.2 litres per hectare of utilised agricultural area (UAA) between 2005 and 2016. It is worth emphasizing the very low diesel fuel consumption per ha of UAA among Polish farms participating in the FADN system. In 2016, it was on average 20.32 litres on farms having standard output between 50 and 100 thousand euro, while the diesel consumption was higher on farms with standard output between 8 and 25 thousand euro (32.92 litres). According to normative data, for example published by the Kuratorium für Technik und Bauwesen in der Landwirtschaft [KTBL 2018], the consumption of diesel in one of the simpler activities of rye cultivation in the no-tillage system is 32.57 litres per hectare. Why is this indicator so low on Polish farms? One can only guess.

Analysing the prices and costs of used diesel fuel in farms oriented towards dairy cattle and milk production, it should be noted that, in accordance with the amended policy aimed at refunding excise duty included in the price of diesel used for agricultural production [Journal of Laws, 2015.1340 and 2018. 2244], farmers are granted specific financial support. According to the latest amendment to the abovementioned Act of November 9,

Table 3. Energy costs per 100 kg of milk produced in dairy farms with differentiated economic size from selected EU countries in 2005, 2010 and 2016

Year	Economic size of farms [thous. EUR]	Farms focused on milk production from selected EU countries*						
		DE	PL	NL	DE	IE	GB	DK
		energy costs [EUR/100 kg of milk]						
2005	2-8	-	4.47	-	-	-	-	-
	8-25	-	2.79	-	-	-	-	-
	25-50	4.45	2.31	-	2.11	1.28	-	-
	50-100	3.98	2.09	2.07	2.00	1.24	1.89	-
	100-500	3.31	2.51	1.58	2.13	1.28	1.43	1.34
	above 500	4.01	-	1.42	-	-	1.37	1.50
2010	2-8	-	4.56	-	-	-	-	-
	8-25	-	3.99	-	-	-	-	-
	25-50	6.07	3.02	-	2.35	2.69	-	-
	50-100	4.99	2.77	2.35	2.32	1.87	2.47	-
	100-500	3.72	2.99	1.75	2.25	1.62	1.73	1.63
	above 500	4.46	-	1.69	-	-	1.62	1.66
2016	8-25	-	3.71	-	-	-	-	-
	25-50	6.73	2.90	-	3.12	-	-	-
	50-100	4.69	2.53	-	2.74	1.64	2.36	-
	100-500	3.42	2.37	1.79	2.46	1.21	1.78	1.59
	above 500	3.35	-	1.54	2.84	-	1.56	1.43

\* De – Germany, PL – Poland, NL – Holland, FR – France, IE – Ireland, GB – Great Britain, DK – Denmark

Source: own collaboration based on [INLB 2018]

2018, the refunded amount of excise duty from diesel fuel was determined by quantity of diesel oil purchased for agricultural production (proved by VAT invoices) and the rate of return to 1 litre specified in the regulation of the Council of Ministers of November 27, 2018 [Journal of Laws, 2018. 2313] and in 2019 the refunded amount is equal to PLN 1.00 per litre – 0.23 EUR/l. However, the amount of tax refund cannot be higher than: (1) the amount representing the refund rate per 1 litre of diesel oil multiplied by 100 (maximum diesel oil consumption per ha of UAA) and the area of arable land owned or co-owned by the agricultural producer, as indicated in the Records of Lands and Buildings as of 1 February of a given year, and 2) the amount representing the refund rate per 1 litre of diesel oil, multiplied by 30 (maximum diesel consumption calculated as per one Livestock unit; LU) and the average annual number recalculated Livestock units of cattle owned by the agricultural producer in the year preceding the year in which the tax refund was submitted.

Summing up the presented regulations, in 2019, a farmer will be able to receive subsidies in the amount of PLN 100 to ha UAA (23.5 EUR) and an additional PLN 30 per one LU of cattle (7.05 EUR), if a farmer collects documents confirming the purchase of diesel fuel and submits the application in due time. The presented legal solutions show that the

Table 4. Selected information on the consumption of diesel fuel and electricity by Polish farms targeted at milk production diversified by economic size in 2005, 2010, 2016

Year	Economic size of farms [thous. EUR]	Diesel fuel consumption					Electric energy usage		
		EUR/farm	EUR/ha	EUR/100 litres of milk	litres/ha	litres/100 litres of milk	EUR	EUR/ha	EUR/100 litres of milk
2005	2-8	154.91	26.85	1.17	38.24	1.67	120.28	20.85	0.91
	8-25	284.79	21.21	0.75	30.17	1.07	222.86	16.60	0.59
	25-50	336.56	13.55	0.39	19.14	0.54	423.78	17.07	0.48
	50-100	513.89	11.66	0.28	16.69	0.41	803.74	18.24	0.45
	100-500	812.88	8.04	0.18	11.60	0.26	1,672.16	16.53	0.38
2010	2-8	232.95	36.13	1.89	43.36	2.27	218.72	33.93	1.78
	8-25	355.60	24.91	0.96	30.32	1.17	339.22	23.76	0.91
	25-50	426.94	16.97	0.48	20.67	0.58	598.57	23.80	0.67
	50-100	629.15	14.18	0.32	17.49	0.39	1,120.11	25.26	0.57
	100-500	1,014.80	10.83	0.22	13.50	0.27	2,404.85	25.66	0.52
2016	2-8	167.66	25.55	1.55	30.95	1.87	209.00	31.85	1.93
	8-25	375.08	25.99	0.97	32.92	1.23	344.48	23.87	0.89
	25-50	475.17	19.19	0.48	24.46	0.62	692.49	27.97	0.70
	50-100	666.58	15.76	0.31	20.32	0.40	1,261.17	29.81	0.58
	100-500	1,527.90	18.22	0.27	23.77	0.35	2,867.93	34.19	0.50

Source: own collaboration based on unpublished data from the Polish FADN

maximum use of diesel oil covered by co-financing could be higher in farms maintaining cattle than in farms carrying out other agricultural production. This solution is not very logical. Farms oriented towards cattle breeding usually have a significant share of grassland (usually of a permanent character) in their arable structure. The fodder obtained from this grassland (silage, hay or green forage) requires fewer agro-technical operations, especially of those requiring significant energy expenditure (in the form of used diesel fuel). Hence, it is difficult to find a logical justification for larger diesel fuel refunds to farms oriented towards (dairy) cattle breeding. It is believed that the method of calculating agricultural fuel subsidies, in accordance with the law in force, is a kind of “camouflaged” form of support for this group of farmers. It is not claimed that a group of farmers running very capital-intensive and labour-intensive activities, such as dairy cattle, should fail to receive additional support, however the support should be part of a robust and complex payment system for farms; support based on excise duty refunds may raise doubts.

Quantitative energy consumption has also increased on Polish farms targeted at cattle breeding and milk production, but it is difficult to determine the increase in electric energy consumption, as these data are not obtainable in the FADN system (Table 4). However, taking into account the average increase in electricity prices in the G<sup>3</sup> tariff

<sup>3</sup> The basic tariff for individual recipients.

in 2016 compared to 2005 by 33% [<http://cena-pradu.pl/tabela.html>], and the average increase in electricity costs by 66% among surveyed dairy farms, it can be stated that the consumption of electricity clearly increased in the analysed period. Solar photovoltaic installation is a solution that might enable reductions in the costs of electricity. Large roofs of livestock buildings and the decreasing purchase and installation prices of solar panels encourage farmers to make such investments. The abolition of customs duties on Chinese photovoltaic panels, in the second half of 2018 by the European Union, had an impact on the reduction of these prices. An important component of the price of a photovoltaic power plant is the installation system – the more complicated and developed, the more expensive. At the end of 2018, the prices of complete solar installations for small and medium enterprises fluctuated between PLN 3,300 and PLN 4,000 per 1 kWp, while in 2013 and 2014, these prices were in the range of PLN 5,500 and 6,000 for 1 kWp. In the last 4 years (2014-2018), prices have dropped by 30-40% [Dziaduszyński et al. 2018].

### SUMMARY AND CONCLUSIONS

1. Due to the progressive (conscious and less conscious) need to improve work efficiency by replacing human labour with machines (capital) or replacing less-efficient machines with better ones, the demand for energy is increasing, which among others can translate into rising prices of various energy carriers. This fact is also related to farms focused on cattle and milk production.
2. In farms targeted at cattle breeding and milk production, in the seven analysed EU countries, the average share of “energy” costs in the total costs structure varied (in the separate years 2005, 2010, 2016) from 2.72% in the largest Danish farms in 2016 (SO above EUR 500,000) to 13.08% in the smallest Polish farms in 2005 (SO 2-8 thousand euro). Regardless of the country, an increase in the economic size of farms focused on milk production, resulted in energy cost savings in relation to 100 kg of milk produced.
3. In Polish farms targeted at cattle breeding and milk production, average diesel consumption was at a relatively low level compared to normative values. Nevertheless, it increased by 3.2 litres per hectare of UAA between 2005 and 2016. Costs of electricity increased by 66% between 2005 and 2016 and was caused by increased consumption as well as higher prices.
4. Farmers in Poland, in accordance with the Act on the refund of excise duty included in the price of diesel used for agricultural production receive specific refunds of excise duty. According to the latest amendment to the Act from 2018, cattle receive an additional refund of PLN 30 per one average livestock unit of bred cattle. It is difficult to find a substantive justification for a larger subsidy within the framework of the so-called „agricultural fuel” for farms keeping cattle.
5. Polish farms that keep animals, including dairy cattle, has unused potential (surface) for the installation of solar energy photovoltaic cells. Mounting solar installations on roofs or buildings does not require the need to engage an additional surface, it saves valuable land and enables the generation of necessary means of production, which is electric energy, although the storage of such energy remains an issue.

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KOSZTY ENERGII W GOSPODARSTWACH UKIERUNKOWANYCH  
NA CHÓW BYDŁA MLECZNEGO – OCENA W LATACH 2005-2016

Słowa kluczowe: gospodarstwa mleczne, koszty energii, dopłaty do paliwa, Unia Europejska

## ABSTRAKT

Cele główne artykułu to: 1) przedstawienie zmian kosztów energii w gospodarstwach ukierunkowanych na produkcję mleka i zróżnicowanych wielkością ekonomiczną z wybranych krajów UE w latach 2005-2016; 2) analiza kosztów energii elektrycznej i oleju napędowego w polskich gospodarstwach mlecznych w latach 2005-2016; 3) przedstawienie i ocena obowiązującego w Polsce systemu dopłat do paliwa wykorzystywanego o celów produkcji rolniczej. Podmiotem badań były gospodarstwa mleczne z wybranych krajów UE uczestniczące w systemie FADN. Realizacja trzeciego celu sprowadzała się do krytycznej analizy wprowadzonej w Polsce nowelizacji Ustawy „O zwrocie podatku akcyzowego zawartego w cenie oleju napędowego wykorzystywanego do produkcji rolnej” [Dz.U. z 2015, poz. 1340 oraz z 2018, poz. 2244]. Z przeprowadzonych badań wynika, że w gospodarstwach ukierunkowanych na chów bydła i produkcję mleka w siedmiu analizowanych krajach UE, przeciętny udział kosztów energii w strukturze kosztów całkowitych wahał się (w wyodrębnionych latach 2005, 2010, 2016) od 2,72% w największych gospodarstwach duńskich w 2016 roku do 13,08% w najmniejszych polskich gospodarstwach w 2005 roku. Niezależnie od kraju, wraz ze zwiększeniem wielkości ekonomicznej gospodarstw ukierunkowanych na produkcję mleka, koszty energii w odniesieniu do 100 kg produkowanego mleka malały. Z analizy rozwiązań prawnych wprowadzonych w Polsce wynika, że potencjalnie wyższe dofinansowanie do oleju napędowego wykorzystywanego do produkcji rolniczej będą mogły uzyskać gospodarstwa mleczne. Jest to bardzo dyskusyjne z ekonomicznego punktu widzenia.

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