p-ISSN 0044-1600
e-ISSN 2392-3458

Zagadnienia Ekonomiki Rolnej

www.zer.waw.pl

1(346) 2016, 79-95

JAN PAWLAK
Institute of Technology and Life Sciences
Warsaw Department

DOI: 10.30858/zer/83052

VALUE OF PRODUCTION VERSUS INPUTS AND COSTS OF ENERGY IN AGRICULTURE

Abstract

In 2004-2014, cost of energy consumed in Polish agriculture (in current prices) increased by 50.9%, and energy inputs in TJ decreased by 6.9%. At the same time, value (in current prices) of global agricultural production increased by 51.9%, final production – by 65.6% and commercial production – by 67.7%, and in fixed prices – respectively, by 14.7%, 19.4% and 23.5%. Gross value added in current prices was by 61.7%, and in fixed prices by 7.8% higher than in 2004. Correlation between the value of production and costs of energy in agriculture (in current prices) is positive and the strongest when gross value added is the measure of agricultural production. The adjustment of the model (linear function) describing correlation was good or satisfactory, depending on the adopted category of agricultural production. Whereas the correlation between value of agricultural production in fixed prices and energy inputs in TJ is negative. The model adjustment is in this case unsatisfactory, no matter which category of agricultural production was taken into account.

Keywords: energy, cost, input, agriculture, production, correlation.

Introduction

Human activity is linked to energy inputs in direct and indirect form. Direct inputs cover consumption of fuel and electric energy. In popular understanding, this form is the most present and it will be covered in this paper. However, it needs to be mentioned that there is an intermediate form of energy inputs, connected to the use of means of production which are not its direct carriers. Their production processes – starting from extraction of raw materials and ending with delivery to the place of use – involves incurring energy inputs.

Energy management affects the condition of the environment (Pawlak, 2015a). Decreasing energy-intensity of production, e.g. in agriculture favours its conservation. According to Wójcicki (2010), meeting the requirements regarding decreased energy use and emission of greenhouse gasses and increased use of RES is not possible in the coming 10-15 years, since along with socio-economic development of Poland its fuel and energy needs grow.

Wójcicki draws attention to the need to conduct technical and economic research of changes at farms. Changes taking place in agriculture cause, e.g., changes in the level of income and energy costs in this section of the national economy. The analysis of the condition, direction and dynamics of these changes is necessary to conduct a current assessment of the condition of the factors of production in agriculture and to make comparisons on the regional and international scale. To this end, the authors used indices of the value of these factors referred to the UAA or the number of farms (Pawlak, 2015b). Analysis of changes in these inputs over time is also vital as a starting point for forecasting their level in the future. What is necessary to do this, is the knowledge of factors influencing the level of these inputs and their strength of impact. Such factors include, e.g.: level of mechanisation and motorisation, and in case of partial analyses of (cumulative) energy inputs – also its technology considering intermediate energy consumption in the form of fertilisers, fodders, plant protection products and other means of production. Energy consumption in the form of its direct carriers (fuels and electric energy) depends on the intensity and technology of agricultural production, and on work organisation, technical condition of energy recipients, soil and weather conditions. The costs of the used energy depend, apart from that, directly on the prices of its carriers.

It can be assumed that if other conditions are unchanged, the value of inputs and costs of energy in agriculture will be proportional to the production value in this section of the national economy. The yield increases in crop production are directly linked to a growth in energy inputs during harvest and transport of crops. However, in case of a decrease or loss in yields, as a result of bad weather conditions, inputs involved in performance of energy-intensive cultivation works and fertilisation remain at the same level, despite a decrease in production value. Hence, the assumption presented above, which in this publication was taken as a working hypothesis, is not straightforward and requires to be checked out by relevant tests.

The importance of the economic aspect in the assessments of the condition of the energy management justifies purposefulness of the analyses of energy inputs and costs. Such analyses are most often conducted on the scale of farms or groups thereof, or within individual types of farming. But they should be also performed on the country scale (Pawlak, 2013). This research is based on the publications of the Central Statistical Office (Polish: *Główny Urząd Statystyczny*, *GUS*).

This paper attempts at definition of correlations between the values of four categories of production and the level of direct energy inputs and costs in the Polish agriculture. The time scope of the analysis covers the 2004-2014 period.

Initial data and methodical assumptions

Looking for the possibility of rationalisation of energy management in agriculture, the authors applied methods of assessing energy-intensity of agricultural production (Wójcicki, 2015b). Research held with their use shows the current condition of the energy management in agriculture, and methods and possibilities of its improvement (Wójcicki, 2015a). Energy has a major share in the production inputs of agriculture. The issue of researching material and energy inputs in the group of 53 family farms was taken up by Wójcicki and Rudeńska (2013; 2014). Studies held in these farms showed that the share of energy carriers used in expenditures incurred by these farms in 2009 amounted to 11.8% and in 2010 it grew to 13.0% (Wójcicki and Rudeńska, 2013). Data on the energy costs incurred by farms are also included in other publications. In most of them, these are referred to the costs of mechanisation. At farms researched by Kocira and Sawa (2005) energy accounted for 36% of operating costs of means of agricultural mechanisation, ranking second as regards depreciation. Similar results were obtained also by other researchers (Tabor, 2001; Wójcicki, 1999). Another source of information on energy costs in agriculture are publications, which use the results of agricultural accounting research held by the Institute of Agricultural and Food Economics – National Research Institute (Goraj and Mańko 2011; Mańko, 2011).

This paper uses statistics informing on the use of energy in agriculture published by the Central Statistical Office. Energy inputs in publications by GUS (2005, 2006, 2007, 2008a, 2009, 2010, 2011a, 2012, 2013, 2014, 2015a) are given in natural units (tonnes, m^3) and in energy units (terajoules, TJ), considering the calorific value of individual energy carriers. Values expressed in terajoules can be summed up and the obtained sums are the measure of the level of energy inputs in the next years. In the study of correlations, being the subject of this paper, they are a point of reference for the value of agricultural production (global, final and commercial production, and gross value added) in fixed prices. In the publications by GUS (2008b, 2011b, 2015b, c, d) the value of agricultural production is given in current prices. Changes in the level of production in fixed prices are given in the form of percentage indices referring, e.g., to the former years taken as 100. On the basis of the data, it is possible to estimate the value of respective agricultural production categories in fixed prices from the year starting the period covered by the analysis, in this case it was 2004. The calculations used the following formula:

$$W_{ksr} = \frac{W_{ksr-1} \cdot a_{ksr}}{100} \tag{1}$$

where:
W_{ksr} – value of the k-th production category in fixed prices in the r-th year (PLN),
W_{ksr-1} – value of the k-th production category in fixed prices last year (PLN),
a_{ksr} – percentage index characterising the growth rate of the value of the k-th agricultural production category in fixed prices in the r-th year to the last year (%).

Given the probable rounding up of the values of the indices a_{ksr}, put forward by GUS, the results of calculations using the above-procedure can be biased by error and should be treated as estimates. In order to check the scale of error, the values of the index in 2014 for all of the considered production categories were calculated with reference to 2005 and they were compared to similar indices given in the publications by GUS (2015b, c). It was stated that the value of error was below 0.4%. On this basis, it was assumed that the obtained agricultural production values in fixed prices can be used in research of correlations between the energy inputs in TJ and the agricultural production value.

In the calculations of costs of energy used in agriculture in current prices, what was used was information on purchase prices of energy carriers in a section covering agriculture, forestry, hunting and fisheries, measured with the use of the weighted arithmetic mean method (GUS 2005, 2006, 2007, 2008a, 2009, 2010, 2011a, 2012, 2013, 2014, 2015a). The range of products was limited to those energy carriers used in agriculture, for which purchase prices in respective years of the period covered by the analysis are available in GUS publications. These are: black coal, brown coal, coke, diesel oil, light fuel oil, heavy fuel oil, gasoline, Liquefied Petroleum Gas (LPG), methane-rich natural gas and nitrogen-rich natural gas, electric and thermal energy. Due to a lack of the necessary data, some types of fuel were omitted, such as: wood and coal peat, solid waste fuel, coal briquettes. Their consumption is considered in GUS publications, but there is no information on their purchase prices in agriculture, forestry, hunting and fisheries. Among fuels not included in this analysis only wood and coal peat have a major share in the structure of energy inputs in agriculture. In 2000-2011, energy carriers considered in this analysis constituted from 84.1% to 88.6% (average 86.8%) of total energy inputs in agriculture (Pawlak, 2013). Hence, they provided a sufficient representation in research of energy cost changes in this section of the national economy.

In GUS publications, the prices of energy carriers are in most of the cases referred only to the values expressed in natural units. Bearing in mind that data in natural units (tonnes, m^3) area rounded up to total values, other values in TJ correspond to energy carriers of fairly low level of consumption of the same value in natural units. Considering the above and the fact that the data in units referring to the calorific value are more precise, they were taken as the basis for calculating energy costs. Because the average weighted costs of energy carriers' purchase in GUS publications refer to the inputs in natural units, it was necessary to calculate prices per 1 TJ of energy included in 12 energy carriers considered in this analysis. To this end, the following formula was used:

$$Ce_n = \frac{Cn_n}{Wo_n} \tag{2}$$

where:
Ce_n – price for unit of the calorific value of the n-th energy carrier ($PLN \cdot TJ^{-1}$),
Cn_n – price for natural unit of the n-th energy carrier ($PLN \cdot t^{-1}$, $PLN \cdot l^{-1}$, $PLN \cdot 1{,}000\ m^{-3}$, $PLN \cdot MWh^{-1}$, $PLN \cdot TJ^{-1}$),
Wo_n – calorific value of measuring unit of the n-th energy carrier ($TJ \cdot t^{-1}$, $TJ \cdot 1{,}000\ m^{-3}$, $TJ \cdot MWh^{-1}$).

During calculations, the following indices of calorific value of energy carriers were taken, which are identical for the entire period covered by the analysis:
- black coal 0.240 $TJ \cdot t^{-1}$,
- brown coal 0.083 $TJ \cdot t^{-1}$,
- coke 0.280 $TJ \cdot t^{-1}$,
- light fuel oil 0.4374 $TJ \cdot t^{-1}$,
- heavy fuel oil 0.407 $TJ \cdot t^{-1}$,
- diesel oil 0.4333 $TJ \cdot t^{-1}$,
- gasoline 0.4479 $TJ \cdot t^{-1}$,
- Liquefied Petroleum Gas (LPG) 0.473 $TJ \cdot t^{-1}$,
- methane-rich natural gas 0.359 $TJ \cdot 1{,}000\ m^{-3}$,
- nitrogen-rich natural gas 0.250 $TJ \cdot 1{,}000\ m^{-3}$,
- electric energy 0.0036 $TJ \cdot MWh^{-1}$.

When GUS publications give prices for purchase of energy carriers in PLN per litre and the calorific value is referred to the weight unit (tonne), additional calculations are necessary. For this purpose the following formula was used:

$$Ce_n = \frac{1000 \cdot Cn_n}{M_n \cdot Wo_n} \tag{3}$$

where:
Cn_n – price of unit of measurement of the n-th energy carrier ($PLN \cdot dm^{-3}$),
M_n – mass density (density) of the n-th energy carrier ($kg \cdot dm^{-3}$).

The following values of mass density were taken in the calculations: for diesel oil – 0.840 $kg \cdot dm^{-3}$, and for gasoline – 0.755 $kg \cdot dm^{-3}$.

The costs of energy carriers used in agriculture were calculated with the use of the formula:

$$Ke_r = \sum_{n=1}^{k} Ne_{nr} \cdot Ce_{nr} \quad (4)$$

where:

Ke_r – cost of energy carriers used in the r-th year (PLN),

Ne_{nr} – consumption of the n-th energy carrier in agriculture in the r-th year (t, m^3, MWh, GJ),

Ce_{nr} – price of a unit of measurement of the n-th energy carrier in agriculture in the r-th year ($PLN \cdot t^{-1}$, $PLN \cdot dm^{-3}$, $PLN \cdot 1{,}000\ m^{-3}$, $PLN \cdot MWh^{-1}$, $PLN \cdot TJ^{-1}$).

In studies on correlations between the energy costs and the agricultural production value, the values of individual categories of production were in current prices.

Research results and analysis

In 2014, energy inputs in the Polish agriculture were by 6.9% lower than in 2004. At the same time, the value (in current prices) of global agricultural production grew by 14.7%, final production – by 19.4% and commercial production – by 23.5%. The gross value added was by 7.8% higher than in 2004 (Table 1).

A decrease in the absolute value of energy inputs in agriculture complies with the statement by Wójcicki (2010) that, contrary to the energy needs of the country and non-agricultural part of rural areas, the energy needs of commercial farms will drop, regardless of a projected growth in the final production of the Polish agriculture by 2030. The energy-intensity of agricultural production declines and will continue to decline along with changes in the agrarian structure and production intensification at commercial family farms. Despite that, energy consumption, especially of liquid fuels per unit of decreasing UAA and electric energy per LU of stocking density, will slowly grow along with a growth in the technical condition of agricultural equipment. Dynamics of the growth will be hindered by economic factors forcing savings and rationalisation of energy management, for instance, through better design of tractors and farm machines and their better operation (Zalewski (ed.), 2015).

Table 1

Energy inputs and production value in the Polish agriculture (fixed prices)

Years	Cost of used energy (TJ)	Global production	Gross value added	Final production	Commercial production
		PLN million			
2004	154,121	69,747.7	25,547.3	53,456.5	46,227.3
2005	161,523	66,748.5	23,937.8	51,104.4	44,100.8
2006	162,171	65,947.6	22,956.4	51,104.4	45,953.1
2007	148,171	69,838.5	24,792.9	53,966.3	46,642.4
2008	150,711	72,073.3	25,759.8	55,909.0	49,487.6
2009	148,833	73,803.1	28,258.5	57,586.3	51,021.7
2010	159,888	71,810.4	27,919.4	56,031.5	50,205.3
2011	154,394	73,390.2	27,668.1	58,048.6	52,113.1
2012	153,797	72,729.7	27,031.8	57,468.1	52,738.5
2013	159,074	75,420.7	30,383.7	61,146.1	55,428.2
2014	143,559	80,021.4	27,527.6	63,836.5	57,091.0

Source: own study on the basis of data from GUS (2006, 2007, 2008a, b, 2009, 2010, 2011a, b, 2012, 2013, 2014, 2015a, b, c, d).

In 2004-2014, UAA in Poland dropped by 10.8% and the number of farms by 24.9%. Therefore, despite a drop in the absolute value of energy inputs in the Polish agriculture, their value per 1 ha of UAA was in 2014 by 4.5% higher than in 2004. Decrease in the number and increase in the average area of farms caused also a growth in the value of the index of energy inputs per one farm. In 2014, the value of the index was by 22.42% higher than in 2004.

In 2004-2014, the cost of energy consumed in the Polish agriculture (in current prices) increased by 50.9%. At the same time, the value of global agricultural production grew by 51.9%, final production – by 65.6% and commercial production – by 67.7%. The gross value added was by 61.7% higher than in 2004 (Table 2).

The correlation between energy costs and the value of global agricultural production in current prices is positive and quite strongly marked (Fig. 1).

The positive correlation between energy costs and the gross value generated in agriculture is stronger (Fig. 2).

The positive correlation between the value of final production and energy costs in agriculture (Fig. 3) is somewhat stronger than in the case of taking global agricultural production as the representative of production, but clearly weaker than the one presented in Figure 2, which shows the correlation between energy costs and gross value added.

Table 2

Cost of used energy and value of production in the Polish agriculture (current prices)

Years	Cost of used energy	Global production	Gross value added	Final production	Commercial production
	PLN million				
2004	6,120.7	69,747.7	25,547.3	53,456.5	46,227.3
2005	7,316.3	63,337.3	22,321.8	50,141.3	42,907.0
2006	7,334.6	65,081.7	22,499.9	51,564.3	45,897.2
2007	7,076.3	81,531.0	29,165.7	61,307.5	52,520.5
2008	7,388.5	83,126.5	27,064.0	63,523.9	56,265.0
2009	7,162.8	79,706.6	27,466.6	63,526.0	56,177.6
2010	8,151.3	84,484.2	31,177.3	66,518.9	59,357.1
2011	9,856.0	100,674.4	41,702.0	79,096.6	71,263.1
2012	10,792.2	103,114.0	40,721.7	81,671.6	74,966.7
2013	10,460.8	107,810.0	46,775.8	88,565.4	80,304.1
2014	9,233.9	105,974.0	-	88,504.0	77,504.0

Source: data from GUS (2006, 2007, 2008a, b, 2009, 2010, 2011a, b, 2012, 2013, 2014, 2015a, b, c, d) and own calculations.

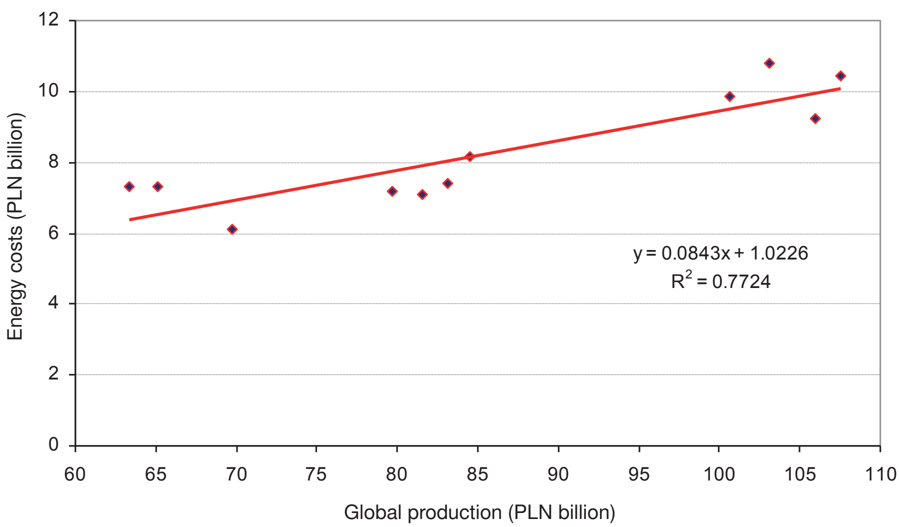

Fig. 1. Value of global production versus energy costs in agriculture.

Source: own study on the basis of data from GUS (2005, 2006, 2007, 2008a,b, 2009, 2010, 2011a, b, 2012, 2013, 2014, 2015a, b, c).

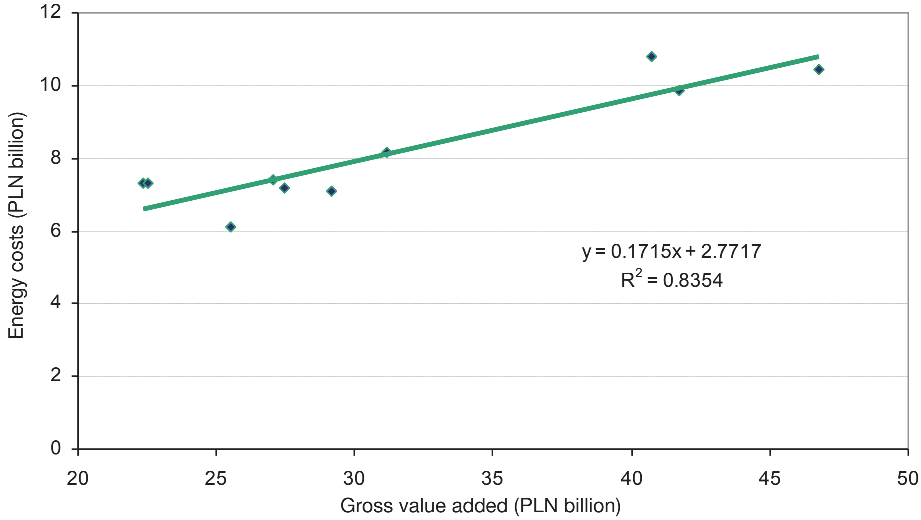

Fig. 2. Gross value added versus energy costs in agriculture.

Source: own study on the basis of data from GUS (2005, 2006, 2007, 2008a, b, 2009, 2010, 2011a, b, 2012, 2013, 2014, 2015a, b, c).

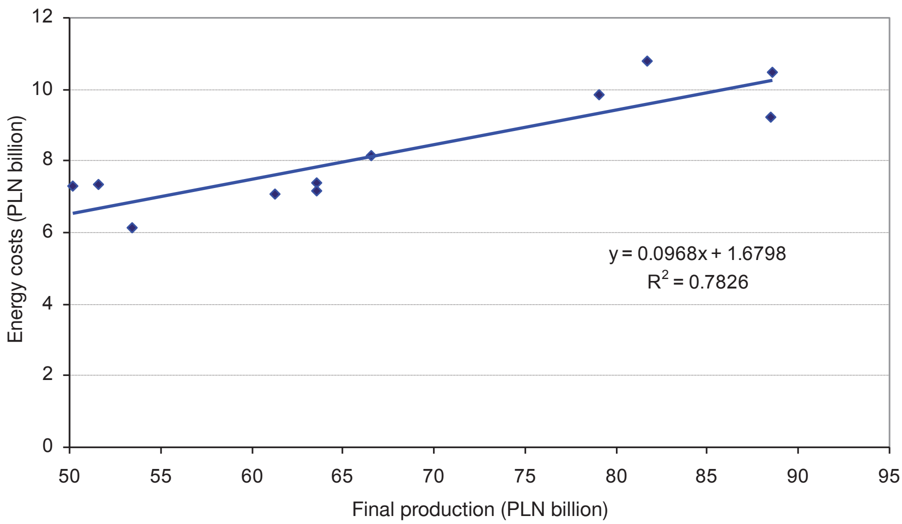

Fig. 3. Value of final production versus energy costs in agriculture.

Source: own study on the basis of data from GUS (2005, 2006, 2007, 2008a,b, 2009, 2010, 2011a, b, 2012, 2013, 2014, 2015a, b, c).

The correlation, presented in Figure 4, between the commercial production value and energy costs is stronger than illustrated by Figures 1 and 3, where agricultural production is represented by global and final production, but weaker than in Figure 2, where gross value added was the representative.

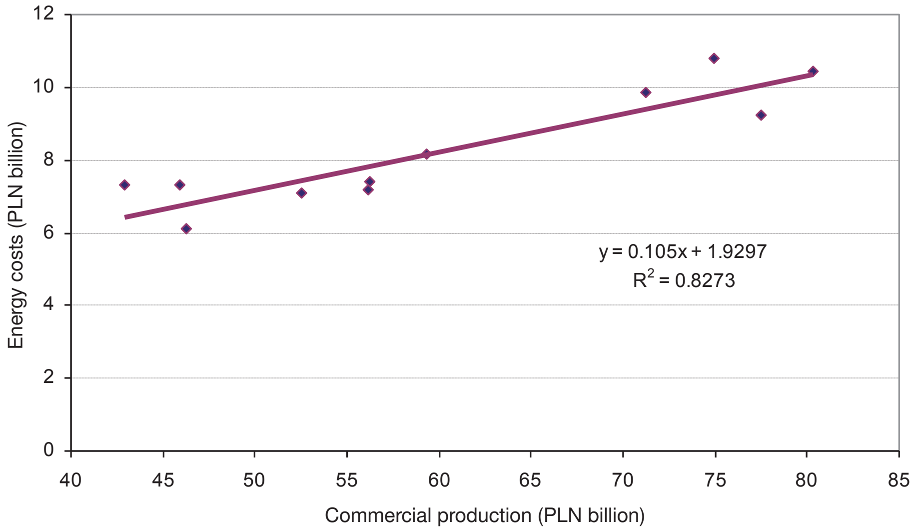

Fig. 4. Value of commercial production versus energy costs in agriculture.

Source: own study on the basis of data from GUS (2005, 2006, 2007, 2008a, b, 2009, 2010, 2011a, b, 2012, 2013, 2014, 2015a, b, c).

In all of the discussed cases a positive correlation between the researched variables was noted. Moreover, in all of the cases the value of the coefficient of determination (0.77-0.84) attests to the fact that the level of energy costs in agriculture, apart from the agricultural production value, was influenced also by other factors, e.g. volatility of weather conditions in respective years and rationalisation of energy management in agriculture. It can be, however, stated that relevant models (in the form of linear functions) were sufficiently or well--adjusted and the correlation between the gross value added and the value of agricultural production is the strongest in the case of taking the gross value added as the representative.

Whereas energy inputs in TJ, corresponding to its fixed costs, in general, showed a downward trend and were in 2014 by 6.9% lower than in 2004. Thus, the correlation between the value of agricultural production in fixed prices and energy inputs is negative, but much weaker than between the value of agricultural production and energy costs in current prices. Adjustment of the model describing this correlation in the form of a linear function is, in this case, unsatisfactory regardless of which of the considered production categories was taken as the representative of agricultural production. It is fairly best pronounced when global production is the representative of agricultural production (Fig. 5).

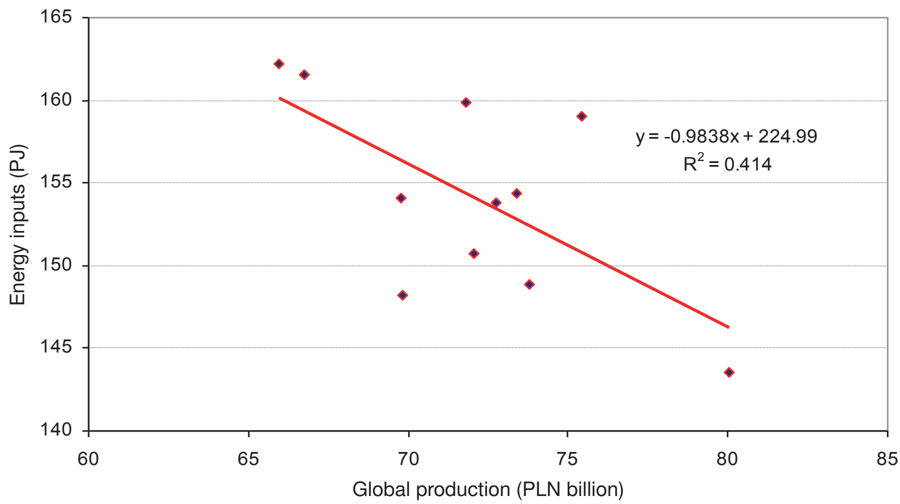

Fig. 5. Value of global production versus energy inputs in agriculture.

Source: own study on the basis of data from GUS (2005, 2006, 2007, 2008a, b, 2009, 2010, 2011a, b, 2012, 2013, 2014, 2015a, b, c).

In case of final and commercial production, the correlation is much less visible (the values of the coefficient of determination R^2 of linear functions describing these correlations amount, respectively, to 0.30 and 0.19). For gross value added, such a correlation is virtually non-existent ($R^2 = 0.02$).

As evident, depending on the adopted basis for calculations (fixed prices and energy costs or fixed prices and energy inputs), the correlations are radically different, which may be surprising. One of the reasons for the differences is varied share of energy carrier having the broadest application in agriculture, i.e. diesel oil, in the structure of energy costs and inputs. Its consumption in respective years of the period covered by the analysis fluctuated, but showed an upward trend in general. In 2014, it was by 6.9% higher than in 2004 (Fig. 6).

The use of other energy carriers decreased, though, but only when considered jointly. The consumption of black and brown coal, coke and thermal energy changed depending on the weather in winter season and on the relationship between energy carriers. Whereas the methane-rich natural gas consumption was in 2014 by 59.1% higher than in 2004, but its share in the structure of energy inputs in agriculture in the period covered by the analysis did not exceed 1.2%.

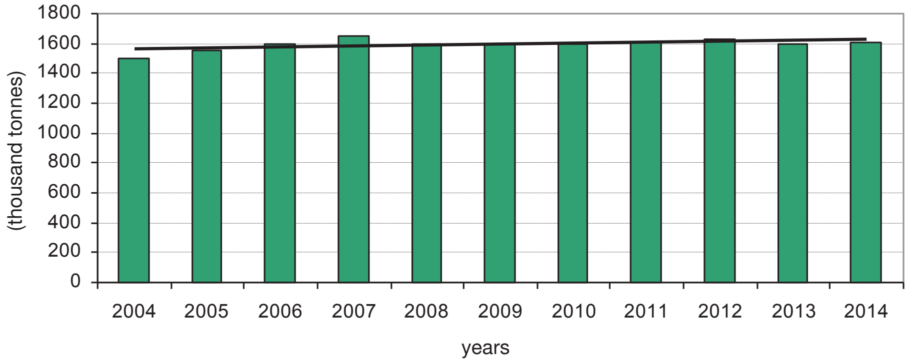

Fig. 6. Diesel oil consumption in the Polish agriculture.

Source: own study on the basis of data from GUS (2005, 2006, 2007, 2008a, 2009, 2010, 2011a, 2012, 2013, 2014, 2015a).

Diesel oil definitely prevailed in the structure of energy costs, with the share of more than three quarters of the total costs of energy used in agriculture (Fig. 7).

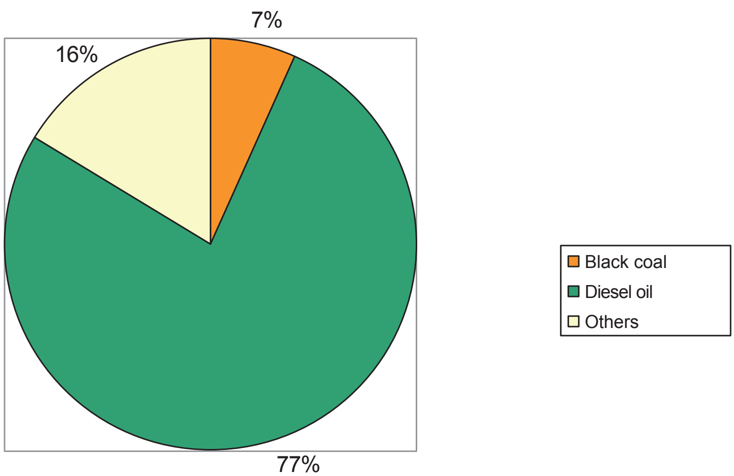

Fig. 7. Share of diesel oil and coal in the structure of energy costs in agriculture.

Source: own study on the basis of data from GUS (2005, 2006, 2007, 2008a, 2009, 2010, 2011a, 2012, 2013, 2014, 2015a).

In the structure of energy inputs, the share of diesel oil is by 32 percentage points lower, while the share of considerably cheaper coal is higher by 20 percentage points (Fig. 8).

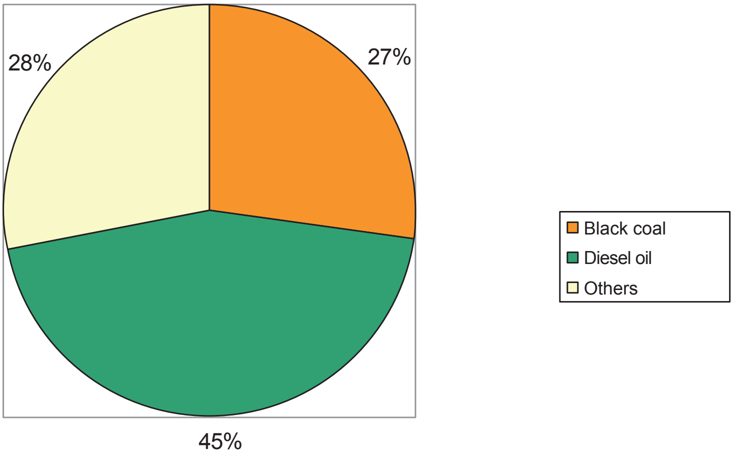

Fig. 8. Share of diesel oil and coal in the structure of energy inputs in agriculture.

Source: own study on the basis of data from GUS (2005, 2006, 2007, 2008a, 2009, 2010, 2011a, 2012, 2013, 2014, 2015a).

Despite the trends to lower the total energy consumption in agriculture, the consumption grows per area unit of UAA and per one farm (Pawlak, 2016). This is caused by limited UAA and number of farms, and also by intensification of agricultural production. The requirements linked to the need to reduce the greenhouse gas emissions and economic aspects will force increasingly more frugal energy management. Lower energy inputs in agriculture can be obtained, e.g., by the use of energy efficient technologies in crop and livestock production. In crop production, the highest energy inputs are incurred during soil cultivation and harvest and transport of crops. Rationalisation thereof favours better efficiency of energy inputs. The use of conservation tillage, consisting in shallow tillage with the use of multi-purpose farm machines and rotary cultivators (developed by the Masovian Research Centre of the Institute of Technology and Life Sciences), instead of traditional farming with the use of ploughing, causes a reduction in fuel consumption for field works in five-year rotation: wheat – sugar beets – maize – rye – winter rape from 240.1 to 105.7 $l \cdot ha^{-1}$, and energy inputs per area unit – from 1,197 to 575 $MJ \cdot ha^{-1}$ (Golka and Ptaszyński, 2014). According to Sørensena et al. (2014), the minimum tillage causes a reduction in the energy inputs in crop production in the conditions of four-year rotation (spring barley – winter barley – winter wheat – winter rape) by 26%, and in case of no tillage system – 41%.

Summary

In 2004-2014, the cost of energy consumed in Polish agriculture (in current prices) increased by 50.9%, and energy inputs in TJ decreased by 6.9%.

In the period covered by the analysis, value (in current prices) of global agricultural production increased by 51.9%, final production – by 65.6%, commercial production – by 67.7%, and in fixed prices – respectively by 14.7%, 19.4% and 23.5%.

Correlation between the value of production and costs of energy in agriculture (in current prices) is positive and the strongest when gross value added is the measure of agricultural production. The values of the coefficient of determination (0.77-0.84) attest to the fact that the level of energy costs in agriculture, apart from the value of agricultural production, also had impact on other factors, e.g. rationalisation of energy management in agriculture, and allow for a statement that respective functions describing these correlations were sufficiently or well-adjusted.

The correlation between the value of agricultural production in fixed prices and energy inputs in TJ is negative. Adjustment of the model describing this correlation in the form of a linear function is, in this case, unsatisfactory regardless of which of the considered production categories was taken as the representative of agricultural production.

The working hypothesis, assuming that there is a positive correlation between the value of production and inputs, and energy costs was only partly confirmed, when the research covered the correlation between the value of agricultural production and energy costs in current prices.

References

Golka, W., Ptaszyński S. (2014). Nakłady na uprawę roli w technologii zachowawczej i tradycyjnej. *Problemy Inżynierii Rolniczej*, no. 3(86), pp. 31-47.

Goraj, L., Mańko, S. (2011). Model szacowania pełnych kosztów działalności gospodarstw rolnych. *Zagadnienia Ekonomiki Rolnej*, no. 3, pp. 28-58.

GUS (2005). *Rocznik Statystyczny Rolnictwa i Obszarów Wiejskich 2005*. Warszawa: Zakład Wydawnictw Statystycznych, p. 485.

GUS (2006). *Gospodarka paliwowo-energetyczna w latach 2004, 2005. Informacje i opracowania statystyczne*. Warszawa. ISSN 1896-7809 p. 249.

GUS (2007). *Gospodarka paliwowo-energetyczna w latach 2005, 2006. Informacje i opracowania statystyczne*. Warszawa, p. 249.

GUS (2008a). *Gospodarka paliwowo-energetyczna w latach 2006, 2007. Informacje i opracowania statystyczne*. Warszawa, p. 249.

GUS (2008b). *Rocznik Statystyczny Rolnictwa i Obszarów Wiejskich 2007*. Warszawa: Zakład Wydawnictw Statystycznych, p. 493.

GUS (2009). *Gospodarka paliwowo-energetyczna w latach 2007, 2008. Informacje i opracowania statystyczne*. Warszawa, p. 276.

GUS (2010). *Gospodarka paliwowo-energetyczna w latach 2008, 2009. Informacje i opracowania statystyczne*. Warszawa, p. 370.

GUS (2011a). *Gospodarka paliwowo-energetyczna w latach 2009, 2010. Informacje i opracowania statystyczne*, p. 290.

GUS (2011b). *Rocznik Statystyczny Rolnictwa 2010*. Warszawa: Zakład Wydawnictw Statystycznych, p. 389.

GUS (2012). *Gospodarka paliwowo-energetyczna w latach 2010, 2011. Informacje i opracowania statystyczne*. Warszawa, p. 294.

GUS (2013). *Gospodarka paliwowo-energetyczna w latach 2011, 2012. Informacje i opracowania statystyczne*. Warszawa, p. 290.

GUS (2014). *Gospodarka paliwowo-energetyczna w latach 2012, 2013. Informacje i opracowania statystyczne*. Warszawa, p. 298.

GUS (2015a). *Gospodarka paliwowo-energetyczna w latach 2013, 2014. Informacje i opracowania statystyczne*. Warszawa, p. 294.

GUS (2015b). *Mały Rocznik Statystyczny Polski 2015*. Warszawa: Zakład Wydawnictw Statystycznych, p. 539.

GUS (2015c). *Rocznik Statystyczny Rolnictwa 2014*. Warszawa: Zakład Wydawnictw Statystycznych, p. 445.

GUS (2015d). *Rocznik Statystyczny Rzeczpospolitej Polskiej 2015*. Warszawa: Zakład Wydawnictw Statystycznych, p. 907.

Kocira, S., Sawa, J. (2005). Koszty mechanizacji w gospodarstwach o różnej wielkości ekonomicznej. *Inżynieria Rolnicza*, no. 6, pp. 321-328.

Mańko, S. (2011). Koszty i opłacalność produkcji ziemniaków w świetle wyników polskiego FADN. *Ziemniak Polski*, no. 4, pp. 8-13.

Pawlak, J. (2013). Koszty energii w rolnictwie polskim. *Zagadnienia Ekonomiki Rolnej*, no. 3, pp. 83-98.

Pawlak, J. (2015a). Rolnictwo a środowisko naturalne. *Problemy Inżynierii Rolniczej,* no. 1(87), pp. 17-28.

Pawlak, J. (2015b). Zużycie energii w rolnictwie polskim w latach 2009-2013. *Problemy Inżynierii Rolniczej*, no. 1(87), pp. 29-40.

Pawlak, J. (2016). Nakłady energii a liczba gospodarstw i powierzchnia użytków rolnych 13. *Problemy Inżynierii Rolniczej*, no. 2(92), in print.

Sørensen, C.G., Halberg, N., Oudshoorn, F.W., Petersen, B.M., Dalgaard, R. (2014). Energy Inputs and GHG Emissions of Tillage Systems. *Biosystems Engineering*, vol. 120, pp. 2-14.

Tabor, S. (2001). Koszty mechanizacji produkcji rolniczej. *Problemy Inżynierii Rolniczej*, no. 4, pp. 113-119.

Wójcicki, Z. (1999). Koszty mechanizacji produkcji rolniczej. *Inżynieria Rolnicza*, no. 4, pp. 21-28.

Wójcicki, Z. (2010). Potrzeby energetyczne i wykorzystanie odnawialnych zasobów energii. *Problemy Inżynierii Rolniczej*, no. 4, pp. 37-47.

Wójcicki, Z. (2014). Wyposażenie techniczne badanych gospodarstw rodzinnych. *Problemy Inżynierii Rolniczej*, no. 4(86), pp. 31-41.

Wójcicki, Z. (2015a). Badanie energochłonności produkcji rolniczej. *Problemy Inżynierii Rolniczej*, no. 4(90).

Wójcicki, Z. (2015b). Metodyka badania energochłonności produkcji rolniczej. *Problemy Inżynierii Rolniczej*, no. 4(90).

Wójcicki, Z., Rudeńska, B. (2013). Rozchody i dochody w badanych gospodarstwach rodzinnych. *Problemy Inżynierii Rolniczej*, no. 2, pp. 43-54.

Wójcicki, Z., Rudeńska, B. (2014). Efektywność nakładów materiałowo-energetycznych w gospodarstwie rolnym. *Problemy Inżynierii Rolniczej*, no. 4(86), pp. 57-70.

Zalewski, A. (ed.) (2015). *Rynek środków produkcji dla rolnictwa. Stan i perspektywy,* no. 42. Warszawa: IERiGŻ-PIB, ARR, MRiRW, p. 45.

JAN PAWLAK
Instytut Technologiczno-Przyrodniczy
Oddział w Warszawie

WARTOŚĆ PRODUKCJI A NAKŁADY I KOSZTY ENERGII W ROLNICTWIE

Abstrakt

W latach 2004-2014 koszt energii zużytej w rolnictwie polskim (w cenach bieżących) zwiększył się o 50,9%, a nakłady energii w TJ – zmniejszyły się o 6,9%. W tym samym czasie wartość (w cenach bieżących) produkcji globalnej rolnictwa wzrosła o 51,9%, produkcji końcowej – o 65,6%, produkcji towarowej – o 67,7%, a w cenach stałych – odpowiednio o 14,7, 19,4 i 23,5%. Wartość dodana brutto w cenach bieżących była o 61,7% większa niż w 2004 r., a w cenach stałych o 7,8% większa niż w 2004 r. Współzależność między wartością produkcji a kosztami energii w rolnictwie (w cenach bieżących) jest dodatnia i najsilniej zaznaczona, gdy miernikiem produkcji rolniczej jest wartość dodana brutto. Dopasowanie modelu (funkcji liniowej) opisującego tę zależność, jest dobre lub zadowalające, zależnie od przyjętej kategorii produkcji rolniczej. Natomiast współzależność między wartością produkcji w cenach stałych a nakładami energii w TJ jest ujemna. Dopasowanie modelu jest w tym przypadku niezadowalające, niezależnie od przyjętej kategorii produkcji rolniczej.

Słowa kluczowe: energia, koszt, nakład, rolnictwo, produkcja rolnicza, współzależność.

Accepted for print: 07.04.2016.

Unless stated otherwise all the materials on the website are available under the Creative Commons Attribution 3.0 Poland license. Some rights reserved to the Institute of Agricultural and Food Economics – National Research Institute.