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DEPENDANCE OF ENERGY INPUTS ON AREA AND ECONOMIC SIZE OF FAMILY FARMS

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ABSTRACT

The objective of the paper is defining the influence of agricultural land area (AL) and economic size on energy inputs in family farms that are beneficiaries of European Union funding. 70 farms of Biłgoraj County that were beneficiaries of EU funding for technical modernization were researched within 2004-2009. In order to define energy inputs, the group of farms that were the object of the research were divided according to the amount of subsidy, area of agricultural land, economic size (ESU) and the income of an enterprise. In the process of characterizing the researched farms according to the level of possessed energy means, tractors, self-propelled combine harvesters and electric engines used in the process of farm production were taken into account, including also the ones mounted in the equipment operated in the farms. The level of energy inputs in the researched farms calculated into area unit was decreasing systematically, both when the amount of funding increased, as well as area, economic size and income of an enterprise. In the group of farms according to the economic size, when its size increased, energy inputs decreased, and the tendency remained the same in farms of the highest income of an enterprise. In farms of a small area (up to 10 ha) of agricultural land (AL), apart from high level of specific labour input, there were high inputs of manual labour.

Introduction

Agriculture technology implementation is connected with installing in the equipment or purchasing for a farm independent energy means, mainly combustion or electric ones. The main source of power in farms are tractors, and then self-propelled farm machines and engines working within the farm (Wasąg, 2011). Energy inputs are observable mainly in the form of manual labour and work of combustion or electric engines. Labour costs increase and decreasing relations between agricultural products and means of production make necessary changes in farms organization. In order to increase a family income, one should extensively organize and manage in an intense manner (Sawa, 1998). Technical condition and structure of possessed mechanization means in specific (organizational and economic)

production conditions influence labour process and define effectiveness of managing in a farm, which plays a major role in the farmers' decision making process on investment purchase and their sources of financing (Sawa, 1994; Wójcicki and Pawlak, 1996; Kocira and Sawa, 2008). The process of improving technical modernization of farms requires increasing the level of labour process mechanization, with the assumption however, that it will have a positive influence on the whole farm production process, including the environment. Production factors are always combined with manual labour impact, they are defined as production means of production process, which are presented in relation of production means (capital) to labour force (labour). For this reason, it is necessary to „equip" labour (man-hour) and work-place (of a man), in order to achieve high effectiveness of farm production mechanization (Kocira and Sawa, 2008).

The objective of the paper is to define the influence of agricultural land area (AL) and economic size on energy inputs in family farms that are beneficiaries of European Union funding.

Material and methodology of the research

In the years 2004–2009 70 farms of Biłgoraj County that were beneficiaries of EU funding for technical modernization were researched. In order to define energy inputs, the group of farms under the research were divided according to the amount of subsidy, area of agricultural land, economic size (ESU) and the income of an enterprise. In the process of characterizing the researched farms according to the level of possessed energy means, tractors, self-propelled combine harvesters and electric engines used in the process of farm production were taken into account, including also the ones mounted in the equipment operated in the farms (e.g. machinery used for re-loading, for preparing pastures, milking machines and milk cooling machines).

Process mechanization level of work in the farms was assumed according to Zaremba (Pawlak and Wójcicki, 1993; Zaremba, 1985; 1986):

$$W = \frac{0{,}2\,L_m}{L_o + 0{,}2\,L_m} \cdot 100 \tag{1}$$

where:
W – mechanization level (%),
L_m – total energy inputs of mechanical means (kWh),
L_o – total inputs of manual labour (man-hour),
0,2 – coefficient balancing specific labour (kWh) with manual labour (man-hour).

The increase of mechanization level coefficient in the period when the research was conducted, was recognized as an effectiveness proof for farmer's action. Apart from this, the coefficient characterises the labour process because it defines percentage share of specific labour in the process execution.

Energy share of specific labour that accompanies every man-hour may constitute the coefficient that defines the character of executed work (Sawa, 2009):

$$U_{ep} = \frac{L_m}{L_r} \tag{2}$$

where:
U_{ep} – work energetic equipment (kWh·man-hour^{-1}),
L_m – specific labour inputs (kWh),
L_r – manual labour inputs (man-hour).

Research results

The highest installed power (kW·100 ha^{-1} AL) was observed in the smallest farms in each researched group (table 1) and was decreasing along with their increase (e.g. of area: from 1241 up to 454 kW·100 ha^{-1} AL). The exception were farms of economic size of 8-16 ESU, where installed power in relation to the lower group (up to 8 ESU) increased from 968 to 1030 kW·100 ha^{-1} AL. However, specific labour inputs only in the group of farms placed according to their area were fluctuating, and they were higher in the group of farms of above 70 ha AL (1398 kWh·ha^{-1} AL) than 50-70 ha AL (999 kWh·ha^{-1} AL). Farms for which the subsidy amount was higher than PLN 150 thousand (table 1) had the highest average area (68.6 ha AL) and the lowest for this group coefficient of installed power (562 kW·100 ha^{-1} AL). Specific labour inputs in calculation to a working hour amounted to 42.41 kWh·man-hour^{-1} and they were only slightly lower than in farms of the area above 70 ha AL (51.48 kWh·man-hour^{-1}). It gets reflected in manual labour inputs that for a farm of the subsidy amount above PLN 150 thousand (80 man-hour·ha^{-1} AL) were higher from the inputs in farms of area above 70 ha AL (68 man-hour·ha^{-1} AL) and 50-70 ha AL (77 man-hour·ha^{-1} AL). Energy inputs for PLN one thousand of subsidy were relatively high in farms that were smaller from the point of view of area (82 man-hour·thousand PLN^{-1} and 524 kWh·thousand PLN^{-1}) and economy (73 man-hour·thousand PLN^{-1} and 814 kWh·thousand PLN^{-1}) , and of the lowest subsidy amount (111 man-hour·thousand PLN^{-1} and 1073 kWh·thousand PLN^{-1}) and the income of an enterprise (77 man-hour·thousand PLN^{-1} and 661 kWh·thousand PLN^{-1}).

Table 1
Energy inputs in the researched farms

Farm groups according to:		Number of farms	Area (ha AL)	Installed power (kW·100 ha^{-1} AL)	Inputs (kWh·ha^{-1} AL)	Energy share (kWh·man-hour^{-1})	Inputs man-hour·ha^{-1} AL (with others)	Energy inputs for a thousand PLN of subsidy amount (rbh·thousand PLN^{-1})	(kWh·thousand PLN^{-1})
Subsidy amount (thousand of PLN):	up to 50	20	13.9	949	2248	15.72	274	111	1073
	50–100	26	17.9	995	2206	17.84	255	53	463
	100–150	10	29.4	687	1795	21.51	192	30	327
	above 150	14	68.6	562	1483	42.41	80	19	361
Area (ha AL):	up to 10	11	7.1	1241	3197	12.30	477	82	524
	10–30	41	16.1	912	2033	17.95	207	65	682
	30–50	6	42.8	526	1151	25.67	95	39	377
	50–70	3	65.0	424	999	32.77	77	18	224
	above 70	9	89.5	454	1398	51.48	68	34	576
ESU:	up to 8	19	13.0	968	2438	15.78	271	73	814
	8–16	29	17.1	1030	2219	17.79	255	66	573
	16–40	17	51.3	570	1608	36.07	121	38	476
	above 40	5	74.7	479	942	31.30	110	35	315
IE (thousand of PLN):	up to 10	19	10.1	1129	2720	14.28	370	77	661
	10–20	18	17.1	983	2118	18.98	226	62	581
	20–50	12	19.6	757	1705	19.12	157	74	813
	above 50	21	60.1	541	1464	35.45	102	33	432
Average for the whole population			28.5	851	2014	22.67	216	59	598

ESU – European Size Unit, DP – income of an enterprise

Table 2
Energy inputs and coefficient of mechanization level according to Zaremba (W) taking into account the subsidy amount

Specification	Level of energy inputs (man-hour·ha^{-1} AL or kWh·ha^{-1} AL) in farms of subsidy amount (thousand PLN)				
	< 50	50-100	100-150	> 150	Average
Labour inputs (man-hour·ha^{-1} AL)					
Total in a farm, including production:	274	255	192	80	200
– crop	69	61	41	28	50
– animal	120	101	71	23	79
– other work plus outside workers	84	93	80	29	72
Inputs (kWh·ha^{-1} AL)					
Total labour of own means, including:	2248	2206	1795	1483	1933
– tractors	1868	1813	1445	1083	1552
– self-propelled combine harvesters	39	52	9	59	40
– pastures preparation	143	143	143	143	143
– milking and milk secure	27	27	27	27	27
– transportation of loading masses	51	51	51	51	51
– other	119	119	119	119	119
Mechanization coefficient according to Zaremba (*W*), (%)	64.8	64.0	67.4	76.0	67.1

In farms, taking into account the subsidy amount (table 2), labour inputs of outside workers were at the level of 72 man-hour·ha^{-1} AL, with general input for crop production 79 man-hour·ha^{-1} AL (2251 man-hour·farm^{-1}) and animal production 50 man-hour·ha^{-1} AL (1425 man-hour·farm^{-1}). In the researched farms there were higher labour inputs incurred for crop production than for animal production. The reason for this is a low number of heads of livestock and high inputs for crop production caused by hiring seasonal workers at large plantations of tobacco and fruit bushes. Wójcicki (2001) obtained in his researches production inputs of own labour (of a family) on an average 1171 man-hour·farm^{-1} with crop production and 2311 man-hour·farm^{-1} with animal production. Manual labour inputs replaced by specific labour were highest in farms with the subsidy amount up to PLN 50 thousand (2248 kWh·ha^{-1} AL), and they got reduced by almost 40% with the subsidy amount above PLN 150 thousand (1483 kWh·ha^{-1} AL). The inputs (table 3) were highest in farms up to 10 ha AL (3197 kWh·ha^{-1} AL) and got reduced significantly with the increase by 20 ha of AL area. In the group of farms according to the economic size it was also proved that together with its increase, energy inputs got reduced, and the tendency remained observable in farms of the highest income of an enterprise. Similar results were obtained by Kocira and others (2006), who stated that farms of the highest economic size incur unit energy inputs that are 3 times lower than in farms of lower economic value.

Table 3
Energy inputs and coefficient of mechanisation level according to Zaremba (W), taking into account the assumed grouping categories of farms

Specification	Level of energy inputs (man-hour·ha^{-1} AL or kWh·ha^{-1} AL) for farms grouped according to												
	farm area (ha AL)					ESU				income of a holding (PLN thousand)			
	< 10	10–30	30–50	50–70	> 70	< 8	8–16	16–40	> 40	< 10	10–20	20–50	> 50
	Labour inputs (rbh·ha^{-1} UR)												
Total in a farm, including:	477	207	95	77	68	271	255	121	110	370	226	157	102
– animal production	126	48	36	32	8	62	73	24	31	87	68	30	24
– crop production	176	90	26	14	26	140	88	43	21	148	78	82	41
– other work plus outside workers	174	68	32	31	34	69	93	54	58	134	80	45	37
	Inputs (kWh·ha^{-1} AL)												
Total labour of own means, including:	3197	2033	1151	999	1398	2438	2219	1608	942	2720	2118	1705	1464
– tractors	2838	1645	772	636	990	2062	1825	1225	553	2347	1730	1316	1075
– self-propelled combine harvesters	18	48	38	22	67	36	53	42	48	31	47	49	48
– motor engines in crop production and other within the farm	341	341	341	341	341	341	341	341	341	341	341	341	341
Mechanization coefficient according to Zaremba (*W*), (%)	57.7	66.8	71.2	73.2	75.3	66.8	65.1	72.6	63.0	61.0	65.8	69.2	72.5

Mechanization level of production according to Zaremba (table 2) increased with the increase of the subsidy amount, but only from 100-150 and area of PLN 150 thousand, and its average value amounted to 67.1%. A similar tendency was observed (table 3) together with the AL area increase and income of an enterprise increase. However, in the group arranged according to economic size, the highest mechanization level was proved by farms within the range of 16-40 ESU (up to 72.6%).

It has been stated (table 3), that in farms of small area (up to 10 ha) AL, apart from high inputs of specific labour (3,197 kWh·ha^{-1} AL), there were high inputs of manual labour reported (477 man-hour·ha^{-1} AL). Mechanization level (table 2) is only a coefficient of labour process organization, and it depends on the management process, which is represented amongst others by a rational way of equipping a farm with mechanization means, and on the production technology, which defines the usage of possessed technical means. For the whole group of researched farms, the coefficient of mechanization level (67.1% on an average) confirms the expected indicator (60-70%) for model farms (Pawlak and Wójcicki, 1993).

Work energetic equipment (fig. 1) increased proportionally to the area increase (ha AL) and assistance amount (PLN thousand·farm^{-1}). Despite the fact that in farms of area above 70 ha AL the subsidy amount decreased in relation to the group from 50-70 ha AL, it did not influence the increase of the analyzed mechanization coefficient.

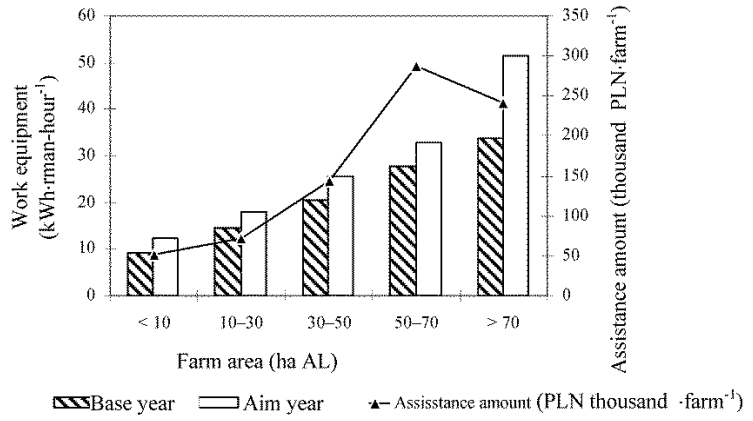

Figure 1. Work energetic equipment taking into account the area of researched farms and assistance amount

Conclusion

The highest installed power was observed in the smallest farms in each researched group, and it was decreasing along with their increase. Energy inputs in the researched farms are derivatives of manual labour and combustion and electric engines work. Their level calculated into to area unit was decreasing systematically, both with the increase of

the subsidy amount, as well as area, economic size and income of an enterprise. In the researched farms higher labour inputs were incurred for crop production than for animal production. The reason for this is a low livestock and high inputs for crop production caused by hiring seasonal workers in big tobacco and fruit bushes farms.

Energy inputs for PLN thousand of the subsidy amount were relatively high in the smallest farms from the point of view of area and economy, and of the lowest subsidy amount level and income of an enterprise. Manual labour inputs replaced by specific labour were highest in farms of assistance amount level up to PLN 50 thousand, and decreased by almost 40% at the subsidy amount above PLN 150 thousand. The inputs were highest in farms up to 10 ha AL and decreased significantly with the increase of area of AL by 20 ha. In the group of farms according to the economic value, it was pointed out as well that with its increase, energy inputs got reduced, and the tendency remained valid for the farms of the highest income of a holding. In farms of small area (up to10 ha) AL, apart from high specific labour inputs, there were high inputs of manual labour observed.

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ZALEŻNOŚĆ NAKŁADÓW ENERGETYCZNYCH OD POWIERZCHNI I WIELKOŚCI EKONOMICZEJ GOSPODARSTW RODZINNYCH

Streszczenie. Celem pracy jest określenie wpływu powierzchni użytków rolnych (UR) i wielkości ekonomicznej na nakłady energetyczne w gospodarstwach rodzinnych korzystających z dofinansowania Unii Europejskiej. W latach 2004-2009 przebadano 70 gospodarstw rolnych z powiatu biłgorajskiego korzystających z dofinansowania UE na modernizację techniczną. Do określenia nakładów energetycznych badaną zbiorowość gospodarstw podzielono wg kryterium kwoty pomocy, powierzchni UR, wielkości ekonomicznej (ESU) i dochodu przedsiębiorstwa. Przy charakteryzowaniu stopnia wyposażenia badanych gospodarstw w środki energetyczne uwzględniono użytkowane w procesie produkcji rolniczej ciągniki, kombajny samobieżne i silniki elektryczne, w tym wmontowane w urządzenia pracujące w obrębie podwórza. Poziom nakładów energetycznych w badanych gospodarstwach w przeliczeniu na jednostkę powierzchni systematycznie spadał, zarówno przy wzroście kwoty pomocy, jak i powierzchni, wielkości ekonomicznej oraz dochodu przedsiębiorstwa. W grupie gospodarstw wg wielkości ekonomicznej wraz z jej wzrostem zmniejszały się nakłady energetyczne, a tendencja ta utrzymywała się w gospodarstwach o największych dochodach przedsiębiorstwa. W gospodarstwach o małej powierzchni (do 10 ha) UR, obok wysokich nakładów pracy uprzedmiotowionej, wystąpiły wysokie nakłady pracy ludzkiej.

Słowa kluczowe: nakłady energetyczne, powierzchnia UR, wielkość ekonomiczna, kwota pomocy, dochód przedsiębiorstwa