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OPERATING COSTS AND THE USE OF MANUFACTURING CAPACITIES OF THE MACHINERY PARK IN ORGANIC FARMS[1]

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ABSTRACT

The objective of the paper was to determine operating costs of the machinery park in organic farms. Moreover, the level of farms equipment with farm machines and devices was determined and the use of their manufacturing capacities was assessed. The scope of the study covered the research in 50 certified organic farms located in the south Poland in Małopolskie, Podkarpackie and Świętokrzyskie voivodeships. The study was carried out within the development subsidy no NR12-0165-10 "Innovative impact of technology and IT support of management on efficiency of production in organic farms". Average area of AL is 12.48 ha. Operating costs of the machinery park were 30 993 PLN·farm^{-1}which annually per one hectare of AL generates the value of PLN 3 369. Amortization constituted the highest participation in total costs, which was as much as 65.7% and energy carriers related to consumption on production of diesel oil, leaded petrol and electric energy. The highest use of manufacturing capacities of the machinery park of organic farms was reported in case of a manure spreader, presses and windrow collectors. In case of spreaders, 19 years are necessary for their total amortization, and in case of presses and windrow collectors – 20 and 21 years. In the researched organic farms, average annual rate of use of possible manufacturing capacities of the majority of machines was only 0.4-1.3%. It forces to lengthen the operating periods, which constitutes the main brake on progress.

Introduction

Organic farming becomes an interesting subject, both among possible consumers as well as producers – farmers. Reasons for such state of affairs should be searched for not only in more frequent negative assessments of intense methods of agricultural production, but also even higher awareness of consumers and rising level of their requirements towards the product and a producer (Kondratowicz-Pozorska, 2006).

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Dynamic development of organic farming in Poland, after EU accession in 2004 gave rise to the need of carrying out research and analysis concerning the branch of agriculture. Getting information on production and economic situation of organic farms and their competitiveness has become crucial, especially because the number of agricultural producers interested in the production of organic methods rises systematically (Kowalska, 2010).

Huge diversity of factors shaping functioning of such farms should be taken into consideration when assessing activity of agricultural farms. Operating costs of the machinery park and the use of its manufacturing capacities are one of these factors. The time of use of a machine in a year is one of the basic factors which decide on unit operating costs of each machine. Along with the increase of the number of hours the machine works its operating costs decrease (Muzalewski, 2003). In conditions of small farms, individual use of a machine on a small area frequently does not allow a farmer to obtain unit operating costs of a machine similar to the market prices of services. The main factor of such situation is low use of farm tractors (approximately 2/3 of normative use) and farm machines in some cases at the level of few hours per a year (Kocira, 2005). A factor, which will decrease these costs is a selection, suitable to the farm conditions, of machines with work parameters which guarantee their best use, which will allow obtaining a better financial result (Kowalik and Grześ, 2006).

Objective, scope and methodology of work

The objective of the paper was to determine the equipment with the machinery park and its operating costs in organic farms. Assessment of the use of manufacturing capacities of machines and tools, which constitute the equipment of the investigated farms, was carried out. The scope of the study covered the research in 50 certified organic farms located in the south Poland in Małopolskie, Podkarpackie and Świętokrzyskie voivodeships. The study was carried out within the development subsidy NR12-0165-10 "Innovative impact of technology and IT support of management on efficiency of production in organic farms". The collected information was obtained on the basis of a guided survey carried out with the farm owner. Information concerned 2011 and the collected data allowed inter alia to carry out characteristic of farms and determination of costs of exploitation and the real use of farm tractors and machines during a year. For comparative analysis, farms were divided into four area groups on account of the size of the agricultural land area:

– group I – up to 5.00 ha – 12 facilities,
– group II – from 5.01 up to 10 ha – 17 facilities,
– group III – from 10.01 up to 20 ha – 12 facilities,
– group IV – above 20.00 ha – 9 facilities.

For evaluation of the use of manufacturing capacities of the machinery park in the investigated farms, the rate of use of manufacturing capacities was assessed according to the following relation (Tabor and Kmita, 2007; Tabor, 2008):

$$S_w = \frac{W_{rz}}{n} \cdot 100\%$$

where:
S_w – the rate of use of manufacturing capacities (%),
W_{rz} – annual use of a machine (h),
n – service life - the use of a machine during operating period (h).

Description of the researched farms

Table 1 presents the area and structure of agricultural land in the researched organic farms. Average area of AL was 12.48 ha and was within 3.32 ha in the group I to 31.80 ha in group IV. In the total structure of agricultural land, arable land was 53.6% and permanent grassland was 36.7%. In the first three area groups there also were orchards – 0.44 ha and perennial plantations – 0.04 ha (i.e. raspberries, strawberries, blueberries, raspberries), which complemented the structure of agricultural land and their use was marginal. In the group of the biggest farms with the area above 20 ha as much as 69.9% constituted permanent grasslands whereas arable land was 30.1%.

Table 1
Area and structure of agricultural land

Farm group	Parameter	Area and structure of agricultural land								
		AL		Perennial grasslands		Orchards		Perennial plantations		Total agricultural land
		(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)
I	Average	1.93	58.4	0.66	19.9	0.65	18.3	0.08	3.4	3.32
	Standard deviation	1.40	–	0.64	–	0.94	–	0.14	–	1.01
II	Average	4.22	62.2	1.97	26.3	0.68	10.9	0.04	0.6	6.91
	Standard deviation	2.04	–	1.94	–	1.29	–	0.09	–	1.53
III	Average	8.23	54.1	6.54	43.3	0.24	2.1	0.05	0.5	15.06
	Standard deviation	5.93	–	5.91	–	0.71	–	0.14	–	3.33
IV	Average	9.64	30.1	22.16	69.9	–	–	–	–	31.80
	Standard deviation	7.47	–	8.25	–	–	–	–	–	8.93
Total (50)	Average	5.61	53.6	6.39	36.7	0.44	8.6	0.04	1.1	12.48
	Standard deviation	5.24	–	8.99	–	0.96	–	0.11	–	10.86

Source: Kwaśniewski et al., 2013

The area of sowing according to plant groups and the livestock was presented in table 2 and the structure of sowing in the researched organic farms was presented in figure 1. In this structure assessed in total for 50 facilities, grains dominated – over 45.8% then fodder

plants – 34.0%, vegetables, root plants (potatoes) while the lowest participation was in case of herbs – it was 1.8% of area (occurred only in two facilities). Farms from the group with area ranging from 10.01 to 20.00 ha and farms with area above 20 ha had in their structure of crops a considerable participation of root plants respectively 40.6% to 70.6%.

Table 2
Area of crops acc. to plant groups and livestock

Farm group	Parameter	Arable land	Plant group					Livestock
			Grains	Root crops	Fodder crops	Vegetables	Herbs	
		(ha·farm.$^{-1}$)						(LSU·ha^{-1} AL)
I	Average	1.93	1.29	0.11	0.36	0.07	0.10	0.69
	Standard deviation	1.40	0.90	0.09	0.54	0.09	0.35	0.30
II	Average	4.22	2.20	0.50	1.05	0.47	–	0.76
	Standard deviation	2.04	1.63	0.58	1.26	1.01	–	0.46
III	Average	8.24	3.06	0.62	2.76	1.17	0.63	0.90
	Standard deviation	5.93	4.07	0.85	2.36	1.74	2.17	0.52
IV	Average	9.64	1.41	0.26	7.95	0.02	–	0.79
	Standard deviation	7.47	1.20	0.27	7.78	0.07	–	0.34
Total	Average	5.61	2.05	0.39	2.54	0.46	0.17	0.78
	Standard deviation	5.24	2.34	0.57	4.36	1.10	1.07	0.41

Source: Kwaśniewski et al., 2013

Whereas, the livestock was very balanced and was 0.76 LSU·ha^{-1} AL in group I and III and 0.80 LSU·ha^{-1} AL in group II and IV. In the number structure in all area groups, cattle prevailed and in the biggest farms it was 97.9%. Thus, almost 70% participation of grasslands in this farm group (Kwaśniewski et al., 2013).

Research results

Equipment of the investigated organic farms in farm tractors and transport means and other machines divided according to the user groups was presented in table 3.

Farm tractors constituted a basic energy means and served as the main source of mechanical tractive and driving force as well as transport and loading means. Authors point in papers such universal use of tractors, not only in organic farms (Kowalski et al., 2012; Muzalewski, 2009).

At the average in the researched population there was 1.64 tractor per a farm. When comparing this saturation in the system of area groups, a logical increase of the number of these means per a statistical farm along with the increase of its area is recorded. In the

group of the facilities which have the smallest area was 0.92 item·farm^{-1}. One farm did not have a tractor, thus a number lower than a unity. Farms from the second group (5.01 to 10.00 ha) had tractors in the number at the average of 1.47 item·farm^{-1}. Thus, each had one tractor and every second one – two tractors. In the third group (10.01 to 20.00 ha) index of saturation was 1.92 item·farm^{-1}. Thus, it means that almost all farms had two tractors. Even higher index of saturation may be observed in the group of the biggest farms - here the index was as much as 2.56.

Table 3
Equipment of farms in farm machines with the system of usage groups

Farm group	Parameter	Machine group															
		Farm tractors		Delivery trucks		Remaining transport means		Cultivation machines		Fertilization, protection and treatment of plants		Machines for sowing and planting		Machines for green forage harvesting		Machines for crops and root crops harvesting	
		(item·farm^{-1})	(item·ha^{-1})	(item·farm^{-1})	(item·ha^{-1})	(item·farm^{-1})	(item·ha^{-1})	(item·farm^{-1})	(item·ha^{-1})	(item·farm^{-1})	(item·ha^{-1})	(item·farm^{-1})	(item·ha^{-1})	(item·farm^{-1})	(item·ha^{-1})	(item·farm^{-1})	(item·ha^{-1})
I	Average	0.92	0.26	–	–	1.25	0.35	2.92	0.82	1.17	0.30	0.50	0.12	1.08	0.31	0.42	0.12
	Standard deviation	0.51	0.15	–	–	1.36	0.40	2.11	0.54	1.70	0.41	0.80	0.19	0.90	0.26	0.51	0.14
II	Average	1.47	0.21	0.18	0.03	1.24	0.18	3.41	0.52	1.94	0.29	1.41	0.22	2.29	0.33	0.71	0.11
	Standard deviation	0.62	0.08	0.39	0.06	1.03	0.14	1.46	0.25	1.25	0.20	0.87	0.15	1.31	0.18	0.69	0.11
III	Average	1.92	0.13	0.42	0.03	1.17	0.08	3.50	0.25	3.00	0.21	1.25	0.09	3.83	0.25	1.08	0.08
	Standard deviation	0.67	0.05	0.51	0.04	0.58	0.05	1.00	0.11	1.71	0.14	0.87	0.07	2.72	0.18	0.51	0.05
IV	Average	2.56	0.08	–	–	1.67	0.06	3.67	0.12	3.11	0.10	1.11	0.03	5.89	0.18	0.67	0.02
	Standard deviation	1.01	0.03	–	–	1.00	0.03	1.32	0.04	1.62	0.05	0.78	0.02	2.26	0.05	0.71	0.02
Total	Average	1.64	0.18	0.16	0.02	1.30	0.18	3.36	0.45	2.22	0.24	1.10	0.13	3.02	0.28	0.72	0.09
	Standard deviation	0.88	0.11	0.37	0.04	1.02	0.24	1.51	0.39	1.68	0.25	0.89	0.15	2.45	0.19	0.64	0.10

Equipment of organic farms with delivery trucks should be recognized as low. Since, at the average per a farm there was 0.16 item of this vehicle. The farm should be equipped with the remaining transport means in the form of trailers, trucks or pulleys independently from the farm size. The researched population of farms within the subjective technical means is not varied with regard to technology. Frequently one trailer or a horse and cart adapted to a tractor was a multifunctional machine and served for transport of produce in a varied form (volume, loose – e.g. grains, tubers, roots etc.). Thus, only 1.30 items of the remaining transport means was at the average per a farm but in the biggest farms this ratio was 1.67.

Number materials presented in table 3 concerning the number of particular groups and types of machines, explicitly indicate a poor assortment of machines which accompany tractors. At the average 3.36 cultivation machines is per a farm. A situation in case of machines used for sowing and planting as well as harvesting of grains and root crops is unfavourable. Here, at the variability of plants, which are treated by these machine groups, their

average number in a farm is only 1.10 item in the first case and 0.72 item in the second case. Whereas, quantity of machines used for harvesting of green forage is favourable – at the average 3.02 item·farm^{-1}.

Operating costs of the machinery park in a unitary view were presented in table 4 and figure 1 presents their structure. Amortization, insurance, energy carriers and costs of spare parts and repairs were included. Costs of labour were not included in the costs. In total, exploitation costs of machines per a statistical farm were 30,993 PLN·farm, which generates the value of PLN 3, 369 per one hectare. Amortization constituted the highest participation in total costs, which was as much as 65.7% and energy carriers related to consumption of diesel oil, leaded petrol and electric energy were at the second place (19.7%). It should be mentioned that very frequently farmers while establishing the production costs or similar services omit amortization of fixed assets mainly machines. Without including amortization costs, production or services efficiency assessed by them, seems to be favourable. However, they are not aware that they "consume" their fixed assets. The remaining components of operating costs of the machinery park have a considerably lower participation.

When comparing the index of amount of unitary costs in the area groups system (table 4) one may mention the decrease along with the increase of average size of the production area – it is a normal phenomenon and does not require additional explanations.

Table 4
Unit costs of machines exploitation

Farm group	Parameter	Average age (years)	Operating costs of machines (PLN·ha^{-1})						
			Machines amortization	Tractors, cars insurance	Energy carriers (fuel, electric energy)	Spare parts	Oils and smears	Ordered repairs	Total costs
I	Average	19	2738	225	910	437	113	141	4564
	Standard deviation	8	1051	163	906	333	75	166	1746
II	Average	21	2711	96	625	278	48	135	3893
	Standard deviation	5	1402	84	319	293	44	188	1752
III	Average	21	2059	42	586	145	26	41	2899
	Standard deviation	5	1567	37	292	108	12	78	1622
IV	Average	16	905	9	318	110	23	46	1411
	Standard deviation	4	313	11	108	171	16	90	554
Total	Average	20	2236	99	629	254	54	98	3369
	Standard deviation	6	1389	121	525	275	56	150	1879

In the discussed table, also an average age of machines according to the accepted division criterion of the researched facilities was presented. The data obtained here explicitly confirm earlier research, where it was found out, that organic farms of Małopolskie voivodeship are equipped with old, exploited equipment frequently purchased on a secondary market. Since, machines are 20 years old at the average.

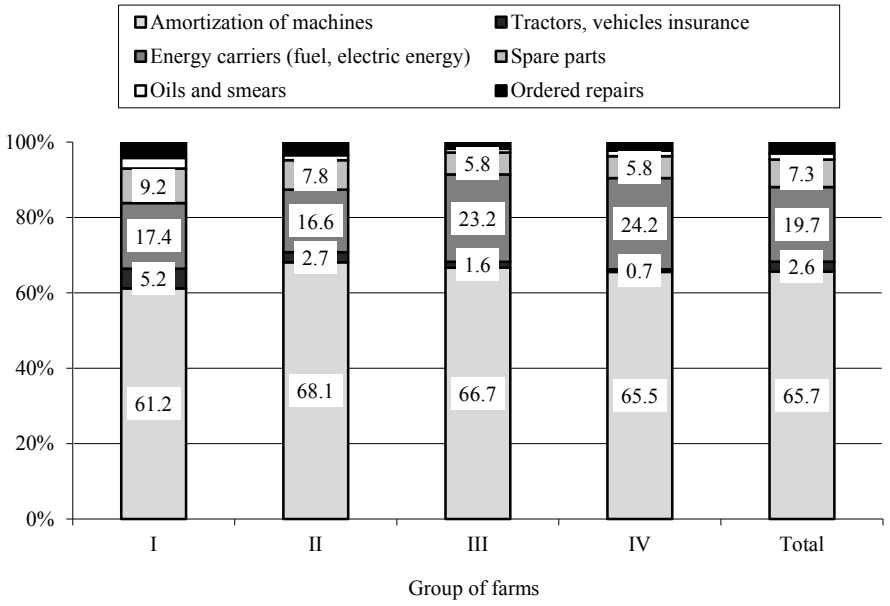

Figure 1. Structure of machines operating costs

Table 5 presents annual use of the machinery park in the investigated organic farms. When assessing the level of use for all farms where given machines were present, from farm tractors, delivery trucks to machines for harvesting produce, one should state that in majority of cases the use was decisively lower than the normative use. Only for manure spreaders, which during a year worked at the average of 92 h – their annual operating time exceeded normative use and in case of presses operated 64 $h \cdot year^{-1}$ it was on the verge of the use predicted by norms. Intense exploitation of manure spreaders resulted from the fact that in many farms they were additionally used as a trailer for transport of produce. Obtained results (table 5) allow assumption that the use of manufacturing capacities of the machinery park in organic farms will be at a very low level.

Table 5
Annual use of the machinery park

Specification	Use (h·year^{-1})				
	Group I	Group II	Group III	Group IV	Total
Delivery trucks	–	440	459	-	450
Farm tractors	127	165	173	171	159
including: 6 kN class	145	188	185	106	156
9 kN class	125	128	195	181	157
14-20 kN class	50	129	110	206	124
Farm trailers	38	56	96	69	65
Tractor trailers	36	37	37	29	35
Dollies	101	40	13	–	51
Ploughs	9	16	20	10	18
Cultivators	4	4	9	7	7
Spike-tooth harrows	5	9	12	17	11
Cultivation aggregates	–	7	9	16	11
Manure spreaders	38	114	19	88	92
Grain drills	5	6	5	2	5
Seeders	1	6	5	2	5
Rotational mowers	67	21	24	28	35
Disc mowers	–	–	17	28	23
Haymakers-rakes	14	17	37	51	30
Combine harvesters	–	16	–	11	14
Presses	–	128	32	32	64
Windrow collector	–	26	129	–	78
Potato spinner	5	7	2	3	5
Elevator-digger	–	7	15	–	11
Potato combine	2	45	47	–	31

The use of manufacturing capacities of the machinery park assessed with the use of indexes of the so-called rate of use expressed with (%) was presented in figure 2 and 3.

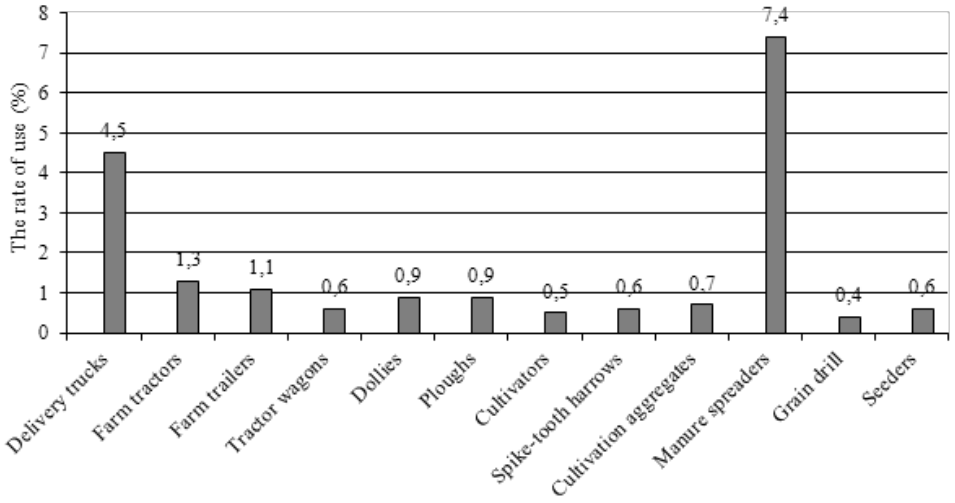

Figure 2. The rate of use of manufacturing capacities of the machinery park (transport means, cultivation machines, fertilization machines, sowing and planting machines)

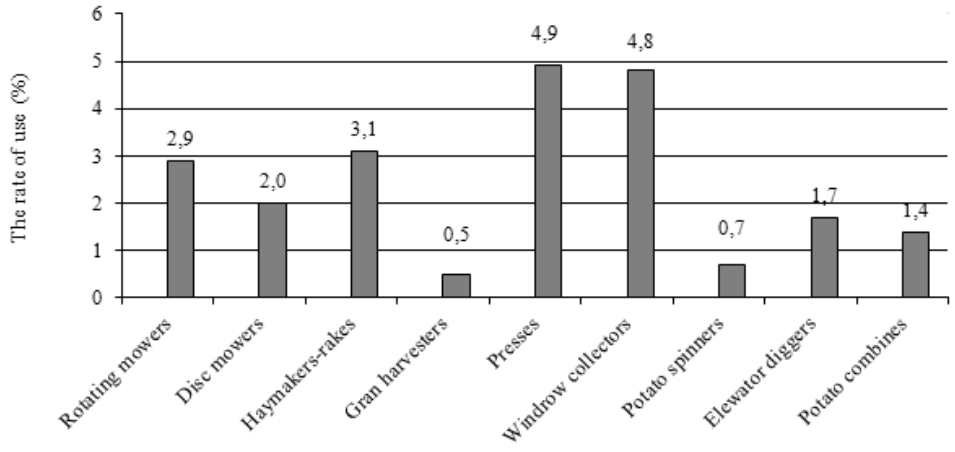

Figure 3. The rate of use of manufacturing capacities of the machinery park (harvesting machine)

For farm tractors the rate of use was at the average only 1.3%. Thus, in order to fully use potential manufacturing capacities of tractors in the investigated farms, they should be operated in such farming conditions (depending on the towing class) within 65 to 78 years. From among the analysed groups of farms, only in the biggest facilities (group IV) real possibilities for rational operation of tractors exist but only for 14-20 kN classes.

It cannot be determined with regard to cultivation tools, for which the rate of use of manufacturing capacities is from 0.5% for cultivators to 0.9% for ploughs. In such cases for their total use respectively 11 and 231 years are necessary. Despite a very low use of these tools, they are eagerly purchased due to a low price. The rate of use of manufacturing capacities for trailers was at the average of 1.1 %. In order to fully use production abilities of trailers, they should be exploited for 93 years. Whereas, the most real possibilities for carrying out rational exploitation exist for manure spreaders, for which the highest use of production abilities exists and the assessed index was the highest – 7.4% (fig. 2). 19 years are necessary for total amortization. While, among machines for harvesting of green forage and produce, the highest rate of use of manufacturing capacities characterized presses and windrow harvesters. Respectively 4.9 and 4.8% (fig. 3). In these examples, in order to completely amortize these type of machines, they should be operated for 20 and 21 years.

The presented results confirmed previous assumption that the use of manufacturing capacities of the machinery park in the investigated organic farms is at a very low level.

Statements and conclusions

1. The investigated farms were characterized by high saturation of equipment with farm tractors. At the average in the researched population there was 1.64 tractor per a farm. These were old tractors, exploited and usually cooperating with equally old equipment (average age 20 years). It considerably influences technologies applied in the investigated farms (old and work-consuming).
2. Operating costs of the machinery park were 30, 993 PLN·farm^{-1} which annually per one hectare of AL generates the value of PLN 3, 369. Amortization constituted the highest participation in total costs, which was as much as 65.7% and energy carriers related to consumption of diesel oil, leaded petrol and electric energy were at the second place (19.7%).
3. The highest use of manufacturing capacities of the machinery park of organic farms was reported in case of a manure spreader, presses and windrow collectors. In case of spreaders, 19 years are necessary for their total amortization, and in case of presses and windrow collectors – 20 and 21 years.
4. At the average over 90 years is necessary to use the manufacturing capacities of the remaining machinery park in many cases, which may limit the introduction of technical progress to organic farms.
5. In the researched organic farms, average annual rate of use of possible manufacturing capacities of the majority of machines was only 0.4-1.3%. It forces to lengthen the operating periods, which constitutes the main brake on progress.

References

Kocira, S. (2005). Wykorzystanie maszyn rolniczych w gospodarstwach o różnej wielkości ekonomicznej. *Problemy Inżynierii Rolniczej, 3*(49), 15-22.

Kondratowicz-Pozorska, J. (2006). Analiza uwarunkowań rozwoju gospodarstw ekologicznych w Polsce. *Zeszyty Naukowe Akademii Rolniczej we Wrocławiu*. *Nr 540*. Wrocław.

Kowalik, I., Grześ, Z. (2006). Wpływ wykorzystania maszyn rolniczych na koszty mechanizacji w gospodarstwach rolniczych o różnej powierzchni. *Inżynieria Rolnicza*, *13*(88), 133-137.
Kowalska, A. (2010). *Jakość i konkurencyjność w rolnictwie ekologicznym*. Wyd. Difin S.A. Warszawa. ISBN 978-83-7641-322-8.
Kowalski, J. i inni (2012). *Założenia, program oraz metodyka badań, analiza badań wstępnych, założenia do projektowania systemu, robocza wersja programu komputerowego.* Monografia. Wyd. PTIR. Kraków. ISBN 978-83-930818-7-5.
Kwaśniewski, D.; Malaga-Toboła, U.; Kuboń, M. (2013). Wielkość produkcji roślinnej a nakłady pracy w gospodarstwach ekologicznych w Polsce południowej. *Journal of Research and Applications in Agricultural Engineering, 58(4)*, 44-48.
Muzalewski, A. (2003). *Koszty eksploatacji maszyn. Wskaźniki eksploatacyjno-ekonomiczne maszyn i ciągników rolniczych stosowanych w gospodarstwach rolnych*. Nr 18. IBMER, Warszawa.
Muzalewski, A. (2009). *Koszty eksploatacji maszyn rolniczych*. Nr 24. IBMER, ISBN 978-83-806-31-4.
Tabor, S., Kmita, W. (2007). Wykorzystanie zdolności produkcyjnych parku maszynowego w gospodarstwach ekologicznych. *Inżynieria Rolnicza, 9*(97), 239-246.
Tabor, S. (2008). Wykorzystanie zdolności produkcyjnych parku maszynowego w wybranych gospodarstwach sadowniczych. *Inżynieria Rolnicza, 6*(104), 211-216.

KOSZTY EKSPLOATACJI A WYKORZYSTANIE ZDOLNOŚCI PRODUKCYJNYCH PARKU MASZYNOWEGO W GOSPODARSTWACH EKOLOGICZNYCH

Streszczenie. Celem pracy było określenie kosztów eksploatacji parku maszynowego w gospodarstwach ekologicznych. Określono również poziom wyposażenia gospodarstw w maszyny i urządzenia rolnicze oraz dokonano oceny wykorzystania ich zdolności produkcyjnych. Zakresem pracy objęto badania przeprowadzone w 50 gospodarstwach ekologicznych z certyfikatem położonych w Polsce południowej, w województwach: małopolskim, podkarpackim i świętokrzyskim. Pracę wykonano w ramach grantu rozwojowego nr NR 12-0165-10 „Innowacyjne oddziaływanie techniki i technologii oraz informatycznego wspomagania zarządzania na efektywność produkcji w gospodarstwach ekologicznych". Średnia powierzchnia UR to 12,48 ha. Koszty eksploatacji parku maszynowego wynosiły rocznie 30 993 PLN·gosp^{-1}, co w przeliczeniu na hektar UR daje wartość 3 369 PLN. Największy udział w kosztach całkowitych, bo aż 65,7% stanowiła amortyzacja, a drugie miejsce (19,7%) zajmują nośniki energii związane ze zużyciem na produkcję oleju napędowego, etyliny i energii elektrycznej. Największe wykorzystanie zdolności produkcyjnych parku maszynowego gospodarstw ekologicznych odnotowano w przypadku roztrząsaczy obornika, pras oraz zbieraczy pokosów. W przypadku roztrząsaczy na całkowite ich zamortyzowanie potrzeba 19 lat, natomiast w przypadku pras i zbieraczy pokosów 20 i 21 lat. W badanych gospodarstwach ekologicznych średnio roczne tempo wykorzystania potencjalnych zdolności produkcyjnych większości maszyn wynosi tylko 0,4-1,3%. Zmusza to do wydłużania okresów eksploatacji, co stanowi główny hamulec postępu.

Słowa kluczowe: gospodarstwa ekologiczne, koszty eksploatacji maszyn, park maszynowy, wykorzystanie zdolności produkcyjnych