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FUEL CONSUMPTION IN FAMILY FARMS

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Summary. The paper reports on the fuel consumption in 123 family farms analysed in 2006. The annual average fuel consumption was 996 litres; the lowest was for farms with one tractor (724 l/year) whereas the highest for farms using combine harvesters (1805 l/year). The fuel consumption calculated per unit of farm area was between 30.3 l/year and 154.1 l/year per hectare. It was proved that the annual fuel consumption was positively correlated with farm area and depended on the farm's technical resources such as tractors and combine harvesters.

Key words: fuel consumption, family farms.

INTRODUCTION

The technical and technological progress is the indirect reason for a continuous increase of fuel outlay in agriculture. More technically advanced and more energy consuming modern machines can be effectively utilized only on big farms. However, in 2006 the average Agriculturally Utilized Area (AUA) of a farm in Poland was only 6.27 ha, and more than 80% of the farms had AUA of less than 10 ha [Statistical Yearbook, 2007]. Consequently the level of use of technical resources was very low. The costs related to energy sources (mainly fuels) have been increasing [Pastorek, Syrový 2001; Pawlak, 2005] and the increase in the price of crude oil has been directly related to the price of diesel which is the main fuel used in Polish agriculture. Between June 2001 and February 2009, the average monthly price of diesel increased by 40%, from 2.60 PLN to 3.65 PLN per litre, and the highest price of 4.75 PLN/l (83% increment) was noted in August 2008 (Fig. 1) [Fuel prices... notowania]. High cost of fuels, as indicated above, is one of the main reasons to look for less energy consuming technologies.

The level of fuel consumption affects directly the cost of mechanization [Landers 2000; Lazarus 2005; Theunissen 2002; Witney 1988]. However, the current disadvantagous land structure and a relatively low number of new machines makes it impossible to significantly reduce energy and fuel outlay. The way forward is to improve the awareness of the farmers with regard to the efficient use of machines and effective agricultural methods. However, there is a need to investigate the consumption of liquid fuel (diesel fuel) in the farms and the relationship between the fuel consumption and a farm's Agriculturally Utilized Area (AUA) as well as its technical resources. The aim of the research was to perform such investigation for selected family farms.

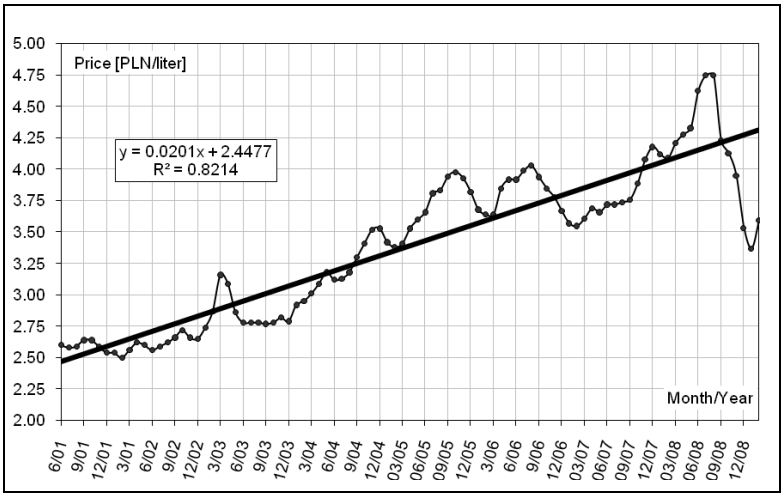


Fig. 1. Price of diesel fuel in Poland from June 2001 to February 2009 (monthly average)

RESEARCH METHODOLOGY AND FARMS CHARACTERISTICS

Research was done in 2006 on a group of 123 family farms from Lublin province by standardized questionnaire. Information from the questionnaire was verified and entered into specially prepared Microsoft Access Database [Lorencowicz and Kocira, 2004]. Microsoft Excel spreadsheet was used for statistical calculations and trends prediction. Annual fuel consumption was estimated as a total value for individual farm and also as an equivalent for a unit of its area (hectare of a farm's Agriculturally Utilized Area).

The analysis was done on 114 farms as 7 farms (of size below 4 ha and above 50 ha) were removed as they significantly differed from the rest of the group and 2 more questionnaires were not considered as they contained wrong or incomplete information. The farms were arranged according to the AUA and were split into two groups according to their technical resources:

1. In terms of tractors:

a) farms with one tractor,

b) farms with multiple tractors,

2. In terms of combine harvesters

a) farms not equipped with combine harvesters,

b) farms equipped with combine harvesters.

It was assumed that the level of technical resources (number of tractors and combine harvesters) affected annual fuel consumption.

The average AUA of the farms under investigation was 13.61 ha, and, after discarding the extreme values, reduced to 11.48 ha (Table 1). The above average was more than double of the average for the Lublin province which, in 2006, was 5.32 [Rocznik Statystyczny ...]. The biggest group among the analyzed farms had area of 5-10 ha – 47%, next 10-15 ha – 31%, above 20 ha – 10%, 15-20 ha – 9% and up to 5 ha – 3% (inclusive of the lower limits).

Table 1. Farm area of investigated farms [hectars of AUA]

Items	Utilized Agricultural Area in hectares				
	Total	With one tractor	With many tractors	Without combine harvesters	With combine harvesters
Minimum	4.31	4.31	7.55	4.31	6.50
Maximum	48.20	20.90	48.20	30.50	48.20
Average	11.48	9.59	16.90	9.78	17.42
Standard Deviation	6.27	3.59	8.44	4.14	8.28

Farms with one tractor as well as farms not equipped with combine harvesters had the smallest AUA average of 9.59 ha and 9.78 ha, respectively. Farms with more than one tractor had the AUA average of 16.90 ha whereas farms equipped with combine harvesters – 17.42 ha.

The investigated farms had not only different UAA but also different machine equipment. In total, there were 145 tractors and 26 combine harvesters. Almost one third of tractors (31%) had power of 30-40 kW, 26% power 20-30 kW, 15% - below 20kW, 13% - above 60kW, 11% - 50 to 60 kW and 3% - 40 to 50kW - Fig. 2.

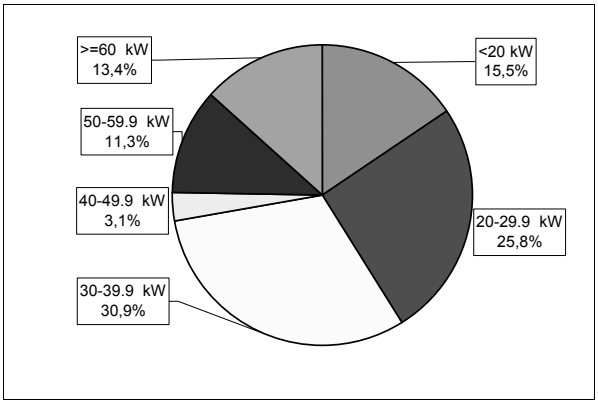


Fig. 2. Structure of tractor power in farms

On average, each farm had tractor power of 35.5 kW, with variations between 18 kW to 98 kW. For the farms with combine harvesters, the available average power increased to ca 160 kW.

RESULTS

The fuel consumption in the investigated family farms varied a lot within the group and was positively correlated with farms' AUA (Table 2). The annual consumption varied from 131 to 4830 litres (or from 14 to 154 litres per hectare). The consumption varied and depended on farms'

technical resources. The highest consumption was in farms equipped with combine harvesters (1805 l/year) and with multiple tractors (1685 l/year).

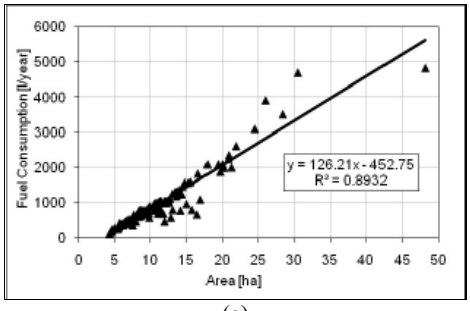
Table 2. Annual fuel consumption for farms with different technical resources

Item	Annual fuel consumption				
	Total	Farms with one tractor	Farms with multiple tractors	Farms not equipped with combine harvesters	Farms equipped with combine harvesters
Litres (total)					
Minimum	131	131	366	131	235
Maximum	4830	2350	4830	4700	4830
Average	996	724	1685	831	1805
Median	769	678	1270	761	1557
Standard deviation	837	403	1195	1156	1156
Litres (per 1 ha)					
Minimum	30.3	30.3	48.5	30.0	31.5
Maximum	154.1	112.4	154.1	154.1	150.6
Average	77.9	71.0	93.0	82.9	99.1
Median	79.0	72.4	95.5	79.3	95.0
Standard deviation	21.8	17.5	22.9	21.9	28.3

All farms equipped with combine harvesters performed harvest contract work which increased their fuel consumption in comparison to other farms by at least 975 l per year. Farms with one tractor had an average fuel consumption calculated per one hectare of 72 litres of diesel, whereas farms equipped with combine harvesters had the fuel consumption 24% higher (95.5 l/ha). Similar results were also received by Pastorek i Syrový [2001].

There was an evident relationship between the annual fuel consumption and farm AUA (Fig. 3). The fuel consumption calculated per hectare was also positively correlated with the farm AUA, although the coefficient of determination was only 0.44. It means that bigger farms had higher energy outlay which was related, among other things, to the fact that such farms were equipped with tractors of higher power and generally higher level of work mechanization.

The relationship between the fuel consumption and farm AUA was also evident for groups of farms, split depending on their technical resources. The coefficient of determination above 0.75 was also reported for farms of different technical resources, such as with one or multiple tractors (Figs. 4 and 5) and for farms not equipped and equipped with combine harvesters (Figs. 6 and 7).



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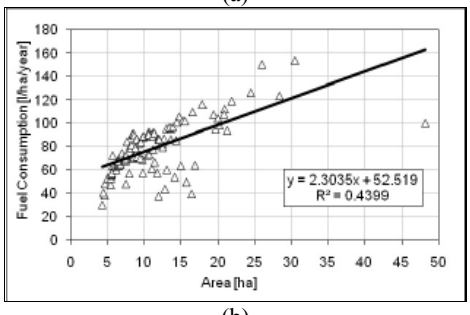
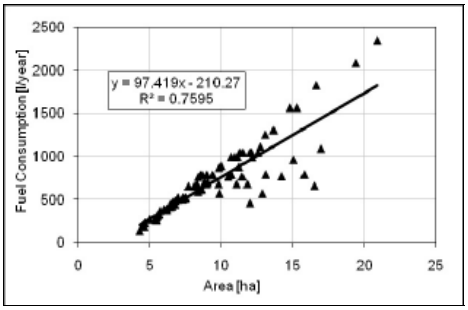


(b)

Fig. 3. Annual fuel consumption in farms: (a) total, (b) expressed per 1 ha



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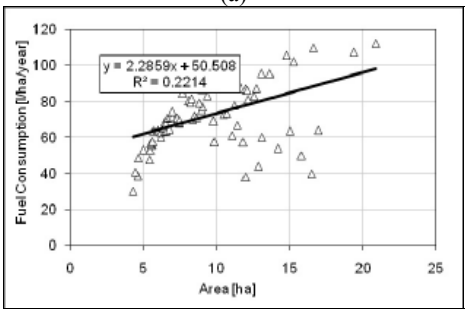
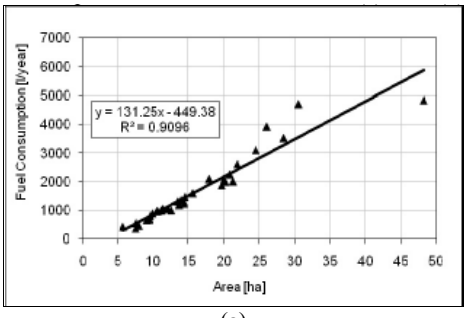


(b)

Fig. 4. Annual fuel consumption in farms with one tractor: (a) total, (b) expressed per 1 ha



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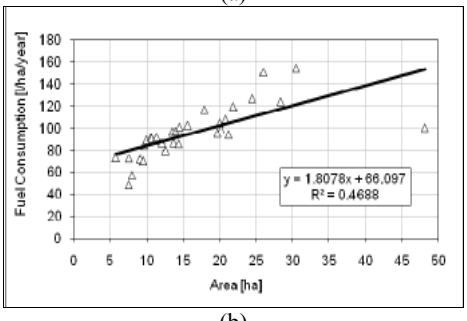
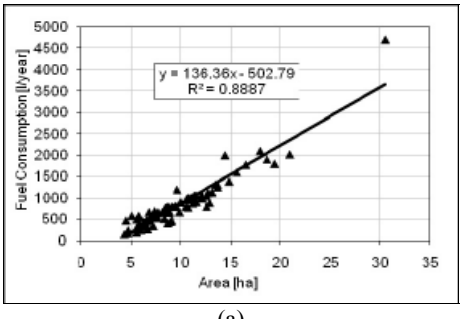


(b)

Fig. 5. Annual fuel consumption in farms with multiple tractors: (a) total, (b) expressed per 1 ha



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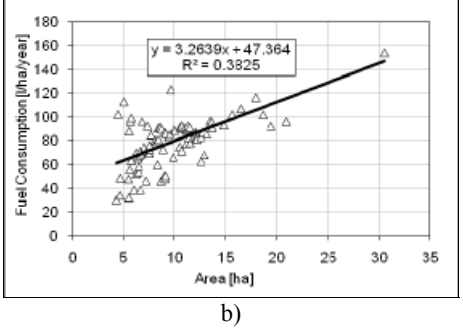
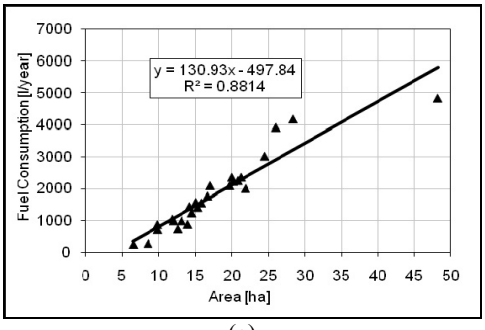


b)

Fig. 6. Annual fuel consumption in farms not equipped with combine harvester: (a) total, (b) expressed per 1 ha



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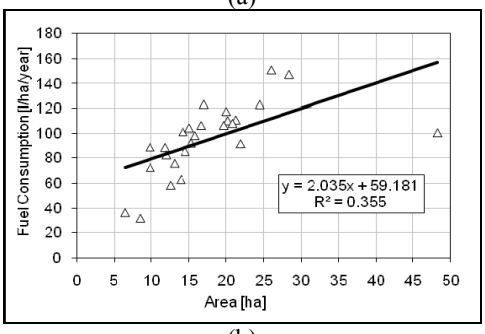

(b)

Fig. 7. Annual fuel consumption in farms equipped with combine harvester: (a) total, (b) expressed per 1 ha

The relationship between the fuel consumption per hectare and AUA was weaker. The coefficient of determination for farms with one tractor was 0.22 whereas for farms with multiple tractors - 0.47. In case of combine harvesters as a criterion, the coefficient was between 0.36 and 0.38.

CONCLUSIONS

1. The annual fuel consumption was between 131 and 4,830 litres, with the average of 996 litres (standard deviation – 837 l/year). The annual fuel consumption was positively correlated with farms AUA and depended also on the farms' technical resources such as tractors and combine harvesters.
2. The average fuel consumption was 79 litres per hectare per year (standard deviation 21.8 l/ha*year). The above value was close to the average fuel consumption for traditional production technologies and depended on the farms' technical resources; it varied from 30.3 l/ha to 154.1 l/ha.
3. There is a need to reduce the outlay on fuel by improving farms' technical resources and by making the technologies for plant production simpler.

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ZUŻYCIE PALIWA W GOSPODARSTWACH RODZINNYCH

Streszczenie. W 2006 roku przebadano 123 gospodarstwa. Roczne zużycie paliwa wynosiło średnio 996 litrów, przy czym najmniejsze było w gospodarstwach z jednym ciągnikiem –724, a największe w gospodarstwach użytkujących kombajny zbożowe – 1805 l/rok. W przeliczeniu na 1 ha wartości te wahały się od 30,3 do 154,1 litra rocznie. Udowodniono, że wielkość rocznego zużycia paliwa jest dodatnio skorelowana z powierzchnią gospodarstw a także zależy od poziomu wyposażenia w ciągniki i kombajny zbożowe.

Słowa kluczowe: zużycie paliwa, gospodarstwa rodzinne.