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COMPARISON OF ECONOMIC EFFICIENCY OF RAPESEED PRODUCTION IN FARMS WITH VARIED FERTILIZATION VARIANTS

Tomasz K. Dobek*, Paweł Kołosowski

Department of Construction and Use of Technical Devices
West Pomeranian University of Technology in Szczecin

* *Corresponding author: e-mail: tomasz.dobek@zut.edu.pl*

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ABSTRACT

Intensive breeding is related to formation of considerable amount of manure which may be used as a natural fertilizer. Manure fertilization may cause reduction of the amount of applied mineral fertilizers and thus reduction of production costs. It may particularly relate to the species with great fertilization requirements such as winter rapeseed. The objective of the research was to compare economic efficiency of rapeseed production in two farms which use different fertilization variants. In one, only mineral fertilizers were used and in the second one – mineral fertilization was supplemented with manure organic fertilization. The use of manure caused reduction of expenditures on materials and raw materials used in production, in particular of fertilizers. At comparable yields obtained by two farms, technology based on manure fertilization proved to be more efficient.

Introduction

Winter rapeseed is the most popular oil plant in Poland. The area of sowing was 951 thousand hectares in Poland in 2014, seeds harvest was 3.3 million tons (Main Statistical Office, 2015). Popularity of this plant may result from a high profitability of production which has been maintained for many years (Dobek, 2005a; Dobek, 2008b; Dobek et al., 2010c). Winter rapeseed has very high nutritive requirements, which, according to estimations, are two times higher than for the analogous unit of wheat plants yield (Kaczor et al., 2003). Therefore, in order to meet the rapeseed requirements, farmers must provide it with a stand which has a proper resourcefulness (Tys et al., 2003). Thus, it requires the use of high doses of fertilizers which carries considerable costs therewith.

In order to limit expenditures on fertilization, farms which carry out animal breeding may fertilize plants with natural fertilizers. It is particularly important in the times of animal production intensification, which is related to formation of considerable amount of manure (Marszałek et al., 2011). Manure is a full-value fertilizer which includes macro and micro-elements (Kwaśny et al., 2011; Staniszewski and Biś, 2012), and its use allows obtaining satisfactory yields at the reduced doses of mineral fertilizers (Annicchiarico et al., 2011). The positive impact of correctly used organic fertilizers on soil micro-environment is not without significance (Balota et al., 2012; Cybulska et al., 2015; Martyniuk et al., 2002).

Despite undoubted advantages of using manure in field cultivations, economic analysis of the justification of its use in particular field cultivations seems to be necessary. It is particularly important in the aspect of possible nuisance of this fertilizer for environment or in the aspect of its negative impact on environment.

Objective, methodology and scope of work

The objective of the research was to compare economic efficiency of winter rapeseed production in two neighbouring farms. In both, comparable production technologies were used and only fertilization was an element of agro-technology which distinguished them. In one farm, organic fertilization with pig manure supplemented with reduced doses of mineral fertilizers (Farm B) was applied and in the other one-only artificial fertilizers (Farm A) (table 1).

Based on the methodology of calculating the agricultural production costs developed by Muzalewski (2010) the list of incurred direct costs for rapeseed production was made and divided into the costs of work, fuel, materials and exploitation costs of machines and devices. Moreover, costs of particular groups of treatments were calculated including expenditures related to the purchase of fuel, hiring workers and exploitation of machines and devices. After revenue from sale of seeds was set with the incurred costs, the income which both farms earned and the coefficient of economic effectiveness of rapeseed production was calculated. Coefficient of economic efficiency was calculated from the following formula (Dobek T. and Dobek M., 2008):

$$Eek = \frac{Ps}{Kp} \tag{1}$$

where:

Eek – rate of economic efficiency of production
Ps – revenues from rapeseed sale, (PLN·ha^{-1})
Kp – rapeseed production costs, (PLN·ha^{-1})

Tests were carried out in three seasons: 2012/2013, 2013/2014 i 2014/2015, in a farm which had a similar level of equipment with machines and similar acreage of approx. 50 ha. Winter rapeseed in B farm took 4.22 ha (2013/2014) to 7.18 ha (2014/2015) and in A farm from 6.30 ha (2012/2013) to 8.30 ha (2014/2015). The research region has a land shape characteristic for an end moraine and soils have a mosaic character. In both farms, most often grains were a forecrop for rapeseed (only in A farm in 2014/2015 a rapeseed forecrop was narrowleaf lupin), both use similar plant protection schedules and choose for cultivation habitats with comparable soil conditions. Although, the most fertile plots are used for rapeseed cultivation these are stands which are relatively weak mainly IV B and V soil class.

B Farm, except for plant production, also carries out a contract fattening of cattle in the open system. Pig breeding is carried out in a non-litter piggery and the produced manure is used as a natural fertilizer. Due to the use of manure, this farm may limit the doses of applied mineral fertilizers, lowering thus the incurred costs. In the rapeseed cultivation a half of an admissible dose of manure, determined based on the amount of nitrogen introduced to soil with manure is applied (20 m^3).

Table 1.
Comparison of technologies of rapeseed production used in the investigated farms

Farm A		Farm B	
Date of treatment	Treatment	Date of treatment	Treatment
VIII/1	Disking (2012/2013 and 2013/2014).	VIII/1	Disking (2012/2013)
VIII/2	Sowing of fertilizers NPK	VIII/2	Manure
VIII/2	Ploughing	VIII/2	Ploughing
VIII/3	Sowing	VIII/3	Sowing of fertilizers NPK
VII/3 or IX/2	Herbicide treatment no. 1	VIII/3	Sowing
IX/2	Herbicide treatment no. 2	IX/1	Herbicide treatment no. 1
IX/3-X/1	Fungicide treatment no. 1	IX/2	Herbicide treatment no. 2
II/3	Top fertilizing	IX/3-X/1	Fungicide treatment no. 1
III/2	Fungicide treatment no. 2	II/3	Top fertilizing
III/3	Insecticide treatment no. 1	III/2	Fungicide treatment no. 1
IV/1	Top fertilizing no. 2	III/3	Insecticide treatment no. 1
IV/1	Fungicide treatment no. 3	IV/1	Top fertilizing no. 2
IV/2	Top fertilizing no. 3 (2014/2015)	IV/1	Fungicide treatment no. 3
IV/3	Insecticide treatment no. 2	IV/3	Insecticide treatment no. 2
V/1	Insecticide + fungicide treatment	V/1	Insecticide + fungicide treatment
VII/2	Dessication + gluing (2012/2013 and 2014/2015)	VII/2	Dessication + gluing (2012/2013 and 2014/2015)
VII/3	Harvest	VII/3	Harvest

Resarch results

The most important element of the cost structure of rapeseed production in the analysed farms was the costs incurred on materials and raw materials for production (table 2). Both in the farm which uses natural fertilizers as well as in the one, which was based on only the use of artificial fertilizers, costs of materials constituted more than a half of the total sum of the production costs (fig. 1). A farm had higher financial expenditures on the purchase of production materials in all three years of research. At the average this difference was 124.46 PLN·ha^{-1}. It results from the use of higher doses of mineral fertilizers by A farm. Considerable sums of money were related to exploitations of machines and devices. However, B farm incurred higher inputs by 21%. The reason for the increase of exploitation costs of machines and devices in this farm was manure fertilization, which requires the use of expensive water bowsers. Additionally, they have a short time of use and high rate of repairs costs, which raises the cost of such treatment. Organic fertilization in this farm also raised the costs of consumed fuel and the costs of work by approximately 16% and 24%. Costs of work constitute 3% of the total sum of direct costs of rapeseed production and are its lowest element. Expenditures related to natural fertilization decided on the higher total sum of direct costs in 2012/2013 and 2013/2014 in farm B. The fact of reduction in both analysed objects of expenditures incurred on the purchase of fuel in 2014/2015 is worth mentioning, which is related to the reduction of this raw material.

Table 2.
Direct costs incurred by the investigated farm

Farm	Season	Fuel cost	Work cost	Exploitation cost	Materials	Sum
		(PLN·ha^{-1})				
A farm	2012/2013	316.17	63.64	577.95	1753.85	2711.61
B farm		384.11	85.29	683.30	1661.46	2814.16
A farm	2013/2014	322.39	72.14	572.97	1749.56	2717.06
B farm		349.49	93.11	685.55	1659.25	2787.40
A farm	2014/2015	234.80	76.05	578.06	2196.69	3085.60
B farm		283,.4	99.93	720.43	1846.49	2949.99

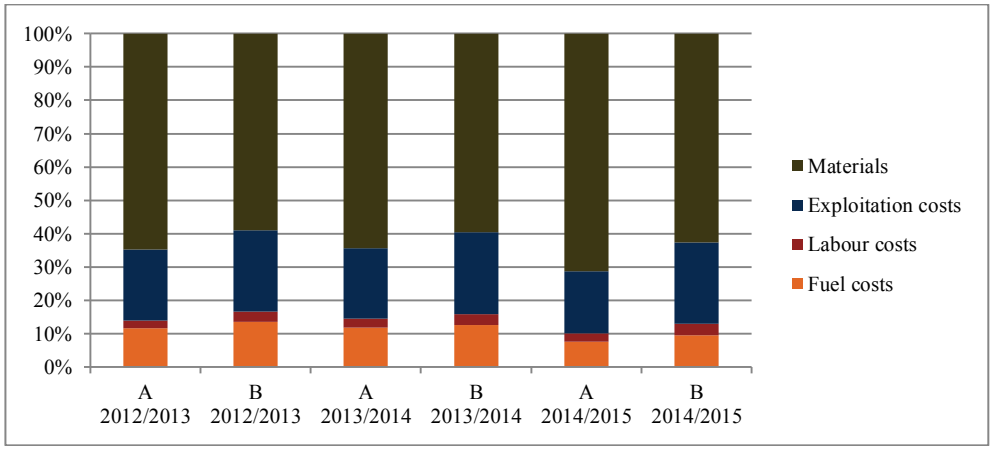

Figure 1. Cost structure in the direct cost structure in a farm which uses only mineral fertilizers (A) and farm which uses manure (B)

Interesting observations may be drawn from the analysis of cost structure of machines and devices exploitation divided into particular groups of treatment (table 3). The biggest differences between the analysed farms occur in case of fertilization. In a farm which uses manure, costs related to fertilization are even 9 times higher (2012/2013) than the costs of this treatment incurred by a farm which uses only artificial fertilizers. In B farm fertilization leaves space in the cost structure of machines exploitation only to expenditures related to the seeds harvesting. In farm A, fertilization constitutes the lowest element of the total sum of the exploitation costs of machines and devices which constitutes approximately 6% at the average (fig. 2). In both farms the highest inputs was incurred by rapeseed harvesting. Costs of this treatment were from 390.85 PLN·ha^{-1} in B farm (2012/2013) to 447.22 PLN·ha^{-1} in A farm (2013/2014). The sum of exploitation costs of machines and devices was at the average by 20% higher than in B farm which results from high costs of manure fertilization.

Table 3.
Costs of machines and devices exploitation including costs of fuel and human work divided into particular groups of treatments

Farm	Season	Cultivation	Fertilization	Sowing	Protection	Harvest	Sum
		(PLN·ha^{-1})					
A farm	2012/2013	206.63	38.16	135.06	134.45	443.47	957.76
B farm		199.81	333.26	121.56	107.23	390.85	1152.70
A farm	2013/2014	210.48	45.30	143.45	121.05	447.22	967.50
B farm		138.55	355.36	142.9	96.85	394.60	1128.15
A farm	2014/2015	128.59	72.08	134.19	126.92	427.14	888.91
B farm		127.64	344.18	134.64	94.10	402.94	1103.50

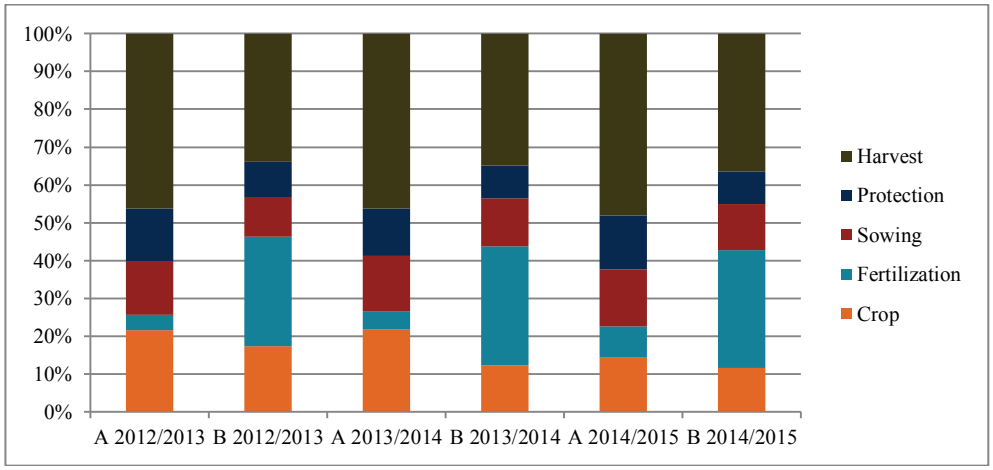

Figure 2. Cost structure of machines and devices exploitation in a farm which uses only mineral fertilizers (A) and farm which uses manure (B)

A farm which uses manure despite lower doses of mineral fertilizers, obtained higher crops or the same as a farm which uses mineral fertilizers (table 4). The highest difference which was 1.3 t·ha^{-1} was reported in 2012/2013. The reduction of crops in this season in A farm should be related to considerable damage caused in winter by game. Beside this exception, the obtained crop always exceeded 3 t·ha^{-1}. Taking into account failure and low agricultural usefulness of soils where rapeseed was sowed, crop of this level may be considered as satisfactory. In the first two years of research, a higher crop was obtained by B farm. On the other hand, in the season 2014/2015, in A farm, a similar efficiency as in B farm was reported. However, it was related to the increase of doses of mineral fertilizers thus increasing considerably the direct production costs. In this season, inputs per a ton of the obtained raw material were higher in A farm by approximately 65 PLN. Both farms cooperate together with relation to the sale of produce because the price they obtained for

the sold raw material was the same for both farms every year. The highest value of the sold rapeseed was reported in 2014/2015 and it amounted to 4970 PLN·ha^{-1} and it was the same in both investigated facilities. Based on the value of economic effectiveness rate it may be said that the rapeseed cultivation within three years of research was always profitable. The highest value of this rate, and thus the highest income was reported in B farm in 2014/2015. The lowest productivity and income was reported in A farm in 2012/2013. However, it happened mainly as a result of gaming damages which a farmer could not avoid.

Table 4.
Economic efficiency of rapeseed production in the analysed farms

Farm	Season	Crop	Price	Value	Direct costs		Economic	Income
		(t·ha^{-1})	(PLN·ha^{-1})	(PLN·ha^{-1})	(PLN·ha^{-1})	(PLN·t^{-1})	efficiency rate	(PLN·ha^{-1})
A farm	2012/2013	2.0	1420.00	2840.00	2711.61	1355.81	1.05	128.39
B farm		3.3	1420.00	4686.00	2814.16	852.78	1.67	1871.84
A farm	2013/2014	3.3	1290.00	4192.50	2717.06	836.02	1.54	1475.44
B farm		3.5	1290.00	4515.00	2865.19	818.63	1.58	1649.81
A farm	2014/2015	3.5	1420.00	4970.00	3085.60	907.53	1.61	1884.40
B farm		3.5	1420.00	4970.00	2949.99	842.85	1.68	2020.01

Conclusion

The use of organic fertilizers caused the increase of economic efficiency of rapeseed production. Organic fertilization causes the increase of expenditures incurred on machines and devices exploitation – at the average by 21% at the same time limiting the expenditures incurred on the purchase of artificial fertilizers. As a result costs of materials and raw materials (the most important element of the direct cost structure of rapeseed production) in a farm which uses manure were reduced by approximately 11%. Higher exploitation costs incurred by a farm which uses manure resulted in the increase of the total sum of direct costs. It is particularly visible within two first years of research when direct costs incurred by A farm were at the average by 125.34 PLN·ha^{-1} lower than in B farm.

Due to the use of manure, B farm obtained a satisfactory crop at the reduced doses of applied mineral fertilizers. During the investigations the crop obtained by B farm was higher by 0.5 t·ha^{-1}. A farm in order to achieve a similar efficiency had to considerably increase the doses of applied mineral fertilizers, which was related to the increase of costs, particularly in 2014/2015. In this season the total sum of costs was higher in A farm for the first time.

Despite higher exploitation costs incurred by a farm which uses manure, this technology is more effective on account of economy. It is mainly related to a higher crop obtained by this farm and lower inputs on fertilization. As a result of using manure, an average income from rapeseed production was higher in B farm by 731 PLN·ha^{-1}, and the coefficient of economic effectiveness by 0.24

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PORÓWNANIE EFEKTYWNOŚCI EKONOMICZNEJ PRODUKCJI RZEPAKU W GOSPODARSTWACH STOSUJĄCYCH RÓŻNE WARIANTY NAWOŻENIA

Streszczenie. Intensywny chów i hodowla zwierząt wiążą się z powstawaniem znacznych ilości gnojowicy, która może zostać wykorzystana jako nawóz naturalny. Nawożenie gnojowicą może przyczynić się do zmniejszenia ilości stosowanych nawozów mineralnych, a przez to obniżenia kosztów produkcji. Dotyczyć to może szczególnie gatunków cechujących się dużymi potrzebami nawozowymi, takich jak rzepak ozimy. Celem badań było porównanie efektywności ekonomicznej produkcji rzepaku w dwóch gospodarstwach, stosujących odmienne warianty nawożenia. W jednym stosowano jedynie nawozy mineralne, w drugim nawożenie mineralne uzupełniano nawożeniem organicznym gnojowicą. Stosowanie gnojowicy przyczyniło się do obniżenia nakładów na materiały i surowce do produkcji, szczególnie nawozy. Przy porównywalnych plonach uzyskiwanych przez oba gospodarstwa, technologia oparta na nawożeniu gnojowicą okazała się bardziej efektywna.

Słowa kluczowe: rzepak ozimy, nawożenie, gnojowica, efektywność ekonomiczna