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## **THE ROLE OF INNOVATION ON COMMERCIAL FARMS IN POLAND**

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### **ABSTRACT**

Changes in relations between production factors necessitate surveys into their effect on the total value of production. This paper aims to determine the extent to which the involvement of production factors in the production process, in particular in connection with progress, that is, broadly interpreted innovation, had an influence on the value of production of specific size farms determined based on cropland area. The surveys were based on figures recorded for individual commercial farms registered in the database of the Polish Farm Accountancy Data Network (FADN). It ensured the methodological uniformity of data used in this paper. The analysis of the production process on farms was carried out by means of the Cobb-Douglas (C-D) production function method. The study makes it possible to evaluate changes in the productivity of production factors on commercial farms in years covered by the surveys. The flexibility of relations between total production in PLN (Polish Zloty) and production factors, i.e. labour output in man-hours and total costs in PLN, was analyzed. Changes in the management effectiveness of commercial farms which occurred when Poland joined the European Union were evaluated. According to the survey, the level of technical and organisational progress was the highest on farms with the largest cropland area, i.e. 30 =< 50 ha and more than 50 ha, as well as on farms with the smallest cropland area, i.e. less than 5 ha. The size of the farm sufficient to satisfy the requirement of farming products is 10=<20 ha of cropland and 20=<30 ha of cropland.

**Keywords:** *agriculture, commercial farms, Poland, production factors, innovation.*

### **INTRODUCTION**

With regard to the necessity to secure the food requirements, despite its small share in the Gross Domestic Product (GDP) agriculture supports permanent economic development. The fundamental task of agriculture is producing easily accessible food at a relatively lower cost. In compliance with the theory of economics, full rationality in agriculture leads to the effective utilization of resources and achievement of the economic optimum; however, neglecting external effects.

Previous studies indicate that agriculture based exclusively on the criteria of microeconomic rationality leads to discrepancies between the microeconomic minimum and the social optimum, which causes the loss of social parts and social environmental benefits (Zegar, 2010). The development of Polish economy based on innovations makes it possible to include Poland in the group of highly developed countries (Chyłek et al., 2016). Innovation is inseparably linked with change. The term ‘innovation’ was introduced into economic studies by Schumpeter who understood it broadly as the production of new products or improvement of the existing ones, the introduction of a new or improved method of production, the opening of a new market, the use of the new selling or purchasing method, the use of new raw materials or semi-finished products, and the introduction of the new organisation of production (Schumpeter, 1960). In turn, the definition of innovation according to the OECD is the implementation of a new or significantly improved product, service or process in business practices, including the implementation of a new marketing or a new organisational method redefining the method of work or relations between the business and the environment (OECD, 2005). The knowledge capital, meaning R&D-related activities, plays a key role in enhancing competitiveness and accelerating economic growth and transformation, both in the domestic economy and in relation to particular sectors, including agriculture (Kijek et al., 2016). In Poland the rate of innovative progress in agriculture is much lower than in other sectors of economy and the implementation of the 2020 strategy in Polish agriculture is carried out using funds provided under the Rural Development Programme (Nosecka and Zaremba, 2016). Improvement of the economic results of all farms is one of the main objectives which can be achieved thanks to increasing the profitability of farms and their competitiveness. Poland has noted down quite a rapid growth in agricultural production, export of agricultural and food products, an increase in income and life standard in rural areas with a relatively low level of productivity of agriculture, overemployment, and poor agrarian structure (Wilkin and Nurzy ska, 2016).

Changes in relations between production factors necessitate surveys into their effect on the total value of production. This paper aims to determine the extent to which the involvement of production factors in the production process, in particular in connection with progress, that is, broadly interpreted innovation, had an influence on the value of production of specific size farms determined based on cropland area. It also attempts to evaluate the effectiveness of production of the analysed factors during the term of Poland’s membership in the European Union.

### **MATERIALS AND METHODS**

The surveys were based on figures recorded for individual commercial farms registered in the database of the Polish Farm Accountancy Data Network FADN (Goraj and Ma ko, 2009). In the European Union commercial farms have a cropland area of at least 1 hectare, and if they are smaller than 1 hectare – they supply a major part of their products to the market or their production exceeds the standard production volume (Goraj and Olewnik, 2011). The analysis made use of

the classification of commercial farms according to cropland area. Table 1 presents the number of farms in a sample covered by the survey grouped according to farm area.

Table 1. The sample of farms covered by the survey according to classes of cropland area in 2004, 2009 and 2012.

Specification	Number of farms in the sample					
	<5 ha	5=<10 ha	10=<20 ha	20=<30 ha	30=<50 ha	>=50 ha
2004	574	1571	3484	2130	1834	1399
2009	354	1185	3012	2156	2134	2096
2012	203	928	2671	1923	2035	2171

Source: Own calculations based on unit empirical data from the monitoring of the Polish FADN

The evaluation of factors shaping the economic situation of agriculture in the period of accession to the European Union is of particular importance with regard to high expectations but also with regard to fears (Zegar, 2009). Years covered by the survey: 2004, 2009, 2012. For the purposes of the study the relationships describing the process of production on farms were quantified. The production function is used for mapping relationships between the outcome of this process and factors involved in this process (Welfe and Welfe, 1996). The production process on commercial farms covered by the survey was analysed by means of the Cobb-Douglas (C-D) production function, which facilitated the analysis of substitution of production factors, the analysis of the productivity of production factors as well as horizontal and vertical comparisons.

The studies made use of the production function taking labour and capital into account (Tomczak, 1983; Bezat and Rembisz, 2011). Land was not included in the equation, among other reasons, with regard to significant limitation of the scope of variability of this characteristic in comparison to others by identifying farm groups according to their area. The objective of the studies was accomplished by means of the Cobb-Douglas (C-D) production function method because it constitutes the theoretical basis for explaining most regularities concerning effectiveness in the economics of agriculture (Bezaty and Rembisz, 2011). The function is as follows:

$$Y = aX_1^\alpha X_2^\beta d, \text{ where:}$$

$a$  – constant describing the specific level of technical and organisational progress,

$Y$  – total value of production in PLN (according to Polish FADN: SE131),

$X_1$  – total labour input in man-hours (SE011),

$X_2$  – stream of capital determined by the costs of production (SE270) in PLN,

$\alpha, \beta$  – regression coefficients specific to respective factors,

$d$  – random factor.

The measurement of business production effectiveness has been a developing concept in recent decades. Production effectiveness surveys are a standard procedure allowing rational allocation of resources. High operating effectiveness of a commercial farm is a reason for continuing investment, whereas low effectiveness is a warning that the activity should be limited or discontinued (Adamkiewicz-Drwiłło, 2002).

## RESULTS AND DISCUSSION

The symbols of characteristics are used consistently throughout the paper and the content and symbolic of the variables comply with the methodology used in the Polish FADN. The initial value of the production potential contributes to multiplying but does not ultimately determine this potential (Góral, 2016). The cross-functional surveys assume that production factors are continuously substituted and that every combination of production factors matches a clearly defined level of production (Nieżgoda, 1986). The production function expressing the relationship between total production in PLN (SE131) as a dependent variable and human labour in man-hours (SE011) and the total cost in PLN (SE270) as independent variables was illustrated by the following equations:

### I. Cropland area group <5 ha

$$2004: SE131' = 1.2091 SE011^{0,0682} SE270^{0,9538}$$

2009: the analysis of the production function was abandoned since the constant (a) and the human labour in man-hours (SE011) turned out to be statistically insignificant.

$$2012: SE131' = 1.6101 SE011^{0,1141} SE270^{0,9012}$$

### III. Cropland area group 10=<20 ha

$$2004: SE131' = 0.9143 SE011^{0,0903} SE270^{0,9648}$$

$$2009: SE131' = 0.1670 SE011^{0,1178} SE270^{1,0827}$$

$$2012: SE131' = 0.4941 SE011^{0,1210} SE270^{0,9944}$$

### V. Cropland area group 30=<50 ha

$$2004: SE131' = 1.5202 SE011^{0,1080} SE270^{0,9162}$$

$$2009: SE131' = 0.2641 SE011^{0,0657} SE270^{1,0752}$$

$$2012: SE131' = 1.7748 SE011^{0,0462} SE270^{0,9430}$$

### II. Cropland area group 5=<10 ha

$$2004: SE131' = 0.6280 SE011^{0,1251} SE270^{0,9698}$$

$$2009: SE131' = 0.3109 SE011^{0,0774} SE270^{1,0610}$$

$$2012: SE131' = 0.4944 SE011^{0,1067} SE270^{1,0079}$$

### IV. Cropland area group 20=<30 ha

$$2004: SE131' = 1.3508 SE011^{0,1039} SE270^{0,9254}$$

$$2009: SE131' = 0.1794 SE011^{0,1008} SE270^{1,0858}$$

2012: the analysis of the production function was abandoned since the constant (a) turned out to be statistically insignificant

### VI. Cropland area group >=50 ha

$$2004: SE131' = 2.0156 SE011^{0,0604} SE270^{0,9268}$$

2009: the analysis of the production function was abandoned since the human labour in man-hours (SE011) turned out to be statistically insignificant

$$2012: SE131' = 2.4493 SE011^{-0,0307} SE270^{0,9728}$$

The analysis was limited to statistical elements of functions that are significant at the adopted level of probability. Statistical verification of regression coefficients in the equations was performed by means of t-Student test assuming the level of significance = 0.01. A statistically significant level of multiple correlation coefficients indicates that this function model matches the coordinates of the analysed characteristics. The presented equations are characterised by a high degree of probability for regression coefficients in the groups of farms and years covered by the survey.

The power function is a function with a constant (irrespective of the value of respective variables) elasticity of the dependent variable, and the elasticity of respective variables equals the evaluations of parameters describing such variables (Czekaj, 2006). The coefficients of production elasticity for respective production factors indicate that the increase in the value of production was to the highest extent shaped by the stream of capital. Such trends in 2004-2007 were also identified in the studies by Niezgodna (2010). The optimum utilization of production factors on a farm using the mechanism of substituting capital for human labour considerably determines the resulting level of production.

Table 3 presents the level of the coefficient of total elasticity of production factors in relation to the production value and the parameter “a” describing a specific level of technical and organisational progress.

Table 3. The level of total production elasticity coefficient (SE131) in relation to workload (SE011) and the stream of capital (SE270) and the parameter “a” describing a specific level of technical and organisational progress for farms covered by the survey grouped according to cropland area in 2004, 2009 and 2012.

Specification	<5 ha	5=<10 ha	10=<20 ha	20=<30 ha	30=<50 ha	>=50 ha
	Total production elasticity coefficient for the analysed factors					
2004	1.0220	1.0950	1.0552	1.0294	1.0241	0.9872
2009	-	1.1384	1.2005	1.1866	1.1409	-
2012	1.0153	1.1146	1.1154	-	0.9892	0.9421
	Parameter “a” – describing a specific level of technical and organisational progress					
2004	1.2091	0.6280	0.9143	1.3508	1.5202	2.0156
2009	-	0.3109	0.1670	0.1794	0.2641	-
2012	1.6101	0.4944	0.4941	-	1.7748	2.4493

Source: Own calculations based on unit empirical data from the monitoring of the Polish FADN.

The total elasticity coefficient is a measure of the impact of changes in production factors on the scale of production (Santeramo, 2014). The power function is characterised by the constant elasticity of production in relation to the factors irrespective of the level of their utilization and the resulting production volume. Regression coefficients are also coefficients of production elasticity in relation to factors (Doszy , 2012). The analysis indicates that a simultaneous increase in the involvement of every factor by 10% maintaining proportions between factors

resulted in an increase in total production in the analysed years for very small farms by 10.22% in 2004 and by 10.15% in 2012, whereas for small farms by 10.95% in 2004, 11.38% in 2009, and 11.15% in 2012, which means the benefits of scale (Milewski and Kwiatkowski, 2013). Similarly for quite small farms, the increase in the involvement of factors by 10% contributed to an increase in total production by: 10.55%, 12.01%, and 11.15% respectively and for quite large farms by 10.29% in 2004 and by 11.87% in 2009. In turn, for large farms the increase in the involvement of every factor by 10% contributed to an increase in total production by: 10.24%, 11.41%, and 9.89% respectively and for very large farms by 9.87% in 2004 and by 9.42% in 2012. It means that in 2004 the increase in the involvement of factors by 10% contributed to a less than proportional increase in total production only for very large farms, and in 2012 also for large and very large farms, whereas for very small, small and quite small farms the increase was more than proportional. Those were the effects of less intensive organisation of production on small farms compared to farms with a large area. In 2009 the increase in production was more than proportional for all the analysed farms grouped according to area, while the level of parameter “a” describing technical and organisational progress was low. This suggests that it is difficult to increase the already high level of technical and organisational progress (innovation) for farms with a large area, whereas increasing the level of innovation for farms with a small area where the level of innovation is lower brings better effects. Due to the deficiency of capital some farmsteads cannot increase innovation in the production potential, e.g. change production techniques to more rationally accommodate their resources in products e.g. introducing new varieties or ecological production (Jó wiak at al., 2012).

### **CONCLUSION**

The basis for determining the competitive advantage of farms is product, process and marketing innovations. According to the survey, the level of technical and organisational progress was the highest on farms with the largest cropland area, i.e. 30=<50 ha and more than 50 ha, as well as on farms with the smallest cropland area, i.e. less than 5 ha. In turn, the differentiated level of production elasticity coefficient confirms the advisability of separating area groups from the whole collective of farms. It also means that the size of the farm sufficient to satisfy the requirement of farming products is 10=<20ha of cropland and 20=<30ha of cropland. Those were the effects of less intensive organisation of production and probably of substituting human labour with capital. It was economically justified in connection with EU grants. The surveys aim to improve the agrarian structure.

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