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The impact of availability of means of transport on agricultural production in selected European countries

Abstract. The object of the paper is to determine the relationship between the number of tractors and production results. Seven European countries with diverse land, production and human resources and different natural and topographic conditions were selected by the application of the purposive sampling method and included in the study. The study period spans from 2004 to 2009. In the analysed population, production results were not in correlation with the number of tractors. When examining the relationship only in some selected countries, the author discovered the existence of differences in the correlation between the number of tractors and the value of agricultural production. The resulting correlation values for developed countries were positive, whereas in the case of developing countries, the values were negative. Thus, the number of tractors influences the value of agricultural production in harmonised economies. Nevertheless, we should also consider a number of additional factors, such as price volatility, weather conditions, etc.

Key words: means of transport , number of tractors, agricultural production.

Introduction

The Industrial Revolution in the second half of the 18th Century was the beginning of major changes in production. One of its consequences was the invention of the internal combustion engine in the 20th Century [Toynbee 2000]. According to many authors, technical progress is a key factor in economic growth [Blaug 2000]. For instance, Solow proves that in the first half of the 20th Century in the U.S. economy, labour productivity growth was due to technical advancement (87.5% influence), followed by the increase in the technical infrastructure of employment (12.5%) [*Gospodarka*… 2007]. In subsequent years, the increase in productivity resulting from technical progress and employment infrastructure steadily became smaller [Czarny 2000]. Determination of the influence of technical progress on productivity within the whole sector is difficult due to the existence of links with other branches of economy. Thus, the estimates may be flawed [Espositi 2000]. In narrow terms, technical progress in agriculture includes innovations of mechanical nature, whereas, in broader terms, it includes innovations of both mechanical and biological nature [Kierul & Majewski 1991]. Other authors additionally distinguished organisational, technological and socioeconomic progress [Strużek 1976; Klepacki 1990]. Once again, accurate assessment of the influence of the individual type of progress on agricultural productivity is not easy. However, the studies indicate that productivity growth is mainly due to technical progress [Rusielik & Świtłyk 2009]. Some authors attribute technical progress mainly to the growth of labour productivity [Malaga-Toboła 2008].

Progress in mechanisation is distinguished within technological progress, which in turn is part of the technical and scientific progress [Wójcicki 2001]. Progress in

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mechanisation affected the dynamic changes in the traction force and in the motorisation of agricultural farms [Wójcik 2004; Pawlak 2006]. It is achieved not only through the construction, manufacture and design of finer agricultural equipment, but also through better and more efficient use of existing and new technologies [Szeptycki 2006]. The low application of technical means of production, especially at small farms, is a factor limiting the efficiency of technical progress implementation [Pawlak 1997]. It should also be noted that progress occurs primarily at developmental farms, i.e. the ones which are open to investments [Wójcicki 2006]. Transport constitutes a significant element of agricultural activity. The studies indicate that agricultural transport consumes approx. 30% of the total labour expenditure, and 40-60% of working time expenditure of traction force [Bielejec 1989]. Thus, transport processes generate material costs. In order to reduce these costs, we need a proper selection of means of transport and an efficient organisation of transport processes [Kokoszka & Tabor 2006]. The studies indicate that the technical infrastructure of farms, i.e. agricultural equipment including tractors, varies significantly across individual farms. The differentiating factors are: size of the farm, its economic strength, natural and topographic factors [Muzalewski 2008].

In the description of the farm, many papers frequently use the term: means of transport, as part of machinery and equipment. A list of means of transport includes tractors, trailers, dump trailers and trucks. According to some authors, in addition to tractors and trucks, traction force shall also include combine harvesters and forage harvesters [Rokicki & Wicki 2010]. For the purpose of this article, means of transport have been limited to agricultural tractors. In 2007, according to estimates, there were 29.8 million tractors operating in the agricultural sector worldwide, of which more than 5% were located in Poland [Pawlak 2010].

Material and methods

In this article, the transport infrastructure of agriculture has been limited to tractors due to the fact that these machines are in common use in agricultural activity. The object of the paper is to determine the relationship between the number of tractors and production results. Seven European countries with diverse land, production and human resources and different natural and topographic conditions have been selected by the application of the purposive sampling method and included in the study, namely: Belarus, Iceland, Poland, Romania, Russia, Spain and Ukraine. Three of these countries are EU member states: Spain joined the EU in 1986, Poland in 2004, and Romania in 2007. Belarus, Ukraine and Russia are former Socialist [Eastern] Block countries. Iceland is not an EU member state and has very specific topographic conditions. The sources of materials for this paper are data provided by the World Bank. The study period spans from 2004 to 2009. When collecting necessary information, the author was not able to obtain complete data for the years 2010-2012, therefore the period between 2004 and 2009 was chosen for the study. The following methods have been applied in this paper: descriptive, tabular, graphic, indicator and correlation coefficient methods.

Research results

The number of tractors in various European countries is variable (Table 1). To a large extent, this number is influenced by the availability of land resources, human resources and the type of production, primarily crop production. Among the countries under the survey, the largest number of tractors was reported for Poland (approximately 1.5 million), and the smallest number – for Iceland. A clear upward trend, which should be considered in positive terms, can be observed in Poland and Spain in the years 2004-2009. Reverse trends can be observed in Russia, Belarus and Ukraine. In addition to the number of tractors, the following parameters are important: age, power and technical condition of tractors. However, these parameters are not taken into account in the present article.

Table 1. Number of agricultural tractors in selected European countries

Specification	Number of agricultural tractors in period 2004-2009					
	2004	2005	2006	2007	2008	2009
Belarus	55330	53581	52613	50436	49517	48100
Iceland	10750	10928	11144	11403	11525	11432
Poland	1365400	1437183	1495287	1553390	1566340	1577290
Romania	171811	173043	174563	174003	174790	176841
Russia	531973	480333	439600	405661	364356	329980
Spain	966598	980808	1000222	1016043	1030440	1038726
Ukraine	370404	352252	344263	336848	335473	333529

Source: results of own research based on „The World Bank Database'', http://data.worldbank.org.

Table 2. Number of tractors per 100 km^2 of agricultural land in selected European countries

Specification	Number of tractors per 100 km^2 of agricultural land in period 2004-2009					
	2004	2005	2006	2007	2008	2009
Belarus	62	60	59	57	56	54
Iceland	57	58	59	61	61	63
Poland	836	904	937	960	970	979
Romania	122	122	124	128	128	130
Russia	25	22	20	19	17	15
Spain	332	336	350	363	366	371
Ukraine	90	85	83	82	81	81

Source: as in Table 1.

The number of tractors per 100 km^2 of agricultural land constitutes a valid basis for comparing various countries (Table 2). This ratio is indicative of the equipment infrastructure of land. The higher the ratio, the better. Comparisons on an international scale present the ratio of the number of tractors per 100 km2 of arable land. However, this method of comparison may be flawed, as the share of arable land in agricultural land varies across countries. The ratio of the number of tractors to agricultural land is a better method for comparing individual countries. The best situation was reported for Poland, with almost

one thousand tractors per 100 km^2, and the worst results in this respect – in Russia (only 54 tractors in 2009). Overall, the highest rates were achieved in EU member states. The resulting correlation coefficient between the number of tractors and the area of agricultural land was negligible and amounted to - 0.07.

Individual countries also varied in terms of population living in rural areas. The indicator shown in Figure 1 presents the number of inhabitants of rural areas per 1 agricultural tractor. The smaller the value, the better. The best result was reported for Iceland (1.8 person per one tractor), and the worst result – for Russia (114 inhabitants per 1 tractor). Thus, the differences between individual countries are significantly large.

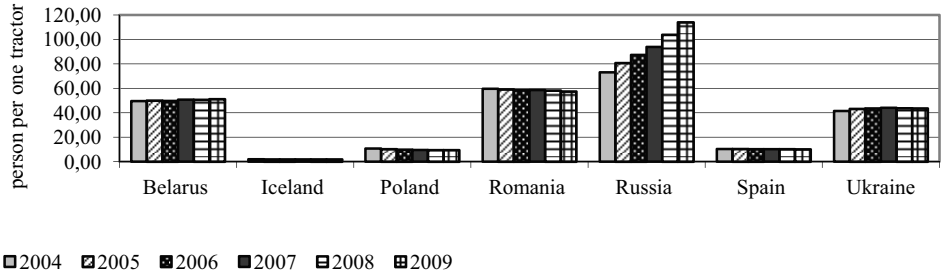

Fig. 1. Number of inhabitants of rural areas per 1 agricultural tractor in selected European countries

Source: as in Table 1.

In developed countries, the share of population working in the country is on the decrease. In 2009, in Iceland, only 4.8% of the population worked in the country, in Spain – 4.2%, but in Poland, as many as 13.3%, and the highest percentage – 29.1% was reported in Romania. In developing countries, for many residents, rural areas also perform social functions, masking the actual unemployment rates.

Table 3. Employment in agricultural sector in selected European countries (as per total employment values, in %)

Specification	Employment in agricultural sector in period 2004-2009 (as per total employment values, in %)					
	2004	2005	2006	2007	2008	2009
Belarus	10,5	10,5	10,5	10,5	10,5	10,5
Iceland	6,4	6,5	6,3	5,9	4,6	4,8
Poland	18,0	17,4	15,8	14,7	14,0	13,3
Romania	31,6	32,1	30,5	29,5	28,7	29,1
Russia	10,2	10,2	10,0	9,0	8,6	9,7
Spain	5,5	5,3	4,8	4,5	4,0	4,2
Ukraine	19,7	19,4	17,6	16,7	15,8	15,6

Source: as in Table 1.

In the agricultural sector, value added per worker varied quite significantly from one country to another (Figure 2). The highest indicators were reported in the most developed countries. The result reported for Poland proved to be quite poor, and the only country with poorer values was Ukraine. This stems from excessively high employment rates in the

agricultural sector in Poland and former socialist countries. The calculation of correlation coefficients indicates a minor relationship between the number of tractors and value added per 1 agricultural worker (0.31). A major positive relationship was observed in Spain (correlation coefficient of 0.91), and a major negative relationship - in Russia (-0.97). Thus, each country should be analysed individually.

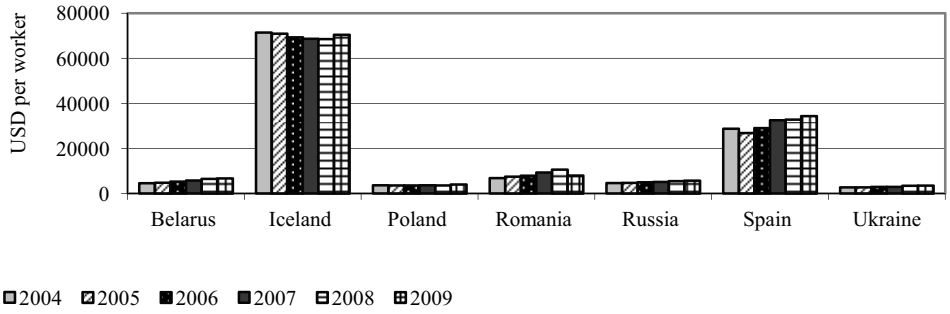

Fig. 2. Value added per agricultural worker in selected European countries (in USD, prices for 2005)

Source: as in Table 1.

In most countries under the analysis, food production was on the increase (Figure 3). Romania, where lower production values were reported, especially in 2008, was exceptional in this regard. Significant growth dynamics were observed in Ukraine whose agricultural land is of high quality. The correlation coefficient between the indices of changes in the number of tractors and the value of food production amounted to -0.41. This proved the existence of a minor negative correlation. This result was achieved mainly due to the decrease in the number of tractors in Russia and Ukraine. In developed countries, such as Iceland, a positive correlation between the number of tractors and the value of food production could be observed (0.94).

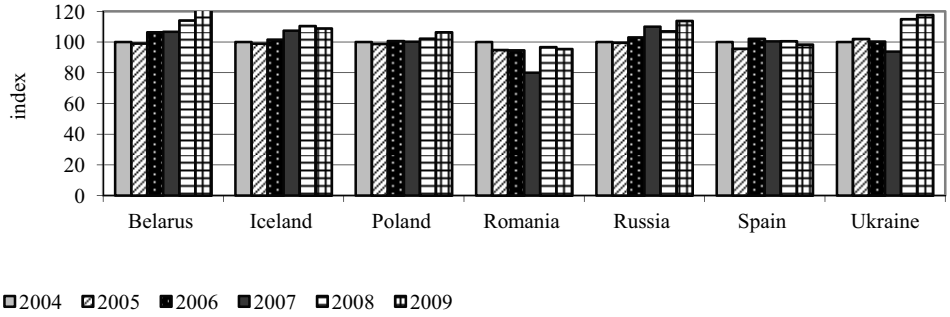

Fig. 3. Dynamics of changes in the value of food production in selected European countries (2004 =100.)

Source: as in Table 1.

In the case of crop production, the trends were similar to those in the production of all food (Figure 4). However, in Romania, where the decline in the value of crop production in 2008 accounted for 58% of production in 2004, the differences became more prominent.

Perhaps as a result of accession to the EU, there occurred some adverse changes in Ukrainian agriculture. Once again, Ukraine showed quite favourable results here. In addition, the correlation coefficient between the indices of the number of agricultural tractors and the value of crop production (correlation coefficient = -0.37) was calculated. The negative correlation was caused either by the decrease in the number of tractors at a similar value of crop production, or vice versa, by the drastic decline in the value of production at a similar number of agricultural tractors. Similarly, as in the case of food production, in the crop production in economically developed countries, there was a minor positive relationship between the number of tractors and the value of crop production (e.g. in Spain – 0.19, Iceland – 0.12, Poland – 0.43).

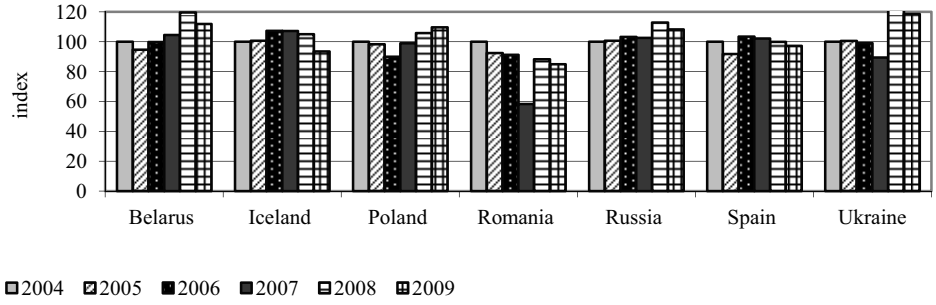

Figure 4. Dynamics of changes in the value of crop production in selected European countries (2004 r. = 100.)
Source: as in Table 1.

Changes in the value of livestock production were not significant (Figure 5). Stagnation can be observed in most countries. Even in Romania, similarly as in Ukraine, the situation was stable. The only exception was Belarus where the value of livestock production in 2009 increased by 29% as compared to 2004. The correlation coefficient between the indices of changes in the number of tractors and the value of livestock production showed a minor negative relationship (-0.37). This result can be explained in the similar manner as in the case of correlation of the value of total food production and the value of crop production. Similarly, in developed countries, the correlation between these values was positive: for Iceland – 0.93, Poland – 0.55, Spain – 0.04.

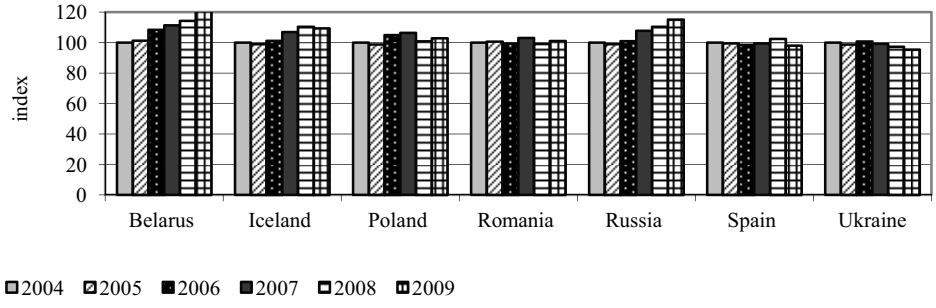

Fig. 5. Dynamics of changes in the value of livestock production in selected European countries (2004 r. = 100.)
Source: as in Table 1.

The results regarding the correlation between the number of tractors and the value of production enable us to conclude that there were differences across countries, and each case should be treated individually. The level of economic development of the country appears to be a crucial factor.

Summary

Technical advancement, including mechanisation, is one of many elements influencing progress in agriculture. Distinguishing the impact of one type of progress from another is difficult and requires application of complex mathematical models. This paper focuses on tractors, i.e. means of transport indispensable in modern agriculture. The author analyses the number of tractors, without regard to their age, power or technical condition. Disproportions occurred across countries under the study. The largest number of tractors per 100 km2 of agricultural land was observed in Poland (979 units in 2009), and the smallest – in Russia (15 units in 2009). The degree of importance of agriculture in the overall economy of individual countries was also variable, as evidenced by the share of employees of the agricultural sector in the total working population.

In the analysed population, production results were not in correlation with the number of tractors. When examining the relationship only in some selected countries, the author discovered the existence of differences in the correlation between the number of tractors and the value of agricultural production. The resulting correlation values for developed countries were positive, whereas in the case of developing countries, the values were negative. Thus, the number of tractors influences the value of agricultural production in harmonised economies. Nevertheless, we should also consider a number of additional factors, such as price volatility, weather conditions, etc.

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