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Productivity of work and land: a comparison between three dissimilar countries

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**Productivity of work and land: a comparison between three
dissimilar countries**

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Productivity of work and land: a comparison between three dissimilar countries

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Abstract

Research background: Analysis of economic and agricultural indicators are important tools to evaluate the performance of agriculture and describe scientific and technical progress (Agol *et al.*, 2014, pp. 1-9; Archibugi and Coco, 2004, pp. 629–654). They also enable comparisons between the performances of different countries. In the comprehensive review by McConnell and Bockstael (2005, pp. 621-669), the measures of development show that competitiveness, both in the international and domestic arena, should be evaluated by two main indexes: the work productivity index and the land productivity index.

Purpose of the article: The objective of this paper is to analyse social and economic factors that influence the efficiency of agriculture in three dissimilar countries: Poland, Unites States of America and China. The analysed countries have characteristic features that influence development of specific branches of agriculture including the level of social and economic growth, structural features of agriculture, agricultural policy, and market situations, thus shaping the level and structure of production. To our knowledge, this is the first study that discusses work and land productivity in these three countries.

Methodology/methods: For calculation of final indexes of work and land productivity for the analysed countries, basic control and economic characteristics are necessary. These were calculated using the Eurostat database (2014) and the Yearbook of International Statistics CSO (2012; 2013a, 2013b) and include the area of agricultural land, number of farms and the average size of farms, the number of people active in agriculture, and gross national production in total and in agriculture.

Findings & Value added: We found that Poland has not yet reached optimal land or work force productivity. The indicators suggest Poland is agriculturally closer to developing countries than developed. In particular, we indicate a low agricultural efficiency compared with Western countries. We conclude that to realise the full potential of Polish agriculture, considerable changes, such as farm consolidation and alternative employment options for farm workers, are necessary. According to the analysed data, Poland in comparison to China and the USA is at the last position in the ranking achieving 4% of the GNP in agriculture. Moreover, the structure of small farms in Poland with the average surface area of 10.38 is considerably lower than in the USA (190 ha) which causes that Poland is a less-competitive country. However, one should remember that not all experiences of leading countries may be directly translated into Polish conditions, where agriculture was shaping in completely different conditions and its present level has its historical preconditions.

Introduction

Analysis of economic and agricultural indicators are important tools to evaluate the performance of agriculture and describe scientific and technical progress (Agol *et al.*, 2014, pp. 1-9; Archibugi *et al.*, 2009, pp. 917–931). They also enable comparisons between the performances of different countries. In the comprehensive review by McConnell and Bockstael (2005, pp. 621-669), the measures of development show that competitiveness, both in the international and domestic arena, should be evaluated by two main indexes: the work productivity index and the land productivity index.

Work productivity depends on the technical degree of agricultural infrastructure and is a function of technical progress (Grotkiewicz and Michałek, 2009, pp. 109-116; Arrow *et al.*, 2007; Guoping *et al.*, 2008, pp. 361-379). The index of work productivity depends on a range of factors including degree of technical infrastructure, size of a farm, farm layout, number of work force and its qualifications, organization of work, field size and layout, and mechanization of agriculture (Michałek *et al.*, 2009, pp. 199-205; Grotkiewicz *et al.*, 2016, pp.43-51; Dethier and Effenberger, 2012, pp. 175-205). According to Kopytek (2000, pp. 30-35), the

possibility of a considerable increase in work productivity seems to be impossible in the near future. However, a second solution is possible, namely moving the employed people to other branches of the national economy (Kopytek, 2000, pp. 30-35).

The land productivity index provides information on the potential for agriculture in a given region and depends on biological and chemical progress (Murage et al. 2000, pp.1-8; Arrow *et al.*, 2007). It depends on many factors, among which the most important are soil quality, climatic conditions, fertilization, plant protection, timeliness of agro-technical treatments, levels of inputs, production orientation, and selection of crop varieties (Grotkiewicz and Michałek, 2009, pp. 109-116).

The objective of this paper is to analyse social and economic factors that influence the efficiency of agriculture in three dissimilar countries: Poland, United States of America and China. The analysed countries have characteristic features that influence development of specific branches of agriculture including the level of social and economic growth, structural features of agriculture, agricultural policy, and market situations, thus shaping the level and structure of production. To our knowledge, this is the first study that discusses work and land productivity in these three countries. Understanding the performance of land use and work productivity indicators that shape global agriculture is critical to aid decision-making regarding the management and competitiveness of agricultural lands worldwide.

Research Methodology

The USA is the largest producer of food in the world. Thus, it has highly developed agricultural systems. The agricultural land comprises 45% of the country's area, which is 9% of the world acreage (CSO, 2012). The average size of an agricultural farm is approximately 190 ha (CSO, 2012; Eurostat, 2014). Monoculture crops and high specialization of cultivation prevail in American farms. High levels of mechanization of some crops almost entirely eliminate physical labour (Yang and Zhu, 2013, pp. 367-382).

China is the second largest country analysed here and the fastest developing national economy of the world, reaching an average rate of increase of 10% annually for the last 30 years (CSO, 2012; CSO 2013b; Cieřlik, 2013, pp.19-28). Agricultural lands were 56% of the total land area in China. The average farm size was 0.6 ha (FAO, 2014). It was also the biggest exporter in the world and the second largest importer (CSO, 2012). Plant production is the foundation of agriculture in China. Food plants

constitute the highest share in the structure of crops (approximately 90% of crops) (Cieřlik, 2013, pp. 19-28). Rice is the most important Chinese crop.

Poland is the smallest country discussed here. Agricultural lands make up 50% of the total land area. The average size of a farm in Poland is 10.38 hectares (CSO, 2012; CSO, 2013a, 2013b). The main cultivation plants in Poland are wheat and rye (CSO, 2012). Agricultural area in Poland is characterized by large variation in the size of farms. Despite the increase in the number and status of ownership of land by large farms, small and medium-sized farms are predominant.

For calculation of final indexes of work and land productivity for the analysed countries, basic control and economic characteristics are necessary. These were calculated using the Eurostat database (2014) and the Yearbook of International Statistics (CSO, 2012; CSO, 2013a, 2013b) and include the area of agricultural land, number of farms and the average size of farms, the number of people active in agriculture, and gross national production in total and in agriculture. For calculating indicators of performance of land and labour were used the following formulas:

$$W_P = \frac{GNP_A}{L_{AR}} \text{ (USD} \cdot \text{man}^{-1}\text{)}$$

where:

W_P - work productivity (USD \cdot man⁻¹)

GNP_A - gross national product in agriculture (USD),

L_{AR} - people professionally active in agriculture (man).

$$W_Z = \frac{GNP_A}{Z_{UR}} \text{ (USD} \cdot \text{ha}^{-1}\text{)}$$

where:

W_Z - land productivity (USD \cdot ha⁻¹)

GNP_A - gross national product in agriculture (USD),

Z_{UR} - area of agricultural land (ha).

Results and discussion

Data necessary for calculation of indexes of work and land productivity are presented in tables 1-4. They reflect the general economic level of analysed countries with a special consideration of agriculture. Poland has

the smallest agricultural land area in comparison to the USA and China. China has the highest percentage of agricultural land in comparison to the total area of the country (56%) among the investigated countries. However, only 20% of this agricultural land area was arable land. In the USA, approximately 40% of agricultural land was arable, and in Poland, it was approximately 80% of the agricultural land area.

Table 1. Selected agricultural-economic characteristics of countries in 2010

Countries	Total area (thousand km ²)	Population (man)	Area of agricultural land (AL) (ha)	Area of AL (ha) / 1 citizen	AL % of the total area
Poland	312 700	38 526 000	15 600 000	0.40	50
China	9 572 900	1 343 239 923	534 300 000	0.39	56
USA	9 526 500	313 387 000	403 500 000	1.29	44.1

Source: Central Statistical Office (2012)

Table 2. Participation of population employed in agriculture in 2010

Countries	Agricultural population	Population professionally active in agriculture L _{AR}	Population professionally active in agriculture L _{AR} in [%] of total population
Poland	5 658 000	2 960 000	7.7
China	834 491 000	500 977 000	36.5
USA	5 148 000	2 509 000	0.8

Source: Central Statistical Office (2012)

Agriculture has always been an important element of the Chinese economy supported by the majority of the population residing in rural areas. Although the percentage of the population employed in the agricultural sector decreases each year, it was still relatively high (almost 37%) in comparison to the developed countries. Moreover, the participation of agriculture in GNP also was decreasing and in 2010, the value of the GNP in agriculture was 10.1% in China, 4% in Poland, and only 1.2% in the USA.

Table 3. Contribution of Agriculture to Gross National Product in 2010

Countries	Total GNP (billion USD)	% GNP _A in agriculture	GNP _A in agriculture (billion USD)	GNP _A / 1 citizen (USD)
Poland	514.1	4.0	20.6	6 947.3
China	7 298.1	10.1	737.1	1 471.3
USA	15 011	1.2	180.1	71 794.3

Source: Central Statistical Office (2012)

Table 4. Crop yields for grain, potatoes, sugar beets, and tree fruit in 2010

Countries	Grain		Potatoes		Sugar beets		Apples	
	Crops from 1 ha in dt	Participation in the world [%]	Crops from 1 ha in dt	Participation in the world [%]	Crops from 1 ha in dt	Participation in the world [%]	Production in millions of tonnes	Participation in the world [%]
Poland	35.6	1.1	211	2.5	483	4.4	2.9	4.1
China	55.3	20.3	147	23.1	424	4.1	25	40
USA	69.9	16.3	450	5.7	621	12.7	5	6.7

Source: Food and Agricultural Organization of the United Nations (2012)

Plant production dominates agriculture in China. The country is a world leader in the cultivation of some crops, i.e. grains (20.3%), potatoes (23.1%), and apples (40%), corroborating the significance of Chinese agriculture. However, low work and land productivity was apparent compared with the developed countries. According to the results, the lowest work efficiency was reported in China ($1,471.3 \text{ USD} \cdot \text{L}_{\text{AR}}^{-1}$), which was 2% of the highest efficiency found in the USA ($71,794.3 \text{ USD} \cdot \text{L}_{\text{AR}}^{-1}$). The grain crop harvest also supported the finding of low efficiency in China. In China during 2010, 1 ha of land yielded 55.3 dt of grain, which was 14.6 dt in 1 ha of land less than in the USA. In Poland, work productivity was almost $7\,000 \text{ USD} \cdot \text{L}_{\text{AR}}^{-1}$. While Poland has a relatively small contribution to the global agricultural market with no product contributing more than 4.5% to the worldwide supply, crop yields per ha of land were moderate.

Table 5. Calculated work and land productivity in agriculture

Country	Work productivity (USD·L _{AR} ⁻¹)	Land productivity (USD·ha ⁻¹)
Poland	6947.3	1318.2
China	1471.3	1405.9
USA	71794.3	446.4

Source: own calculations based on Central Statistical Office (2012), Eurostat (2014)

Differences between Polish, Chinese, and American agriculture including the size of farms, their productivity, employment infrastructure, as well as effectiveness of production were very high and consequently affected the final agri-economic indexes of work and land productivity. In comparison to the developed countries, China has low productivity of workers in the agricultural sector. Average productivity of a Chinese farmer was 2% of the productivity of an American worker in 2011. In Poland, it was almost 7000 USD, which was approximately 10% of the American worker productivity.

Despite great expansion of agricultural products and the power of countries such as China and the USA, the presented indexes indicate that Poland is an important player in the international arena given its high import and export rates, which prove a high economic level of Poland (CSO, 2012; CSO, 2013b). In addition, given natural resources, there is still potential to improve the productivity of Polish agriculture (Królczyk *et al.*, 2014, pp. 663-672). Agricultural land covers over 50% of the area of the country, of which the majority is arable land (CSO, 2012).

Farms should undertake development initiatives based on new and innovative technologies, which will translate into competitiveness of countries and as a result will increase productivity of one of the most important economic growth factors. However, in order to make this progress highly efficient, preparatory operations in the agrarian structure are necessary. First, the introduced technical capital requires structural changes in agriculture through the concentration of land towards the formation of large agricultural enterprises. Second, land productivity is the lowest in comparison to EU countries, which is influenced not only by soil and climate, but also by a considerable consumption of industrial production means such as mineral fertilizers and crop protection products. As an example, based on the analyses which were carried out (Michałek *et al.*, 2009, pp. 199-205.) in Poland land productivity is 961 USD·ha AL⁻¹

and in Holland this ratio is 7224 USD·ha AL⁻¹, in Portugal 3407 USD·ha AL⁻¹ and in Belgium 2813 USD·ha AL⁻¹. Thus, consolidation of farmland and an increase in technological innovations are required for technical progress.

Conclusions

Based on the analyses, which were carried out, it was determined that agricultural areas in Poland constitute 50% of the country's territory. Furthermore, in Poland arable land prevails, and thus gives an opportunity to expand and adjust to western markets and to become at the same time a backstage of raw materials for developed and developing countries. The Polish agriculture constitutes one of the most important economy sectors. However, its participation in formation of the gross national product, which is a measure of economic activity, is the lowest. According to the analysed data, Poland in comparison to China and the USA is at the last position in the ranking achieving 4% of the GNP in agriculture. Moreover, the structure of small farms in Poland with the average surface area of 10.38 is considerably lower than in the USA (190 ha) which causes that Poland is a less-competitive country. However, one should remember that not all experiences of leading countries may be directly translated into Polish conditions, where agriculture was shaping in completely different conditions and its present level has its historical preconditions. An excessive number of people working in the Polish agriculture constitutes one of the most important factors which limit the speed of economic transformations in this sector. In Poland, active population in agriculture is approximately 3 million people. It constitutes an indicator of 7.7% in total. It is one of the highest indicators in the European Union. In the USA, active population in agriculture is represented by 0.8% of the total economically active, while in China the ratio reaches a level of over 36%.

Acceleration of the desired structural changes is possible due to intensive forms of management by modernization of farms and replacing old machines with new, development of new technologies due to high expenditures on science, decrease in population employed in agricultural production. Furthermore, improvement of productivity indicators based on the factors which shape the level of management, may cause the increase of the competitiveness level and thus will influence the trade and will open new perspectives on international markets.

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