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received: 30.08.2020
acceptance: 21.09.2020
published: 23.09.2020
JEL codes: Q12, D24

Annals PAAAE • 2020 • Vol. XXII • No. (3)

DOI: 10.5604/01.3001.0014.4096

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CHANGES IN RESOURCES AND THE STRUCTURE OF PRODUCTION FACTORS AND THEIR PRODUCTIVITY IN HORTICULTURAL HOLDINGS IN THE YEARS 2010-2018

Key words: structure of factors of production, effectiveness of factors of production,
horticultural production, horticultural holdings, FADN

ABSTRACT. The aim of the research was to assess the changes in relations between factors of production and their effectiveness in horticultural holdings depending on their economic size in Poland in the years 2010-2018. The general characteristics of FADN horticultural holdings in Poland have been presented, followed by a description of the capital-labor ratio and the capital-land ratio and land resources per work unit, that is, the basic correlations between factors of production. Productivity of work, land and capital measured by gross added value was determined. On the basis of research, it was found that the resources of production factors increased along with the economic size of horticultural holdings. In the examined period, land resources decreased (apart from the biggest farms), labor expenditures were reduced, while capital resources increased. Increase in capital value, accompanied by a reduction in land and labor resources, resulted in enhancing the capital-labor ratio and capital-land ratio. In general, as economic size increased, so did the productivity of factors of production. The highest productivity of labor, land and capital was recorded in the biggest holdings. In the examined period, in all classes of economic size, an increase in labor and land productivity was observed (with the exception of the largest holdings), as well as a decrease in capital productivity (in all classes). Deterioration of capital productivity of horticultural holdings was due to a greater increase in capital value in comparison with gross added value. In the examined period, productivity of factors of production decreased in the largest holdings (economic class 5), despite the achievement of the highest productivity of factors of production in comparison with other classes.

INTRODUCTION

Organizations, including agricultural and horticultural holdings, operate in a specific environment, characterized by turbulent changes [Griffin 1999, Penc 2001]. Despite the fact that the nature of the enterprise-environment correlation is bidirectional, the impact of the environment is much greater than that of the enterprise. This is due to the low bargaining power of agricultural producers, their substantial dispersion and competition,

as well as low level of organization of agricultural producers. As a result, business entities adapt to changes [Runowski 2009]. A significant feature of changes in the environment – particularly economic ones – is the emergence of certain regularities. One of the economic regularities is that the costs of labor grow faster in comparison with other factors of production; another is that the costs of all types of factors increase faster than prices of agricultural products [Runowski 2004, Ziętara 2013].

The basic objective of operation of agricultural farms and enterprises is the generation of a satisfactory income for owners. For this purpose, it is reasonable to collect and then adapt the basic factor of productions on farms [Filipiak, Runowski 2018]. Development opportunities in agriculture depend on the effective use of factors of production, and a key role is played by adapting resources and expenditure to achieve agricultural production while using them in a highly effective manner [Kołodziejczak 2014]. On the other hand, the highly effective utilization of factors of production results in an enhanced capability of competing on the market [Baer-Nawrocka, Markiewicz 2013]. The dynamics of changes in factors of production are related to the supply of land and possibility of departure of persons employed in agriculture. Land resources are limited, and so is the outflow of people from agriculture. According to the classical theory of economy, business entities apply the same structure of production resources, which leads to the equalization of labor pay and other factors of production applied in various ways [Sass 2016, referring to: Woś 2001].

In Poland, agriculture is characterized by a visibly high potential, which is due to a large area of arable land and substantial labor resources. However, their availability and productivity is highly diversified among individual regions [Gołębiewska 2013]. On the one hand, this may constitute a development opportunity; on the other, however, it may lead to a limitation of dynamics of modernization changes in agriculture [Krasowicz, Kuś 2012, Wicki 2016].

Horticulture plays an important role in agricultural production, including plant production in Poland. Fruit and vegetables are cultivated on an area of 573.3 thousand hectares – that is, around 3.1% of arable land. The value of global fruit and vegetable production in 2016 amounted to PLN 16.6 billion, which constituted more than 14.6% of global agricultural production and 31.5% of global plant production [GUS 2018]. The value of export of horticultural products in 2018 exceeded EUR 2,867.6 million, which constituted more than 18.1% of exported products of plant origin [GUS 2018]. For the sake of comparison, research conducted by Wojciech Ziętara and Jolanta Sobierajewska [2012] shows that in the years 2000-2009, the share of horticultural production in overall agricultural production was around 11%, while the share of the area of vegetables and orchards in the AL area was only 3%.

RESEARCH MATERIAL AND METHODS

The aim of the research was to assess the changes in relations between factors of production and their productivity in horticultural holdings of varying economic size in Poland in the years 2010-2018. Research included holdings participating in the Polish FADN system, type: horticulture (Type 2)¹. Horticultural holdings in FADN are farms grouped on the basis of the share of value of production from individual types of agricultural activity to the total production value of the holding, specializing in the cultivation of vegetables, mushrooms, flowers and decorative plants². Then, horticultural holdings were classified according to their economic size, and, due to the availability of FADN data, holdings of class 2 to 5 were included in the analysis. The number of horticultural holdings in each class was practically the same, ranging from around 80 to 90 entities in each group.

The study included a description of general characteristics of horticultural holdings according to FADN depending on their economic size, followed by an identification of correlations between basic factors of production (the capital-labor ratio and capital-land ratio and land resources for labor expenditure) and the effectiveness of factors of production (land, labor and capital). The effectiveness of factors of production was measured using gross added value at current prices and fixed prices for 2018. As a deflator for gross added value, the index used was the end agricultural production price, while the total value of assets was adjusted using the index of goods and services purchased in agriculture for investment purposes. Labor and land expenditure were analyzed in natural units.

The study employed descriptive statistics, including the calculation of absolute and relative dynamics of changes using linear and exponential regression. Tabular and descriptive methodology was always used. The basic research material consisted of data from the Polish FADN, the Central Statistical Office and literature on the subject.

CHARACTERISTICS OF THE HORTICULTURAL HOLDINGS EXAMINED

In the examined holdings, resources increased along with economic size. Holdings belonging to economic class 5 had the most resources. An average class 5 horticultural holding, in the examined period, had an area of approximately 12.2 hectares, around 6.3 AWU of employees and a capital worth around PLN 1.7 million. Table 1 presents the

¹ In the research, data from the Polish FADN from the time series creator were used according to type and economic size [FADN 2020]. Further research was conducted using a TF8ES6 spreadsheet, which facilitated the identification of holdings classified according to type (type 2 horticultural holdings) and economic size (class 1 from € 4,000 to 8,000, class 2 from € 8,000 to 25,000, class 3 from € 25,000 to 50,000, class 4 from € 50,000 to 100,000, class 5 from € 100,000 to 500,000 and class 6 \geq € 500,000).

² In FADN accounting, horticultural holdings included entities specializing in the cultivation of vegetables, strawberries, mushrooms, flowers and decorative plants. The category does not include orchards, which belong to a separate type 3, specializing in the cultivation of decorative trees and bushes (permanent plantations). The study focused on horticultural holdings, and category names were applied in accordance with FADN terminology.

Table 1. Resources of horticultural holdings according to economic size in Poland in the years 2010-2018

Production factors	Economic size	Average 2010-2018	Average annual growth [%]*	2010 = 100	Annual resource change	Coefficient of variation [%]
Land [ha]	2	4.25	-0.52	94.39	-0.02	9.64
	3	6.67	-1.77	90.50	-0.12	7.98
	4	8.42	-2.10	82.27	-0.18	12.05
	5	12.22	5.70	135.15	0.66	22.40
	total	5.62	0.50	99.65	0.03	4.58
AWU [number]	2	1.76	-2.12	77.84	-0.04	9.65
	3	2.35	-1.74	88.49	-0.04	7.16
	4	3.33	-3.03	87.36	-0.10	12.17
	5	6.26	-2.52	72.81	-0.14	11.97
	total	2.46	-0.74	91.20	-0.02	6.74
Total capital [PLN]**	2	266,690.66	3.81	127.43	9,727.14	18.61
	3	570,184.57	5.57	119.91	30,448.15	22.35
	4	760,608.78	1.57	124.62	12,173.52	6.83
	5	1,709,337.19	0.41	90.24	8,196.64	10.38
	total	478,546.88	6.01	130.86	28,237.78	18.48

* average annual growth calculated on the basis of the exponential function, ** 2018 fixed prices

Source: own compilation based on Polish FADN data

basic factors of production in horticultural holdings of varying economic size in Poland in the years 2010-2018³.

In the years 2010-2018, in almost all economic size classes, a reduction of land resources was recorded, with the exception of the largest holdings. In class 5, in the examined period, there was an average annual increase by 5.7%. The highest decrease in land resources was recorded among economic class 4 holdings (on average, by 2.1% annually). In the year 2018, in the horticultural holdings examined, land resources amounted to around 4.3 hectares of arable land for economic size class 2, around 6.7 hectares of arable land for class 3, around 8.4 hectares of arable land for class 4 and more than 12.2 hectares of arable land for class 5.

In the years 2010-2018, land expenditure decreased in all economic size classes. The highest decrease in labor expenditure was recorded in economic size class 4 (on average, by more than 3.03% annually) and in class 5 (at an annual average of 2.52%). In 2018, labor expenditure in horticultural holdings of economic size class 2 to 5 amounted to: 1.76 AWU, 2.35 AWU, 3.33 AWU and 6.26 AWU per holding, respectively.

³ In Polish FADN, horticultural holdings only include classes 2 to 5 of economic size. No data is available for economic class 1 and 6 holdings.

In the examined period, the value of capital increased in horticultural holdings of all economic size classes. The highest increase in capital value was observed in holdings of economic size class 3 (a real annual increase by 5.57% and nominal annual increase by 7.32% on average) and class 2 (real annual increase by 3.81% and nominal annual increase by 5.55%). The lowest increase in the value of total assets was recorded among the largest holdings – that is, belonging to economic size class 5 (a real annual increase by 0.41% and nominal annual increase by 2.16% on average) Against fixed prices for 2018, the value of capital in economic size class 5 decreased by almost 10%.

CHANGES IN RELATIONS BETWEEN PRODUCTION FACTORS IN HORTICULTURAL HOLDINGS DEPENDING ON ECONOMIC SIZE

In the examined period, the capital-labor ratio and the capital-land ratio increased. The increase in value of capital accompanied by a decrease in labor expenditure resulted in greater dynamics of increase of the capital-labor ratio. The capital-labor ratio increased along with economic size (Table 2). In horticultural holdings of class 5, there was more than

Table 2. The capital-land ratio and the capital-labor ratio and land resources for labor expenditures in horticultural holdings in years 2010-2018

Production factors*	Economic size	Average 2010-2018	Average annual growth [%]	2010 = 100	Annual resource change	Coefficient of variation [%]
C/E [PLN/ AWU]	2	153,141.67	5.93	163.71	9,185.38	23.27
	3	245,120.11	7.31	135.51	17,125.09	26.80
	4	231,917.95	4.60	142.65	10,651.87	16.00
	5	275,562.07	2.93	123.93	8,091.75	12.35
	total	196,151.33	6.75	143.49	13,218.92	21.54
C/L [PLN/ha UR]	2	62,514.04	4.32	134.99	2,630.52	13.38
	3	86,696.10	7.35	132.51	6,140.39	27.88
	4	91,682.93	3.67	151.48	3,384.16	15.77
	5	144,191.69	-5.29	66.77	-7,579.99	16.88
	total	85,031.21	5.51	131.31	4,663.63	16.86
L/E [ha UR/ AWU]	2	2.43	1.60	121.27	0.04	13.77
	3	2.84	-0.03	102.26	0.00	6.14
	4	2.55	0.92	94.17	0.02	13.95
	5	1.99	8.22	185.62	0.16	28.88
	total	2.30	1.23	109.27	0.03	8.75

*C/E – Capital [PLN]/Employment [AWU], C/L – Capital [PLN]/Land [ha UR],
L/E – Land [ha UR]/Employment [AWU]

Source: own compilation based on Polish FADN data

PLN 275.6 thousand per 1 AWU, while in class 2 it was more than PLN 153.1 thousand per AWU, that is, 1.8 times greater. In the examined period, the value of assets per 1 AWU increased most in class 2 of economic size (the average real increase was 7.31%, and nominal increase was 9.06%); increase was the lowest in class 5 (real by 2.93%, nominal by 4.67%). In absolute values, the highest increase in the capital-labor ratio was also recorded in economic size class 3, where the value of total assets per 1 AWU increased annually in real terms by around PLN 17.1 thousand (nominally by PLN 19.8 thousand).

The capital-land ratio in horticultural holdings, like the capital-labor ratio, increased along with the holding's economic size. In economic size class 5, the value was around PLN 144.2 thousand per 1 hectare of arable land; in class 2, it was only PLN 62.5 thousand per 1 hectare of arable land, that is, 2.3 times higher. In terms of the capital-land ratio, an increase was recorded in almost all economic size classes, with the exception of the largest holdings (class 4). In the largest holdings, the value of capital per 1 hectare decreased annually in real terms by an average of around 5.3%. It was down to the fact that the increase in the holding area in the examined period was greater than the increase in capital, which resulted in a reduction of the capital-land ratio.

However, if land resources per 1 AWU are taken into account, it can be observed that as the economic size increases, the area per 1 fully employed person decreases. However,

Table 3. The effectiveness of labor land and capital in horticultural holdings in Poland depending on their economic size in years 2010-2018

Production factors*	Economic size	Average 2010-2018	Average annual growth [%]	2010 = 100	Annual resource change	Coefficient of variation [%]
GVA/E [PLN/AWU]	2	34,054.87	4.31	103.80	1,445.43	24.52
	3	47,892.39	2.86	95.46	1,436.33	29.03
	4	52,486.00	1.05	92.68	504.11	13.50
	5	72,924.47	-0.36	88.92	-265.57	12.36
	total	43,949.18	4.55	118.08	1,986.65	19.30
GVA/L [PLN/ha]	2	13,958.98	2.70	85.60	404.08	18.37
	3	16,970.10	2.90	93.34	540.85	30.34
	4	20,725.58	0.13	98.41	12.15	11.94
	5	39,010.02	-8.57	47.90	-3,331.85	27.52
	total	19,056.25	3.31	108.06	620.70	13.52
GVA/C [PLN/PLN]	2	0.22	-1.62	63.41	0.00	15.69
	3	0.20	-4.45	70.44	-0.01	23.04
	4	0.23	-3.54	64.97	-0.01	14.84
	5	0.27	-3.28	71.74	-0.01	13.94
	total	0.23	-2.20	82.29	-0.01	10.64

*GVA – Gross Value Added, E – employment, L – land, C – capital

Source: own compilation based on Polish FADN data

in the examined period, in holdings characterized by the biggest economic size, increase in land area per full-time employee was the highest (by 8.22% on the average). In the examined period, in class 5, the average was around 1.99 hectares of arable land per 1 full-time employee; for class 2, it was 2.43 hectares.

Figure 1 presents the dynamics of relations between factors of production in horticultural holdings depending on their economic size in the years 2010-2018. It could be seen in all economic classes that the capital-labor ratio increased; as mentioned before, the increase was the least significant among the biggest holdings. The capital-land ratio increased as well, with the exception of the biggest holdings. In the examined period, in class 5, the annual value of capital per 1 hectare of arable land decreased on average by 5.3%. Almost in all classes, an increase in the area of arable land per 1 full-time employee was recorded, with the exception of holdings of economic size class 3 (0.00%). The highest increase in the area of land per 1 AWU was recorded by the biggest holdings (an annual average of 8.2%).

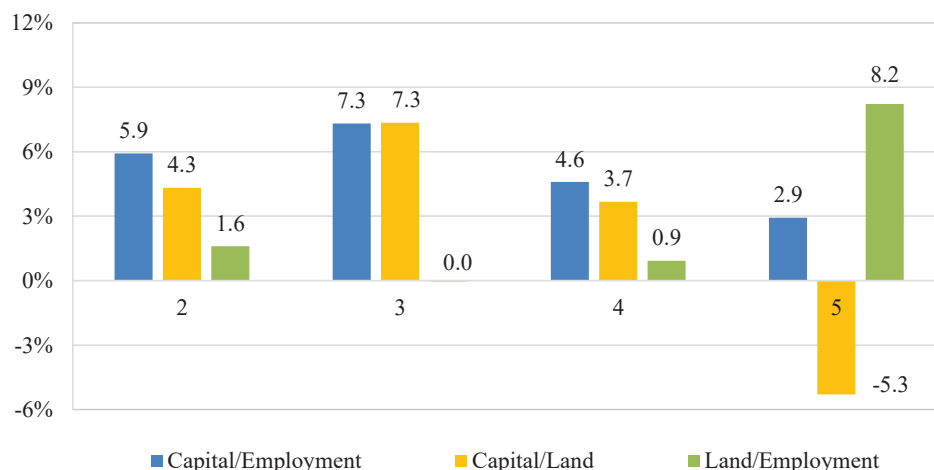


Figure 1. Changes in relations between factors of production in horticultural holdings in Poland, varying in terms of their economic size, in the years 2010-2018

Source: own compilation based on Polish FADN data

In general, as the economic size increased, so did the productivity of factors of production. The effectiveness of production factors in horticultural holdings depending on their economic size has been presented in Table 3 and Figure 2.

Labor productivity in holdings of economic size class 5 in the examined period was, on average, around PLN 72.9 thousand per 1 AWU, while in class 2 holdings it was only PLN 34.1 thousand, that is, more than 2 times greater. In the examined period, an increase in labor productivity was visible in almost all size classes, with the exception of the biggest holdings (an average annual decrease by 0.36%). A nominal increase was recorded in all classes of economic size, and among the biggest holdings, it amounted to 1.55%. The highest increase in labor productivity was recorded by the smallest farms (an

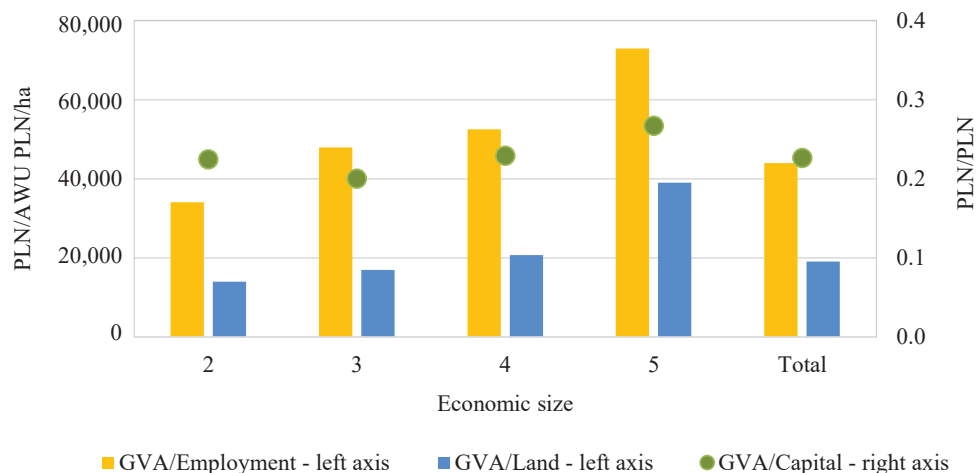


Figure 2. Productivity of labor [PLN/AWU] land [PLN/hectare] and capital [PLN/PLN] in horticultural holdings in Poland in the years 2010-2018 depending on economic size

Source: own compilation based on Polish FADN data

annual average of 4.31%). In these holdings, labor productivity increased by approximately PLN 1,445 annually.

Land productivity, like labor productivity, increased along with economic size. In the biggest holdings (class 5), in the examined period, gross added value per 1 hectare of arable land was on average more than PLN 39.0 thousand, and in the smallest holdings, it was only an average of PLN 14.0 thousand, that is, almost 2.8 times greater. In the examined period, an increase in land productivity was recorded in almost all classes of horticultural holdings, with the exception of the biggest entities. In the latter, an annual average decrease by 8.57% (the nominal annual average being 6.67%) was recorded. Therefore, the increase in land resources in the biggest holding was greater than the increase in gross added value. The highest increase in land productivity was recorded in holdings of economic size class 3 (an annual average of 2.90%) and class 2 (an annual average of 2.70%).

Like in the previous cases, describing the labor productivity and land production factors, capital productivity increased along with economic size. On average, capital productivity was the highest among the biggest holdings (for class 4, the average was PLN 0.27 of gross added value per PLN 1 of capital value). In the smallest holdings, on the other hand, capital productivity was the lowest. In the second class of economic size, gross added value amounted to PLN 0.22 per PLN 1 of capital, and in the third class, added value was only PLN 0.20 per PLN 1 of capital.

In the examined period, a decrease in capital productivity was recorded by all horticultural holdings. This decrease was the highest in holdings of economic size class 3 and 4 (an annual average of 4.45% and 3.54%, respectively). On the other hand, a decrease in capital productivity was the lowest among the smallest holdings (an annual average of 1.62%).

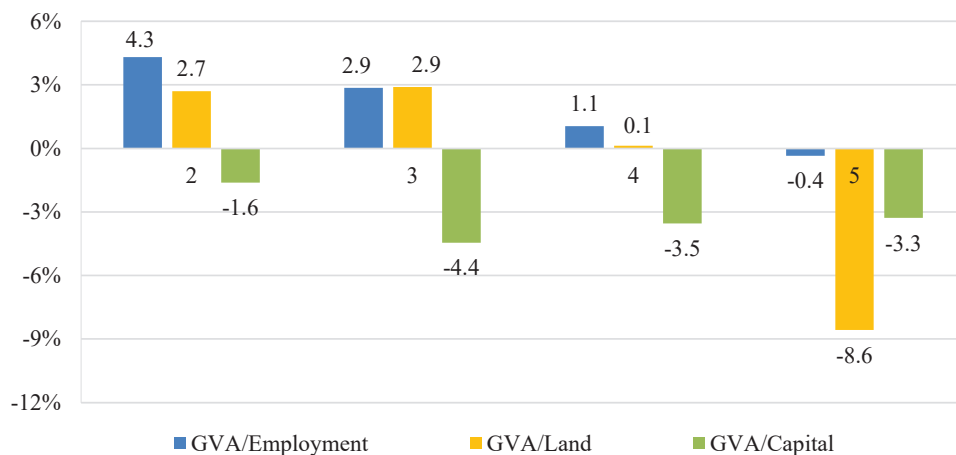


Figure 3. Changes in the productivity of factors of production in horticultural holdings that varied in terms of economic size in the years 2010-2018 [annual average in %]

Source: own compilation based on Polish FADN data

Figure 3 presents the dynamics of changes in the productivity of production factors in horticultural holdings depending on their economic size in the years 2010-2018 in Poland. In class 2, 3 and 4 holdings, an increase of land and labor productivity was recorded. In the biggest holdings, the productivity of all factors of production decreased. In the examined period, a decrease in capital productivity was recorded for all horticultural holdings classified in accordance with their economic size, and it was most visible in holdings of class two and three.

The decrease in capital productivity among horticultural holdings was due to a greater increase in capital in comparison with gross added value or production of value. It means that every additional unit of capital produced much less. This may be due to the indivisibility of capital, as the purchase of fixed assets results in a surge of capital, while an increase in the value of new production may be disproportionate.

SUMMARY AND CONCLUSIONS

Under the present conditions, agricultural holdings are subjected to a very substantial impact of micro- and macro-environments. Changes in the environment should be monitored in order to adapt to them in advance and survive on the market. Entities, which are the most effective and competitive, will be able to survive and develop.

The production capacity of agricultural holdings is correlated with the substitutability of factors of production. The quantities of these factors are less significant than the correlations between them. Agricultural holdings, including horticultural holdings, concern three factors of production, which are used for production purposes. Therefore, it is crucial to achieve a relatively permanent effectiveness (productivity) of these factors. One of the typical features of production factors is that some of them are in excess, while the

quantity of others is insufficient. In such case, it is necessary to choose a combination of production factors, which will warrant their effectiveness, known as effective allocation of production factors.

In Poland, the potential for developing agriculture and horticulture is substantial due to a large area of arable land and labor availability. However, in recent years, labor and land resources have started to decrease, which has been accompanied by an increase in labor costs and land value. Factors that facilitate the development of horticulture in Poland include: many years of tradition, knowledge and the experience of agricultural producers, relatively low labor costs, a well-developed processing industry, geographical location, the growing purchasing power of consumers and changing nutritional trends [KOWR 2018].

Several conclusions have been drawn from the research project:

1. In the examined period, in almost all economic size classes, land resources decreased (with the exception of the biggest holdings), while labor expenditure decreased and capital resources increased. Horticultural holdings showed a tendency to replace labor with capital. However, a relatively lowest increase in capital value was recorded among the biggest holdings.
2. In the years 2010-2018, the capital-labor ratio and capital-land ratio increased. The increase in capital value, accompanied by a reduction in land and labor resources (with the exception of the biggest holdings) resulted in enhancing the capital-labor ratio and capital-land ratio. As economic size increased, area per 1 full-time employee decreased.
3. In general, as economic size increased, so did the productivity of individual factors of production. In the examined period, the highest productivity of labor, land and capital was recorded among the biggest holdings (economic size class 5). In the biggest holdings (class 5), in comparison with the smallest holdings (class 2), work productivity was higher more than 2 times, land productivity was 2.7 times greater, and capital productivity was higher by around 19%. Therefore, it is possible to state that a scale effect was observed, as the effectiveness of the production factor increased along with economic size.
4. In the examined period, an increase in land and labor productivity was observed in all groups of horticultural holdings (with the exception of the biggest holdings), while capital productivity decreased (in all classes). Nevertheless, despite the highest productivity of production factors, a decrease in the productivity of all factors of production was recorded by the biggest holdings. While the nominal value of labor productivity increased, in real terms, unfortunately, a decrease was observed. A similar situation was recorded with regard to land productivity - it increased in all economic size classes with the exception of the biggest holdings.

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ZMIANY ZASOBÓW I STRUKTURY CZYNNIKÓW PRODUKCJI ORAZ ICH WYDAJNOŚCI W GOSPODARSTWACH OGRODNICZYCH W LATACH 2010-2018

Słowa kluczowe: struktura czynników produkcji, efektywność czynników produkcji, produkcja ogrodnicza, gospodarstwa ogrodnicze, FADN

ABSTRAKT

Celem badań była ocena zmian relacji czynników produkcji i ich efektywności w gospodarstwach ogrodniczych, w zależności od wielkości ekonomicznej, w Polsce w latach 2010-2018. Przedstawiono ogólną charakterystykę gospodarstw ogrodniczych FADN w Polsce, następnie określono techniczne uzbrojenie pracy i ziemi oraz zasoby ziemi przypadające na jednostkę pracy, czyli podstawowe relacje pomiędzy czynnikami produkcji. Określono wydajność pracy, ziemi oraz kapitału mierzoną wartością dodaną brutto. Na podstawie badań stwierdzono, że wraz ze wzrostem wielkości ekonomicznej gospodarstw ogrodniczych zwiększały się zasoby czynników produkcji. W badanym okresie zmniejszały się zasoby ziemi (oprócz gospodarstw największych) i nakłady pracy, natomiast zwiększały się zasoby kapitału. Wzrost wartości kapitału, przy jednoczesnym spadku zasobów ziemi i pracy, powodował zwiększenie technicznego uzbrojenia siły roboczej i ziemi. Generalnie, wraz ze wzrostem wielkości ekonomicznej zwiększała się wydajność czynników produkcji. Największą wydajność pracy, ziemi i kapitału obserwowano w największych gospodarstwach. W badanym okresie we wszystkich klasach wielkości ekonomicznej występował wzrost wydajności pracy i ziemi (z wyjątkiem gospodarstw największych) i spadek wydajności kapitału (we wszystkich klasach). Spadek wydajności kapitału gospodarstw ogrodniczych wynikał z większego wzrostu wartości kapitału niż wartości dodanej brutto. W badanym okresie występował spadek wydajności czynników produkcji w największych gospodarstwach (5 klasa ekonomiczna), pomimo osiągania największych wydajności czynników produkcji w porównaniu z innymi klasami.

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