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Production and economic efficiency in the cultivation of strawberry (*Fragaria* × *ananassa* Duch.) depending on the method of production – case study

Efektywność produkcyjna i ekonomiczna w uprawie truskawki (*Fragaria* × *ananassa* Duch.) w zależności od metody produkcji – studium przypadku

Summary. The aim of the research was to evaluate the production and economic efficiency of the cultivation of three strawberry varieties depending on the two cultivation methods used (organic and conventional). The research was conducted in 2018–2020 in eight horticultural farms cultivating strawberries for processing purposes in the Podkarpackie Voivodeship. The analysis of the production efficiency was based on the obtained levels of yields, while the analysis of the economic efficiency was carried out using selected measures, i.e. the production value, direct surplus, net income and the production profitability index. The research revealed that, generally higher yields in the analysed farms were obtained on plantations managed using the organic method than on those based on the conventional one. Moreover, irrespective of the production method, the highest yields were obtained in the first year and the lowest in the last year of harvests. Also irrespective of the production method, higher yields were obtained from the cultivation of the Dipred variety compared to the other varieties. The overall production costs, due to a significant share of labour and plant protection costs, were higher in the organic farms than in the conventional ones. In addition, the economic efficiency of organic crops was higher than or comparable to conventional ones, which was mainly influenced by higher fruit sales prices and higher yields.

Key words: strawberry, yield, production efficiency, economic effectiveness

INTRODUCTION

Poland is one of the largest berries producers both in Europe and in the world [Gołębiewska and Sobczak 2012, Kraciński 2014]. FAOSTAT [https://www.fao.org/faostat/en/#data/QCL] data shows that in 2020, 575.6 thousand tons of berry fruit were harvested, including 167.3 thousand tons of strawberries, 146.5 thousand tons of currants and 121.7 thousand tons of raspberries. In terms of the crops volumes, Poland is in the forefront of global and European producers of these types of fruit. In the production of strawberries, Poland was fifth in the world and second in the European Union, third in the world and first in Europe in the production of raspberries, and first in Europe and second in the world in currants production. Although more currants are produced in Russia, but in principle entirely for internal consumption, not for the commodity market.

What is more, berry production is an important branch of horticultural production in our country. Based on data from the Institute of Agricultural and Food Economics – National Research Institute, for many years, the average annual berry fruit cultivation area has been around 145 thousand hectares, with production amounting to around 500 thousand tons. The largest share of both the cultivation area and production is attributed to strawberries. In 2020, the strawberry cultivation area was 50.10 thousand hectares and the yields reached close 170 thousand tons, which accounted for 34.15% of the total area under berry fruit cultivation and 33.33% of the total yield of berries in Poland, respectively. According to FAOSTAT data in the years 2000–2020 in Poland, the strawberry cultivation area was 33.20–65.75 thousand hectares and the yields reached 131.44–242.11 thousand tons. Taking into account the acreage of strawberry cultivation in the world, Poland was placed only behind China, and ahead of Russia, Spain and Mexico. However, in terms of the harvest volume depending on the year, we were third to fifth in the world.

According to Kraciński [2014], strawberry production is fostered by the favourable natural, climatic and soil conditions in Poland. As stressed by many authors, inter alia, by Bacchella et al. [2008], Roussos et al. [2009], Kahu et al. [2010], and Gecer et al. [2013], the above-mentioned conditions are extremely important because, together with the field location, plantation age, and the selection of an appropriate variety in combination with suitable agrotechnical procedures, they are considered essential for ensuring the optimal parameters, i.e. the quantity and quality of strawberry crops.

According to Trajer and Krzyżanowska [2017], taking into consideration the climatic and soil conditions, the relatively low degree of environmental pollution, as well as social and historical aspects, Polish agriculture has a great predisposition to use organic production methods. As emphasised by the authors, the consumption of chemical substances in Polish agricultural production has always been lower than in most European countries. Therefore, the organic quality of the agricultural production area and its biodiversity are among the best-ranked in Europe. This appears particularly significant when referring to the objectives set by the European Commission in the Farm to Fork Strategy (F2F) and the EU Biodiversity Strategy. Based on these documents, by 2030, at least 25% of the agricultural land in the EU will have been used for organic farming, with organic aquaculture recording a significant increase. For this reason, changes in the legal, social and international dimensions, or widely-perceived progress made in agriculture and related areas, are currently considered the most important factors for the development of farms and their surroundings. Achievements in the field of agricultural,

technical, economic and ecological knowledge are of particular importance in this respect [Komorowska 2011a], given especially that organic production systems can be a way to ensure sustainable production, thus enabling the preservation of natural resources for the present and future generations [Rembiałkowska 2007]. Therefore, issues concerning the production and economic effects of organic strawberry cultivation are increasingly addressed, inter alia, by Brzozowski and Zmarlicki [2012], and Bujdei et al. [2018]. Nonetheless, there is still very limited comparative research on the efficiency of organic and conventional cultivation, justified mainly from the perspective of producers, but also consumers. Such research was conducted by, Komorowska [2011a], Conti et al. [2014], Nachtman [2015], Rysin et al. [2015], Krause and Machek [2018], to name a few. A review of the research comparing the effects and impact of conventional and organic production on the quality of selected horticultural products was conducted, inter alia, by Renagold et al. [2010] and Ceglie et al. [2016].

The aim of the research was to evaluate the production and economic efficiency of the cultivation of three strawberry varieties depending on the two cultivation methods used, i.e. organic and conventional.

MATERIAL AND METHODS

The research was conducted in 2018–2020, in eight specialist horticultural farms with strawberry cultivation for processing purposes, in the Podkarpackie Voivodeship. The selection of farms for the research was purposeful. The presented data reflect the average results for the adopted types of farms and should not be directly translated into the average results for the country. These data, however, allow for the presentation of certain phenomena and dependencies in this respect. They also provide a basis for formulating conclusions relating not only to the studied sample. All the farms belonged to or cooperated with a producer group dealing with organic fruit cultivation. In four of them, only organic production was carried out, while the remaining four were based on conventional cultivation. All the organic farms had obtained the relevant organic production certificates. The level of yields of the three strawberry varieties – Honeoye, Aprica and Dipred – was used as a measure of production efficiency, taking into consideration the impact of the production method (organic vs conventional). The choice of the varieties was by no means accidental, as these three are recommended by farmers, inter alia, for organic cultivation, especially in the production of strawberries for processing purposes. Two research objects were distinguished, each of them consisting of four farms with three plantations of each of the strawberry varieties under analysis. This corresponded to a real yield reflecting the cultivation prospects under genuine commercial production conditions. Both organic and conventional fruit were sold to the same processing plant. The average annual fruit purchase price offered by the above-mentioned processing plant, which was the recipient of the fruit, was used in the research. All the plantations, both conventional and organic, were managed using the same fruit cultivation technology. Strawberries were grown on raised fields lined with non-woven black crop cover, in a two-row system. Drip irrigation was used to water the plants. All the cultivation operations were performed in accordance with generally applied principles for the selected cultivation method. The levels of unit and overall costs were analysed,

with the costs of hired labour, plant protection costs and direct costs being distinguished in the latter case. The production value, direct surplus and net income, and the production profitability index were used as selected measures of the economic efficiency of strawberry production. Individual types of costs and income were presented per hectare of arable land. The data were reported as average figures for the three years under analysis. The costs, production and income were expressed in USD, based on the average annual exchange rate as announced by the National Bank of Poland for the period of 2018–2020 [https://www.nbp.pl/]. The average annual exchange rates were calculated as the average rates for a one-year period. The obtained results were subjected to statistical univariate analysis of variance. The significance of the difference was estimated using the Tukey test, with the significance level determined at $\alpha = 0.05$.

RESULTS AND DISCUSSION

Strawberry is one of the most frequently consumed berry fruit, and its cultivation area is increasing worldwide, which is accompanied by the emergence of new production practices to increase yields and maintain a favourable balance with the surrounding environment [Martínez-Ferri et al. 2014], as well as to raise the production and economic efficiency [Diel et al. 2016, Martins de Lima et al. 2021, Giovannini et al. 2021]. Strawberry cultivation carried out in an organic system can be considered one of such practices. However, it is necessary to run the plantation in line with the principles of organic farming and to perform all agrotechnical procedures, including plant protection, with the utmost care and attention.

The research revealed that in 2018–2020 the yield obtained in the farms based on the organic cultivation method were higher than in those using conventional cultivation (tab. 1). In the farms with the organic cultivation method, the yields, depending on the year, ranged from 15.42 $t \cdot ha^{-1}$ to 18.41 $t \cdot ha^{-1}$, and in 2018–2020 they amounted, on average, to 17.24 $t \cdot ha^{-1}$. In the farms with the conventional cultivation method, the yields ranged from 13.37 $t \cdot ha^{-1}$ in 2020 to 18.79 $t \cdot ha^{-1}$ in 2018, amounting, on average, to 15.87 $t \cdot ha^{-1}$ in the entire three-year period under analysis. These differences in the yields were not statistically significant. However, it should be stressed that in the farms under analysis, the average yields on plantations producing fruit for industrial purposes (regardless of the cultivation method) were 30–40% higher than the national average. They also exceeded average yields obtained from plantations of dessert strawberries (compared to Zmarlicki and Brzozowski 2020).

Statistically significant differences were found in the level of costs – total costs, labour costs and plant protection costs. In the farms under analysis, the total costs of strawberry production were 37.80% higher for organic cultivation and amounted, on average, to 20847.11 $USD \cdot ha^{-1}$. In individual years, they ranged from 20548.33 $USD \cdot ha^{-1}$ to 21023.00 $USD \cdot ha^{-1}$. In contrast, in the farms where strawberries were grown using conventional methods, the average production costs were much lower and, depending on the year, ranged from 14481.67 $USD \cdot ha^{-1}$ to 16161.33 $USD \cdot ha^{-1}$. In the years under analysis, they reached an average level of 15121.33 $USD \cdot ha^{-1}$. The difference in production costs depending on the strawberry cultivation method was mainly caused by the level of outlays, and the labour and plant protection costs. On average, in the organic farms,

4–5 more treatment procedures were implemented than in the conventional farms, while the cost of plant protection chemicals per treatment was, in average terms, 44% higher than that of conventional protection preparations. The differences in labour costs on the organically and conventionally managed plantations, depending on the year, ranged from 1896.33 USD·ha^{-1} to 3442.33 USD·ha^{-1}, reaching an average of 2850.67 USD·ha^{-1} in the analysed period, and were by 34% higher on the organic plantations, in average terms. This was caused by considerably higher labour input – by 152%, mainly for phytosanitary treatments, including the removal and disposal of dead leaves from the plantation in spring, protection measures, mowing and weed removal. In addition, differences in plant protection costs, depending on the production method, ranged from 614.67 USD·ha^{-1} to 813.67 USD·ha^{-1} in individual years (on average, 672.56 USD·ha^{-1}).

Table 1. Production and economic effects of cultivation of 1 ha of strawberries in the surveyed farms in 2018–2020

Production method	Years			Average from 2018–2020
	2018	2019	2020	
the yield (t·ha^{-1})				
A	18.41	17.89	15.42	17.24[a]
B	18.79	15.47	13.37	15.87[a]
total costs (USD·ha^{-1})				
A	21023.00	20970.00	20548.33	20847.11[a]
B	16161.33	14721.00	14481.67	15121.33[b]
plant protection costs (USD·ha^{-1})				
A	1698.00	1579.67	1603.00	1626.89[a]
B	884.33	965.00	1013.67	954.33[b]
labour costs (USD·ha^{-1})				
A	11023.00	11436.67	10975.00	11144.89[a]
B	9126.67	8023.33	7732.67	8294.22[b]
sales price (USD·kg^{-1})				
A	1.55	1.64	1.59	1.59[a]
B	1.49	1.27	1.12	1.29[b]
production value (USD·ha^{-1})				
A	28563.33	29300.33	24563.33	27475.67[a]
B	27990.67	19551.67	15049.00	20863.78[b]
gross margin (USD·ha^{-1})				
A	13496.33	13936.00	9604.67	12345.67[a]
B	16033.33	8787.00	4677.33	9832.56[a]
profitability of production (%)				
A	135.85	139.68	119.33	131.62[a]
B	173.21	132.90	103.64	136.59[a]

A – organic method, B – conventional method. The means followed by the same letters do not differ at $\alpha = 0.05$
Source: author's own study

The recorded higher level of costs in the production of strawberries in the organic system, as compared to the conventional system, did not translate into lower effectiveness. Based on data in Table 1, economic efficiency in the farms based on organic cultivation was similar to or higher than in those based on conventional cultivation. The farms using the organic strawberry cultivation method had a higher direct surplus, with an average of 2513.11 USD·ha^{-1}, compared to the farms producing fruit for processing purposes using the conventional method. These farms also achieved a higher value of commodity production. Its average value achieved by the farms under analysis for a hectare of crops in 2018–2020, in the organic system, was USD 27475.67, while in the conventional system – USD 20863.78. This was determined by both the already mentioned higher yield level, and also the sales prices. The average sales price of organic fruit in 2018–2020 was 1.59 USD·kg^{-1}, while that of fruit from conventional cultivation was 1.29 USD·kg^{-1}. The difference was statistically significant, as was that in the production value. The analysis of the production profitability in the farms revealed that the cultivation of strawberries in the conventional system was, on average, by merely 5 percentage points higher than in the organic system. Moreover, strawberry production in the farms was profitable in all years under analysis, irrespective of the production method employed. Similar results were obtained in the studies by Brzozowski and Zmarlicki [2012], Paszko [2018].

The level of yields is one of the most important determinants of fruit production profitability [Paszko 2006, Gołębiewska and Sobczak 2012, Wróblewska et al. 2020]. It is often of key importance in establishing the profitability of farms and according to Vittori et al. [2018], it is taken into consideration by producers when choosing new varieties for cultivation. Therefore, it largely determines the functioning, development and competitiveness of farms [Wróblewska et al. 2020].

In the present research, it was observed that the level of strawberry yields obtained depending on the production method differed depending on the years and varieties under analysis. The average yield for 2018–2020 indicates that Dipred was the most prolific among the varieties studied. This variety displays high yield-enhancing potential and very high fruit resistance to adverse climatic conditions, which contributes to achieving high productivity. Moreover, the analyses revealed that the obtained yields of strawberries on the organic plantations were higher than those recorded in the conventional production system in a three-year period for Honeoye, and in a two-year period for both Aprica and Dipred. Therefore, the conclusion that organic farms in every case are characterised by lower production efficiency, as was pointed out in the studies by Komorowska [2011b] and Seufert et al. [2012], Brzozowski and Zmarlicki [2012], and other authors, hardly appears valid. The yield of Honeoye strawberries cultivated in the organic system was higher than that in the conventional system by 0.94 t·ha^{-1} in 2018, 1.94 t·ha^{-1} in 2019, and 1.50 t·ha^{-1} in 2020. In the case of the other two varieties, the differences were higher and amounted to 2.50 and 3.20 t·ha^{-1} for Aprica, and 2.82 t·ha^{-1} and 1.45 t· ha^{-1} for Dipred, respectively, in 2019 and 2020.

For all varieties, irrespective of the cultivation method, generally the highest yields were obtained in 2018 (the Dipred variety cultivated in the organic system was an exception), i.e. in the first year of fructification, whereas the lowest yields were recorded in 2020, when the plantations were to be tilled under. This is consistent with the generally used practice of cultivating strawberries for no more than 3 years of fructification, also

for processing purposes. In the farms based on the organic cultivation system, the yield depending on the variety in 2018 ranged from 17.00 t·ha^{-1} to 19.28 t·ha^{-1}, and in the farms using the conventional cultivation method – from 18.34 t·ha^{-1} to 19.62 t·ha^{-1}. In contract, in 2020 these yields, depending on the variety, ranged from 13.80 t·ha^{-1} to 16.65 t·ha^{-1} in the organic plantations, and from 12.30 t·ha^{-1} to 15.20 t·ha^{-1} in the conventional ones.

According to Zmarlicki and Brzozowski [2020], strawberry production in Poland in recent years has undergone substantial changes and is becoming more and more intense. These changes are mainly connected with the time of harvesting season, for example, by shifting crops under cover and by producers obtaining higher prices for fruit in the period that was once considered 'off season'. Nonetheless, the studies by Gołębiewska and Sobczak [2012], and Kraciński [2014] indicate that a number of plantations continue to be run using extensive methods with limited use of mineral fertilisers and plant protection products, resulting in lower yields. Usually, in such a cultivation system, the labour input is very high while the costs are low. This applies, above all, to farms managed in an organic way, but the plantations in the farms under analysis are not some of these.

Table 2. The yield of three strawberry cultivars depends on the method of production, in the years 2018–2020 (t·ha^{-1})

Varieties	Production method	Years			Average from 2018–2020
		2018	2019	2020	
Honeoye	A	19.28	16.84	13.80	16.64^{a}
	B	18.34	14.90	12.30	15.18^{a}
Aprica	A	18.96	17.70	15.80	17.49^{a}
	B	19.62	15.20	12.60	15.81^{a}
Dipred	A	17.00	19.12	16.65	17.59^{a}
	B	18.40	16.30	15.20	16.63^{a}

A – organic method, B – conventional method. The means followed by the same letters do not differ at $\alpha = 0.05$
Source: author's own study

The analysis of the data showed that the overall production costs, irrespective of the fruit variety, were higher, on average, by 5750 USD·ha^{-1}, i.e. by 27.56% in the organic system, compared to the conventional one. The differences were statistically significant. Also in the study by Brzozowski and Zmarlicki [2015], the costs of organic strawberry production were higher by 9.20% than the costs of conventional cultivation. On organic plantations in the farms under analysis, the overall costs of strawberry production, depending on the variety, ranged from 20112.14 USD·ha^{-1} to 21552.39 USD·ha^{-1}, and on conventional plantations from 15065.64 USD·ha^{-1} to 15136.85 USD·ha^{-1} (Tab. 3). As explained earlier, this was mainly due to higher material costs (including plant protection products) and labour costs, especially harvesting costs in the organic farms. The specific approach to plant treatments in the farms under analysis resulted in the protection costs of organic plantations being, on average, 41.15% higher than on the conventional plantations. This was due to the fact that plant protection on organic plantations required significantly more treatments compared to that on conventional plantations. Moreover, organic preparations were more expensive than pesticides. At the same time, labour costs were, on average, 25.67% higher on the organic plantations than on the conventional

plantations, which was related to the higher number of working hours for plantation maintenance (example – herbicides used to protect against weeds were not permitted, and it was necessary to remove weeds by hand). For the Honeoye variety, the difference amounted to 2744.39 USD·ha^{-1} (25.01%), for the Aprica variety to 3417.21 USD·ha^{-1} (29.19%), and for the Dipred variety to 2453.79 USD ·ha^{-1} (22.80%).

Similarly, in the research conducted by Komorowska [2011b], Zmarlicki and Brzozowski [2020], labour costs had the highest share in the cost structure, in average terms accounting for 54.15% of the total value of the overall costs, while plant protection costs, depending on the variety and production technology applied, ranged from 6.10% to 7.88% of the overall costs. Irrespective of the variety and cultivation method, direct costs accounted for about 73% of the total value of costs – on average, 72.59% on the organic plantations, and 72.92% on the conventional ones. In the organic cultivation system, they amounted, on average, to 15130.33 USD·ha^{-1} and were higher than in the conventional cultivation system, where they amounted to 11009.30 USD·ha^{-1}. Unit costs on the organic plantations were higher, between 0.22 USD·kg^{-1} and 0.27 USD·kg^{-1}, depending on the year and variety, than those in conventional cultivation. For the Honeoye variety, the differences were not statistically significant.

Table 3. The costs in strawberry production, depends on the method of production (average from the years 2018–2020)

Specification	Honeoye		Aprica		Dipred	
	A	B	A	B	A	B
Total costs (USD·ha^{-1})	20112.14^{a}	15065.64^{b}	21552.39^{a}	15136.85^{b}	20862.83^{a}	15090.79^{b}
Plant protection costs (USD·ha^{-1})	1583.87^{a}	961.30^{b}	1682.43^{a}	987.69^{b}	1611.27^{a}	920.66^{b}
Labour costs (USD·ha^{-1})	10971.87^{a}	8227.48^{b}	11708.55^{a}	8291.34^{b}	10760.20^{a}	8306.41^{b}
Direct costs (USD·ha^{-1})	14841.04^{a}	11050.61^{b}	15662.10^{a}	11121.82^{b}	14887.85^{a}	10855.45^{b}
Unit cost (USD·kg^{-1})	1.23^{a}	1.01^{a}	1.24^{a}	0.98^{b}	1.19^{a}	0.91^{b}

A – organic method, B – conventional method. The means followed by the same letters do not differ at $\alpha = 0.05$
Source: author's own study

In addition, in the farms surveyed in 2018–2020, there was relatively little variation in the level of average annual cultivation costs within the analysed varieties, as well as average annual labour and plant protection costs. This is due to the very similar strawberry production technology, which was actually a fundamental methodological assumption. The differences were supposed to result only from different cultivation methods associated with not using chemical preparations on strawberry plantations.

The production of berry fruit is burdened with a high risk resulting, to a large extent, from the variability of fruit sales prices [Paszko 2006]. The data presented in Table 4 show that the average sales price per kilogram of organic strawberry fruit in the farms under analysis, depending on the variety, was 16.86–22.94% higher than the average

sales price of the strawberries obtained in the conventional cultivation system. This directly affected the economic efficiency of organic plantations which, despite the higher costs of organic treatments, was comparable to or higher than that obtained from the conventional plantations. In the farms surveyed in 2018–2020, the average value of strawberry production differed mainly due to the cultivation method and fruit variety, but these differences were not statistically significant.

Table 4. Selected indicators of the economic efficiency of strawberry production in the farms under analysis (average from of the years 2018–2020)

Specification	Honeoye		Aprica		Dipred	
	A	B	A	B	A	B
Average sales price (USD·kg^{-1})	1.58^{a}	1.26^{a}	1.67^{a}	1.29^{b}	1.58^{a}	1.32^{a}
Production value (USD·ha^{-1})	26152.73^{a}	19369.20^{a}	26388.54^{a}	20670.18^{a}	27886.93^{a}	22036.08^{a}
Gross margin (USD·ha^{-1})	11311.69^{a}	8318.58^{a}	12615.86^{a}	9548.36^{a}	12999.08^{a}	11180.63^{a}
Net income (USD·ha^{-1})	6040.59^{a}	4303.56^{a}	6725.57^{a}	5533.33^{a}	7024.11^{a}	6945.29^{a}
Profitability of production (%)	130.07^{a}	127.92^{a}	131.18^{a}	135.38^{a}	133.61^{a}	146.46^{a}

A – organic method, B – conventional method. The means followed by the same letters do not differ at $\alpha = 0.05$
Source: author's own study

Irrespective of the variety, the average value of fruit production was significantly higher in the organic farms compared to the conventional ones. For the Honeoye variety, the difference in the production value was the highest and amounted to 6783.53 USD·ha^{-1}, while for the Aprica and Dipred varieties, the differences were 5718.36 USD·ha^{-1} and 5850.85 USD·ha^{-1}, respectively. This directly affected the level of other economic results, i.e. direct surplus, net income and the production profitability index. These were significantly higher for the Dipred variety, compared to the other varieties under analysis. The production values of the Dipred variety grown using the organic and conventional cultivation methods amounted to 27886.93 USD·ha^{-1} and 22036.08 USD·ha^{-1}, respectively. In comparison, the production values of the Aprica variety in the organic and conventional cultivation systems were lower than those of Dipred by 1498.39 USD·ha^{-1} and 1365.90 USD·ha^{-1}, respectively, and the production values of the Honeoye variety by 1734.20 USD·ha^{-1} and 2666.88 USD·ha^{-1}, respectively. The above situation was affected mainly by higher yields obtained on the Dipred plantation.

In the analysed period, the cultivation of all strawberry varieties, irrespective of the production method employed, was profitable and cost-effective, as proven by the average values of direct surplus, net income and the profitability index for the period of 2018–2020. However, in the farms under analysis, higher income was obtained from organic plantations. The value of direct surplus obtained in the organic cultivation system, depending on the variety, ranged from 11311.69 USD·ha^{-1} to 12999.08 USD·ha^{-1}, and the value of net income from 6040.59 USD·ha^{-1} to 7024.11 USD·ha^{-1}. In comparson, in the conventional cultivation system, depending on the variety, the value of

direct surplus ranged from USD 8318.58·ha^{-1} to 11180.63 USD·ha^{-1}, and the value of net income – from 4303.56 USD·ha^{-1} to 6945.29 USD·ha^{-1}. It is, nonetheless, worth stressing that, in the years under analysis, on the plantations managed using the conventional method, irrespective of the variety, the levels of both direct surplus and net income showed a decreasing tendency. This was influenced by the decreasing yields and the dropping prices of fruit obtained in conventional production. In turn, the slightly lower economic efficiency, measured by the production profitability index, on the organic plantations, as compared to the conventional ones, was determined by the level of production costs.

CONCLUSIONS

The results of the conducted research indicate that, in general, in the analysed farms with strawberry cultivation, higher yields were obtained from the plantations based on the organic method than from the conventional one. Furthermore, regardless of the production method, the highest yields were obtained in the first year and the lowest in the last year of fructification. It is also worth stressing that, irrespective of the cultivation method, the average yields of fruit intended for processing were 30–40% higher in the farms under analysis than the national average. They also exceeded the average yields on dessert strawberry plantations. Regardless of the production method, higher yields were obtained from the cultivation of the Dipred variety compared to the other varieties. However, the overall production costs were higher by nearly 30% in the organic cultivation system than in the conventional one. In addition, expenditures on plant protection products in the organic farms were over 40% higher than those on conventional plantations. Paradoxically, this was due to both the necessity of conducting far more treatments involving organic plant preparations on such plantations, compared to the conventional ones, and the prices of organic plant preparations exceeding those of pesticides. The higher level of overall costs on the plantations based on organic plant protection was also influenced by significantly higher expenditures on labour, especially related to plantation maintenance.

As revealed by the research, in spite of the higher costs of organic production, the economic efficiency of such plantations was higher than or comparable to conventional ones. This was mainly influenced by the higher sales prices of organic fruit and higher yields. However, the production profitability of the organic plantations was slightly lower compared to the conventional ones, which was mainly influenced by the higher level of production costs recorded on organic plantations. The conducted research shows that organic production of strawberries may be a significant source of income for farmers. However, it should be remembered that all treatments must be performed with the utmost care and in accordance with the methodology of organic production. In addition, farmers must be aware of the need to incur higher plant protection costs with products dedicated to organic production.

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