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PRODUCTION POTENTIAL OF THE VEGETABLE SECTOR IN POLAND AND SELECTED EU COUNTRIES

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ABSTRACT

The aim of the research was to assess the production potential of the vegetable sector, as a factor of competitiveness, in Poland and selected EU countries. The evaluation of vegetable production was based on a comparative analysis of the level and changes in land area devoted to crops, yields, the number of farms and the average area of crops on the farm, the species structure of crops, the level of basic vegetable yields, and the resources of the factors of vegetable farm production from the FADN system. The research has shown that Poland's high and growing position in vegetable production results mainly from the high acreage of crops, their partially complementary structure, and above all from relatively low labour costs compared to other surveyed EU countries. On the other hand, the improvement of effectiveness is not supported by the large fragmentation of Polish farms, although an increase in the average area of cultivation per farm was observed in the examined period. The research shows that in most of the analysed countries there was still a large fragmentation of vegetable farms. The analysis of vegetable farm inputs (on the basis of FADN data) in selected countries also shows that in the analysed period, a decrease in production factor resources was observed in Poland, Italy and France.

Key words: vegetable production, vegetable farms, FADN, Poland , EU

JEL codes: Q12, D24, J24

INTRODUCTION

Within the agricultural sector the production and marketing of horticultural products (mainly vegetables, fruits, pot plants and cut flowers, or ornamental trees and shrubs) plays a specific role due to its high labour and capital intensity [Menrad and Gabriel 2009]. Vegetable production belongs to one of the most important branches of agricultural production. The world harvest in 2017 was over 1.1 billion t, while production alone covered 58 million ha. More than 75% of this production was obtained in Asia [Shahbandeh 2020]. EU vegetable production in 2017 was over 60 million t, with most being tomatoes (around 17 million t), followed by onions (over 5.5 million t), white and red cabbages (5.2 million t) and carrots (over 5.1 million t). As a comparison, in Poland in recent years, about 5.5 million tons of vegetables have been produced annually. In this area, Poland has been ranked third in the EU, after Spain and Italy [FAO 2020].

Poland's potential in terms of agricultural development opportunities, including the vegetable industry, is considerable compared to other EU countries. It is mainly related to substantial land resources and labour, although, in the case of the latter, a decrease in resources has been observed for several years with

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a simultaneous increase in labour costs, although as indicated by Ziętara and Sobierajewska [2013], compared to many EU countries, they were relatively lower at the beginning of the last decade. The agricultural land in farms in Poland in 2016 amounted to 14.4 million ha, which constituted 7.9% of the EU 28 area (4th place in the EU). The workload in 2017 in Poland amounted to about 1.84 million working in agriculture, i.e. 18.9% of total working in agriculture in the EU (2nd place in the EU) [GUS 2018].

Vegetable production in Poland plays an essential role in agricultural production and its importance is gradually increasing. The share of vegetables in the total agricultural output in Poland in 2017 was about 8.7%, in the total plant output about 18.0% and in the area of arable land (AL) about 1.6%. The share of vegetables and their preserves constituted about 5.0% in the export of food products and 23.3% in the export of plant products. According to data from The Agricultural Property Agency [KOWR 2018], in 2016, field vegetables were grown in 73,000 agricultural holdings, and vegetables under cover of about 9,000 holdings, as compared to 370,000 and 23,000 in 2005, respectively. The average area of vegetable cultivation in Polish agricultural holdings is also expanding, although it is still small. In 2016, the average area of field vegetables in a holding was 2.6 ha and undercover vegetables 0.5 ha. The development of the Polish vegetable industry was supported by relatively low labour costs, the increasing purchasing power of consumers, a developed processing industry, convenient geographical location for establishing business contacts, and changing nutritional trends [KOWR 2018].

RESEARCH METHODOLOGY

The aim of the research was to assess the production potential of the vegetable sector in Poland and selected EU countries as a factor of competitiveness. The countries which are the largest vegetable producers on the EU common market were selected for comparison. After initial data verification, Spain, Italy, Poland, France, the Netherlands and Germany were selected for further research. These countries had, depending on the year, a share of over 72% of total EU vegetable production.

The evaluation of vegetable production potential in Poland and selected countries was made based on a comparative analysis of the level and changes of the area of crops, yields, the number of farms and the average area of crops on the farm, the species structure of crops, the level of basic vegetable yields, and analysis of the resources of the factors of vegetable farm production from the FADN system. The European Farm Accountancy Data Network (FADN) was established in 1965 (Council Regulation 79/65). The network aims to collect agricultural holdings accountancy data in order to establish income and business analyses of agricultural holdings [Neuenfeldt and Gocht 2014]. FADN dataset is useful to estimate with a quantitative approach and, for a long time, the role and effect of political decisions about i.a. rural development implemented by the EU [Galuzzo 2014, Garrone et al. 2019]. The starting point in the analysis of crop structure and yields was the crop structure in Poland. Horticultural farms within the FADN are farms grouped into type 2 (GTF 2) based on the share of the value of production from each agricultural activity to the value of the total production of the holding, which specialises in the cultivation of vegetables, strawberries, mushrooms, flowers and ornamental plants.

Descriptive methods were used in the analyses, including the determination of percentages and the absolute and relative dynamics of changes in the application of:

- linear regression of the form:

$$f(x) = ax + b;$$

- exponential of the form:

$$f(x) = a^x.$$

indicating an average annual change in the phenomenon as a percentage.

In the study, data from EUROSTAT, GUS[1], IERiGŻ[2], the EU agricultural accounting system FADN, as well as literature on the discussed issues,

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were used. Data of the EU FADN system were obtained from the Agriculture and Rural Development Directorate-General (DG 6) of the European Commission (EC) in Brussels. The research covered the period of years 2004–2018[3], i.e. years after Poland's accession to the EU.

Taking into account the variability of weather conditions and the need to smooth out any deviations related to it, periods of five years were generally used. Due to the unavailability of data in some research areas, the periods may differ and be shorter, e.g. three years. Calculations were made of the average annual rate of changes in the area or harvests in the entire analysed period, without focusing on selected sub-periods, due to their different lengths. This was to clearly visualize the results. Tabular, graphic and descriptive methods were used to present the results.

PRODUCTION VOLUME AND AVERAGE CULTIVATION AREA

The largest area of field vegetable cultivation among EU countries in the years 2004–2018 was in Italy and amounted on average to 435.41 thousand ha (Table 1). Spain was in second place, France in third place, and Poland in fourth place with an average of 347.69 thousand, 247.65 thousand and 193.98 thousand ha respectively. The share of the above countries in the total EU cultivation area was 21.18, 16.91, 21.95 and 9.42% respectively. The vegetable harvest was also the highest in Italy (12.97 million t), followed by Spain (11.96 million t), with France (5.95 million t) and Poland (4.95 million t) in third and fourth place. Fewer vegetables were grown in Germany (110.56 thousand ha) and the Netherlands (82.81 thousand ha). The harvest was also lower in these countries, with the Netherlands in fifth place with an average harvest of 4.46 million t, which indicates high productivity of the vegetable industry in this country, and Germany in sixth place (3.42 million t). Also, according to a study by Filipiak and Maciejczak [2008], in the years 2004–2007 Poland was ranked fourth in global vegetable production in the EU after Italy, Spain and France. As indicated by De Cicco [2019] in 2017, the places of these countries in EU vegetable production have not changed.

Considering the changes between 2004 and 2018, in Italy and France, the area under cultivation and the harvest of ground vegetables decreased by –1.70 and –0.70% of the area and –1.3% of the harvest in both countries, respectively. In the other countries analysed, production increased. The annual increase in area was 0.76 and 0.46% in Germany and Poland, 0.15 and 0.02% in the Netherlands and Spain, and the harvest was 1.26 and 1.59%, and 0.80 and 1.06%, respectively. A comparison of the dynamics of changes in the area of crops and harvest shows that in most countries (except France and Italy) there was an increase in productivity per area unit. It should be emphasized that in the case of Poland, the indicated increase in production (changes in the cultivated area are particularly visible in Poland in the 2004–2008 and 2009–2013 sub-periods) does not confirm the results of previous research, which showed a clear decrease in the area of crops and harvest after 2004 [Olewnicki 2011, Jabłońska et al. 2017]. This discrepancy results from the fact that the Eurostat data used in this paper and the data of the Statistics Poland, used in the above publications are clearly different. On the other hand, the aforementioned downward trend, resulting from previous studies, was the result of a change in the definition of a vegetable farm by the Central Statistical Office, for which, since 2010, according to Eurostat rules, farms with more than 0.1 ha of crops were taken into account.

Regardless of the direction of changes in the area of vegetable cultivation, the number of vegetable farms has been decreasing in all countries surveyed. In the years 2005–2016, the greatest decrease was recorded in Poland, as much as by 75.58% (Table 2). However, it was partly a result of the mentioned change in the approach of Statistics Poland to the definition of a "vegetable commercial farm". The data of the agricultural censuses from 2002 and 2010 [GUS 2002, 2010] show that the number of farms decreased 5.6 times in those years, from 617.2 thousand to 110.2 thousand [Jabłońska et al. 2013]. A visible decrease in the number of vegetable farms also took place in Ita-

[3] In the case of the analysis of FADN farms, the research period covers the years 2004–2019.

Table 1. Cultivated area and ground vegetable harvest in selected EU countries in 2004–2018

Country	Period			2004-2018		
	2004–2008	2009–2013	2014–2018	average size	average annual change	share in the EU
	cultivated area					
	thousand ha				%	%
France	260.98	232.94	249.02	247.65	–0.70	12.05
Spain	368.72	306.90	367.44	347.69	0.02	16.91
Netherlands	85.56	79.73	86.95	84.08	0.15	4.09
Germany	109.58	109.96	117.44	112.33	0.76	5.46
Italy	485.06	407.43	413.75	435.41	–1.70	21.18
Poland	181.04*	208.33	189.41	193.98**	0.46	9.42
UE	2 108.64	1 916.75	2 101.79	2 055.73	–0.30	100.00
Country	harvest					
	million t				%	%
France	6.20	6.18	5.46	5.95	–1.30	10.41
Spain	12.15	9.99	13.74	11.96	1.06	20.93
Netherlands	4.49	4.76	4.92	4.73	0.80	8.27
Germany	3.21	3.52	3.63	3.45	1.26	6.04
Italy	13.96	12.82	12.14	12.97	–1.30	22.71
Poland	4.65*	4.71	5.42	4.95**	1.59	8.65
UE	57.42	51.11	62.84	57.12	0.68	100.00

* 2005–2008, ** 2005–2018,

Source: Authors' own study based on EUROSTAT data.

ly (by 42.24%), to a lesser extent in Spain, Germany and Holland (by 39.37, 37.74, 26.37%, respectively) and the smallest decrease was recorded in France (by 20.32%).

The result of the reported changes in the area of cultivation and the number of farms was an increase in the average cultivation area per farm. This phenomenon was mostly noticed in Poland, where the average area of a vegetable farm increased by 4.6 times between 2005 and 2016, while in Italy 2.03, Germany 1.73, The Netherlands 1.51 and Spain 1.10 times. In France, there was an increase of 3.21%. However, there is still a large fragmentation of farms in Italy, Spain and Poland. In 2016 the average farm grew vegetables on an area of 3.48 ha, 2.26 ha and 2.16 ha respectively. In France, it was 5.36 ha, in Germany 8.90 ha and in Holland 10.06 ha. This very low average area of vegetable crops in Polish, Spanish and Italian farms is not conducive to the improvement of economic efficiency of production and development

Table 2. Number of vegetable farms and average area under vegetables in selected EU countries in the years 2005–2016

Country	Number of farms				Average farm area			
	2005/ 2007	2010/ 2013	2016		2005/ 2007	2010/ 2013	2016	
	thousand units			index: 2005 = 100	thousand units			index: 2005 = 100
France	39.8	37.73	32.98	79.68	6.10	5.36	6.10	103.21
Spain	142.45	107.57	91.41	60.63	2.00	2.21	2.26	120.21
Netherlands	9.54	8.17	7.23	73.63	8.34	10.06	11.63	151.04
Germany	17.88	13.82	11.63	62.26	6.71	8.90	11.21	173.80
Poland	434.81	141.08	113.04	24.42	0.53	1.29	2.16	459.58
Italy	139.06	95.69	79.59	57.76	1.68	2.91	3.48	203.51

* available data for years 2005, 2007, 2010, 2013, 2016.

Source: Authors' own study based on EUROSTAT data.

of the whole sector. It adversely affects the competitive position. In comparison, according to Brzozowski and Zmarlicki (2017), orchard farms in Poland with a growing area of about 20 ha are considered to be highly competitive compared to their counterparts in neighbouring countries, and 13 ha and 8–13 ESU (European Size Units) are considered to be the minimum size for their development and competitiveness. It should be added that in all countries the area of vegetable cultivation on a single farm was much lower than that of typical agricultural crops. In 2010, the average farm area was 56.1 ha in Germany, 54.9 ha in France, 26.5 ha in the Netherlands, 9.6 ha in Poland and 8.0 ha in Italy [Nosecka et al. 2011].

PRODUCTION SPECIES STRUCTURE

In the countries studied, the species structure of field vegetable crops is different, determined to a large extent by climatic conditions. In Poland, the most important species are onions, cabbage, carrots and beetroot, which in the years 2004–2018 accounted for almost 50% of the total area of vegetable crops and 60% of the total harvest (Table 3). The first three species covered 13–14% of the total area each, and beetroot 6%. In the case of beetroot, cabbage and carrots, Poland is the largest producer in the EU and in the case of onions, it ranks second [Filipiak and Maciejczak 2008]. Carrots and, above all, onions also play a large role in the field vegetable crops of the Netherlands. Here, onion production occupied an average of 34% of the total crop area and provided 29% of the total vegetable harvest. It is worth emphasizing that in the case of onions in the Netherlands, there was a large increase in the share of cultivated area between the studied sub-periods, i.e. 2004–2008 and 2014–2018. The share of carrots in the area and harvest was 11%. Onions and carrots (9% each) and cabbages (7%) are important species in the German vegetable industry. In Germany and the Netherlands, the share of beet production is low.

It should be underlined here that the importance of the above species in the vegetable production in Poland decreased in the years 2004–2018 by several percentage points (though it should be noted, however, that the share of other vegetables clearly increased in the area and harvest, between the analysed sub-periods in Poland), while in the Netherlands and Germany the changes were insignificant, with the exception of onions in the Netherlands, whose share in the area of vegetable crops increased from 29 to 38%. It can, therefore, be concluded that from the point of view of the production structure, the Netherlands and Germany are growing competitors of Poland, taking into account further development of the sector. The southern European countries, i.e. France, Spain and Italy, are not competitors. Here the above four species are of lesser importance, with the total share in the area of cultivation at the level of 10%. In the Mediterranean countries, the main species is tomato, produced e.g. in Italy and Spain for about 24 and 16% of the vegetable area. Melons, peppers, watermelons, lettuces and endives are also relatively important vegetables. Thus, the structure of crops in Poland, as well as in Germany and the Netherlands, is complementary to those countries.

The decrease in the share of cabbage, carrots, onions and beets in the area of crops and the harvest of field vegetables in Poland is a result of the decrease in the production of these species. Despite the observed variability of the cultivation area and harvest in the analysed sub-periods, the area under cultivation between 2004 and 2018 decreased annually between 2.3 and 3.3%, and the harvest between 0.8 and 2.7% (Table 4). According to a study of Filipiak (2014), the decline in the area of cultivation of most vegetables in Poland began in the early 1990s. At the same time, the area of cultivation and the harvest of onions grew in other countries, as did cabbage and beetroot (apart from France), and carrots in Germany and the Netherlands. Thus, from a production point of view, Poland is reducing its competitive position, facing increasing competition from other countries on the market of leading Polish vegetables.

However, Poland continues to be a European leader in vegetable production. This primarily applies to cabbage and beets. In the years 2014–2018, the area under cultivation and harvest of cabbage in Poland was 2.5 and 1.7 times higher than in Germany, 4.9 and 6.2 times higher than in Spain, 4.4 and 8.2 times higher than in Italy, 8.3 and 5.3 times higher than in the Netherlands and 27.5 and 16.5 times higher than in France. Over the same period, and by country in

Table 3. Structure of area under cultivation and harvest of vegetables in Poland and selected EU countries in the years 2004–2018 [%]

Vegetable	Years																	
	2004–2018						in it											
							2004–2008						2014–2018					
	France	Spain	Netherlands	Germany	Poland	Italy	France	Spain	Netherlands	Germany	Poland	Italy	France	Spain	Netherlands	Germany	Poland	Italy
	cultivated area [%]																	
Cabbage	0.45	1.42	2.39	7.01	**13.66**	1.03	0.44	1.33	1.91	5.94	**18.58**	0.91	0.33	1.27	3.15	7.72	**12.05**	1.25
Carrot	5.28	2.13	10.58	9.42	**13.03**	2.81	5.40	2.34	10.04	9.29	**17.62**	2.73	4.97	1.81	10.43	9.71	**11.87**	2.81
Onion	4.06	6.67	34.11	9.59	**14.44**	2.90	3.39	5.87	29.37	7.82	**19.33**	2.64	4.86	6.79	37.71	11.38	**13.71**	3.12
Beetroot	1.09	0.25	0.62	1.31	**6.17**	0.15	0.92	0.17	0.41	1.21	**8.06**	0.10	1.2	0.31	0.87	1.45	**5.68**	0.21
Other*	89.12	89.53	52.30	72.67	**52.70**	93.11	89.85	90.29	58.27	75.74	**36.41**	93.62	88.64	89.82	47.84	69.74	**56.69**	92.61
Vegetable	harvest [%]																	
Cabbage	1.31	1.40	3.22	15.67	**23.01**	0.81	1.39	1.30	2.98	14.32	**29.70**	0.73	1.10	1.16	3.83	16.27	**18.34**	1.00
Carrot	9.71	3.45	11.31	16.71	**16.86**	4.23	10.01	3.78	11.30	16.74	**20.61**	4.28	10.19	2.86	11.63	17.28	**14.29**	4.31
Onion	6.44	10.05	27.97	14.08	**13.17**	3.04	5.67	8.92	25.15	11.93	**16.42**	2.72	7.79	9.64	29.98	15.95	**11.36**	3.55
Beetroot	2.08	0.32	0.66	1.87	**6.80**	0.10	1.82	0.19	0.53	1.68	**8.12**	0.07	2.47	0.40	0.84	2.13	**6.01**	0.16
Other*	80.46	84.78	56.84	51.67	**40.16**	91.82	81.11	85.81	60.04	55.33	**25.15**	92.20	78.45	85.94	53.72	48.37	**50.0**	90.98

*other brassica vegetables, leafy vegetables, fruit-growing vegetables, root, tuber and bulb vegetables, fresh pulses.

Source: Authors' own study based on EUROSTAT data.

Table 4. Cultivation area and harvest of particular vegetables in Poland and selected EU countries in the years 2004–2018

Country	Cultivation area					Harvest				
	period			2004–2018		period			2004–2018	
	2004––2008	2009––2013	2014––2018			2004––2008	2009––2013	2014––2018		
	thousand ha				average annual change in %	thousand t				average annual change in %
					cabbage					
France	1.16	1.33	0.83	1.11	–3.40	86.02	86.59	60.31	77.64	–3.80
Spain	4.91*	5.33**	4.67	4.95	.	157.64*	187.48**	159.97	167.72	.
Netherlands	1.63	1.65	2.74	2.01	4.72	133.80	134.60	188.42	152.27	2.82
Germany	6.51	8.06	8.99	7.85	3.27	459.20	573.35	590.92	541.16	2.28
Poland	31.00	25.59	22.83	26.47	–3.30	1 281.32	1 138.26	994.56	1138.05	–2.70
Italy	4.42	3.81	5.16	4.46	0.52	102.32	89.45	121.75	104.51	0.79
EU	121.42	100.46	101.80	94.56	2.17	3135.15	3623.70	3667.06	3475.30	1.58
					carrot					
France	14.08	12.75	12.39	13.07	–1.40	620.70	555.48	556.73	577.64	–1.20
Spain	8.62*	7.13**	6.66	7.40	.	459.77*	391.98**	392.88	413.18	.
Netherlands	8.59	9.02	9.07	8.89	0.58	507.60	524.00	572.23	534.61	1.16
Germany	10.18	10.17	11.30	10.55	1.11	536.83	566.86	627.43	577.04	1.55
Poland	29.39	23.85	22.48	25.24	–2.80	889.07	837.09	775.16	833.77	–1.50
Italy	13.22	11.79	11.63	12.21	–1.30	597.90	525.88	523.58	549.12	–1.40
EU	115.75	110.73	116.73	114.41	0.12	4958.43	4903.06	5462.66	5108.05	0.95
					onion					
France	8.84	9.24	12.10	10.06	3.02	351.38	372.83	425.83	383.35	1.92
Spain	21.65	22.96	24.95	23.18	1.22	1083.72	1198.42	1325.18	1202.44	1.92
Netherlands	25.13	28.12	32.79	28.68	2.60	1 129.2**0**	1 360.20	1475.39	1321.60	2.38
Germany	8.57	10.39	13.25	10.74	4.31	382.58	496.52	579.12	486.07	3.86
Poland	32.24	25.72	25.98	27.98	–2.40	708.14	629.67	616.23	651.34	–1.60
Italy	12.80	12.13	12.90	12.61	0.08	380.08	373.71	430.89	394.89	1.12
EU	151.67	158.51	177.67	162.62	1.57	5 092.07	5636.49	6337.03	5688.53	2.03
					beetroot					
France	2.40	.	3.00	.	.	112.58	.	135.00	.	.
Spain	0.64*	0.64***	1.15	0.87	.	22.85	27.8	55.06	37.71	.
Netherlands	0.35	0.47	0.76	0.52	7.84	24.00	28.60	41.57	31.39	5.36
Germany	1.33	1.39	1.68	1.47	2.17	53.94	62.72	77.38	64.68	3.13
Poland	13.45	11.68	10.75	11.96	–2.30	350.12	333.14	326.09	336.45	–0.08
Italy	0.50	.	0.87	.	.	9.62	.	19.49	.	.
EU	26.45	17.09	21.14	21.56	–2.10	754.24	506.93	700.01	646.60	–0.60

*2004–2007, **2010–2013, ***2011

Source: Authors' own study based on EUROSTAT data.

the same order as above, beets were 6.3 and 4.2 times higher (than Germany), 9.3 and 5.9 (Spain), 12.4 and 16.7 (Italy), 14.1 and 7.8 (the Netherlands), 3.6 and 2.4 (France). Also, in Poland the area of cultivation and carrot harvest was the largest. The area was about 3 times higher than in Spain, 2.5 times higher than in the Netherlands and about 2 times higher than in Germany, France and Italy. Poland's carrot yield was 2 times (Spain), 1.4 times (the Netherlands and France), 1.2 times (Germany) and 1.5 times (Italy). As far as onions are concerned, Poland is a bigger producer than France, Italy and Germany, with harvests 1.5, 1.4 and 1.0 times higher, respectively, and an area about 2 times higher. But the Netherlands is the leader in the EU, with an average 2014–2018 onion harvest 2.4 times higher than in Poland, although it was grown on an area only 26% higher. In Spain, too, the harvest was 2.2 times higher, with the same area of cultivation.

COMPARISON OF YIELD LEVEL IN INVESTIGATED COUNTRIES

Not only the absolute level of production and the direction of change but also the productivity from the unit of area, which is the result of the level of yield achieved, is indicative of the production potential affecting the competitive position. The dynamics of changes in the area of cultivation and harvest of cabbage, carrots, onions and beets, presented in the previous chapter, show that in the examined period there was an increase in yields. Relatively the greatest improvement was recorded in Poland. Beet yields grew the strongest, by 1.52% per year, with an increase of 0.96% in Germany and a decrease of –2.5% in the Netherlands. Carrot yields grew annually by 1.36%, while in France, the Netherlands, Germany and Spain it was an increase by 0.93, 0.58, 0.44 and 0.25%, respectively, and in Italy a decrease by –0.10% (Table 5.). The growth of onion yields was slower, by 0.81% per year, in Poland and only in Italy was it faster, by 1.06%. In Spain, they grew by 0.73%, and in France, in Germany and the Netherlands, it decreased by –1.1, –0.5 and –0.2% annually. The situation with cabbage yields was similar. In Poland, it grew by 0.63% per year, with an increase of 0.28 and 0.69% in Italy and Spain and a decrease in the other three countries.

The above phenomenon of relatively faster crop growth in Poland should be assessed positively from the point of view of the further development of the vegetable industry and its competitiveness. This is necessary because Polish yields are still at very low levels. Most importantly, there is a big difference in comparison with vegetable yields in the Netherlands and Germany, because it is 1.6–2.0 times higher.

VEGETABLE PRODUCTION FACTOR STOCKS

The average area of a horticultural farm in the EU in 2004–2007 was approximately 6.2 ha a.a (agricultural area), while in 2016–2019 it was 6.71 ha a.a.. Between 2004 and 2019, the area of farms in the EU countries increased approximately by 1.0%. In all countries selected for the analysis, there was an increase in the area of horticultural holdings during the period considered. The largest increase in area was in Dutch farms (by 4.4% on average per year), German farms (by 4.1%) and Italian farms (by 4%), while the smallest increase was in Spanish farms (by 0.2% on average per year) and French farms (by 1.0% on average per year).

In 2016–2019, the largest holdings were observed in the Netherlands (13.2 ha a.a on average), followed by France (about 10.1 ha a.a on average) and Germany (about 9.5 ha a.a on average). By far the smallest holdings were in Italy (on average about 5.7 ha a.a) and in Poland (on average 5.4 ha a.a).

If we compare the size of Dutch, French and German farms with Polish farms, they were 2.5, 1.9 and 1.8 times larger, respectively (Table 6). At this point, it should be mentioned that the farms in the FADN system have been selected deliberately and include entities producing mainly for the market with a minimum economic size of 4 ESU[4].

[4]Since 2010, within the FADN classification, entities with a minimum economic size of 4 ESU (until 2010 2 ESU) have been classified into particular types, as well as into particular agricultural types on the basis of Standard Output (SO) (from 2010 Standard Gross Margin – SGM)

Table 5. Yields of particular vegetables in Poland and selected EU countries in the years 2004–2018

Country	Period				2004–2018		
	2004–2008	2009–2013	2014–2018				
	t/ha			index: Poland = 100%	t/ha	average annual change in %	index: Poland = 100%
				cabbage			
France	74.16	44.91	72.22	165	69.03	–0.50	159
Spain	31.85	35.25	34.27	78	33.83	0.69	78
Netherlands	82.09	81.38	68.60	157	77.37	–1.90	178
Germany	70.52	71.12	65.60	150	69.42	–1.00	160
Poland	41.34	44.48	43.78	100	43.48	0.63	100
Italy	23.15	23.47	23.88	55	23.50	0.28	54
EU	**25.82**	**36.07**	**36.06**	**82**	34.82	–0.40	**80**
				carrot			
France	44.08	43.55	47.96	139	45.23	0.93	135
Spain	53.37	55.16	56.02	162	54.94	0.25	164
Netherlands	59.06	58.09	63.16	183	60.11	0.58	179
Germany	52.74	55.73	55.77	162	54.75	0.44	163
Poland	30.25	35.10	**34.48**	**100**	**33.51**	1.36	**100**
Italy	45.23	44.60	45.08	131	44.98	–0.10	134
EU	**42.84**	**44.28**	**46.79**	**136**	44.58	0.84	133
				onion			
France	39.75	40.37	35.10	148	38.38	–1.10	150
Spain	50.08	52.94	53.50	226	51.93	0.73	203
Netherlands	44.93	48.37	45.03	190	46.11	–0.20	181
Germany	44.63	47.78	43.76	185	45.38	–0.50	199
Poland	21.96	24.48	23.71	**100**	**23.52**	0.81	**100**
Italy	29.69	30.80	33.47	141	31.32	1.06	123
EU	**33.57**	**35.56**	**35.68**	**150**	34.93	0.46	**149**
				beetroot			
France	46.91	.	45.01	148	45.91	.	161
Spain	35.81	.	47.61	157	41.82	.	147
Netherlands	68.97	61.37	55.76	183	62.27	–2.50	218
Germany	40.55	45.06	45.89	151	43.79	0.96	154
Poland	26.04	28.51	30.39	100	**28.50**	1.52	**100**
Italy	19.24	..	22.50	74	20.46	.	72
EU	**28.52**	**29.66**	**33.59**	**111**	30.20	1.00	**106**

Source: Author's own study based on EUROSTAT data.

Another resource to be analysed was the labour resources present in the horticultural holdings of the FADN system. In 2004–2007, on average in EU countries, labour resources were about 3.2 AWU per farm and 0.52 AWU per 1 ha a.a, while in 2016–2019 labour resources were 3.47 AWU per farm and 0.51 AWU per 1 ha a.a, respectively. During the period studied, EU countries experienced a slight increase in the labour resources (by 0.5% on average per year). In the analysed years in almost all countries selected for the study, an increase in labour resources was recorded, except for French and Polish agricultural holdings. The greatest increase in labour resources was observed in Dutch (by 3.1% on average per year), German (2.9%) and Spanish (by 1.9%) households. France and Poland experienced a decrease in labour resources of 0.9% and 0.4% on average per year. In 2016–2019, Dutch (8.56 AWU per farm) and German (6.45 AWU) farms had the highest labour resources per farm. The lowest labour resources were

in Italian (about 2.63 AWU per household) and Polish (2.74 AWU) households.

If we take into account labour resources per 1 ha UR, the highest labour resources were characterised by Dutch (approximately 0.70 AWU per 1 ha a.a on average in 2004–2019) and German (0.69 AWU per 1 ha a.a) farms. In other countries, labour resources were much lower and ranged from 0.35 AWU per 1 ha a.a (Spain), 0.48 AWU per 1 ha a.a (France) and 0.56 AWU per 1 ha a.a (Poland). In the studied period, almost all the countries experienced a decrease in labour resources per 1 ha a.a; only in Spanish farms was an increase observed (1.7% on average per year). In the case of Spain, an increase in total labour input per 1 ha a.a was associated with keeping the Agricultural Area at a similar level and an increase in total labour input. In the remaining countries, a decrease in labour input per ha a.a was observed, the highest in Italy (average annual decrease of 3.9%) and Poland (2.6%). Labour resources per 1 ha a.a in Poland were higher by about 60.0% than in Spain, and by 16.7% than in France, while lower than in the Netherlands by 20%, Germany by about 19.8%, and Italy by 12.5% (Fig. 1). The presented analysis of the labour input shows that labour intensity of vegetable production in Poland is higher than in the other EU countries selected for the study. Significantly higher labour input of Poland compared to the old EU-15 countries characterizes the entire agricultural production. In 2017, agricultural labour resources per 100 ha a.a[4] in Poland were 12.8, while in other countries they were: France 2.7, Germany 3.2, Italy 6.8 and the Netherlands 10.6 [CSO 2018].

In the period 2004–2019, average own labour inputs in vegetable farms in EU countries were about 1.40 FWU per farm and 0.44 FWU per 1 ha a.a. During the period investigated there was a decrease in own labour input on average per year by 0.71 and 1.71% respectively. In the examined period, a slight increase in own labour input per farm was recorded only in Polish (annual average by 0.37%) and German (annual average by 0.32%) agricultural holdings. In the remaining countries, a decrease in own labour input was observed, the highest in French agricultural holdings (annual average by 1.02%) and Italian agricultural holdings (annual average by 0.94%). The highest outlays of own labour per farm were observed in Dutch (1.66 FWU per farm), Polish (1.63 FWU) and French farms (1.55 FWU). The lowest expenditure of own labour per farm was in Spanish agricultural holdings (1.23 FWU).

If we take into account the own labour input per 1 ha a.a in the countries selected for the study, a decrease was recorded in all horticultural holdings. The highest decrease in own labour input per 1 ha a.a was recorded in Italian (on average by 4.98%), Dutch (4.81%) and German (by 3.81%) agricultural holdings. In the study period, the highest own labour input per 1 ha a.a was in Italian (on average 0.31 FWU per 1 ha a.a) and Polish agricultural holdings (on average 0.31 FWU per 1 ha a.a), while the lowest in Spanish (on average 0.14 FWU per 1 ha a.a), Dutch (on average 0.17 FWU per 1 ha a.a) and French (on average 0.18 FWU per 1 ha a.a) agricultural holdings.

The presented comparative analysis shows that vegetable production in Poland and Italy is based mainly on the farmer's and his/her family's labour. The share of own labour input in the total labour input in the holding was about 56.4% in Poland and about 55.6% in Italy. At the same time, in Poland in the analysed period the importance of own labour was increasing with the downward tendency of total labour input. The lowest share of own labour input in total labour input was in Dutch (on average 23.4%) and German (on average about 26.7%) agricultural holdings (Table 6).

The last resource describing horticultural holdings was the value of fixed assets (tangible assets). In 2004–2007, the value of fixed assets in EU countries averaged about 216.9 thousand euro per horticultural farm and 34.9 thousand euro per 1 ha a.a, while in 2016–2019 it was about 269.0 thousand euro per farm and 40.1 thousand euro per 1 ha a.a. In 2004–2019, the value of fixed assets per farm in the EU countries increased on

[4] Labour resources measured in terms of agricultural workers per 100 ha a.a, data on agricultural workers are presented according to the methodology of the International Labour Organization (ILO) and relate to persons of working age (15––64 years) engaged in work in agriculture, hunting, forestry and fishing that brings them a salary or income. Workers include people employed on the basis of an employment relationship and employers and self-employed.

Table 6. Inputs of production factors of farms specializing in field vegetable cultivation in Poland and selected EU countries in the years 2004–2019 [per farm and per 1 ha of UAA]

Country	Per farm			Per 1 ha of UAA		
	average 2004–2007	average 2016–2019	average annual change 2019/2004 [%]	average 2004–2007	average 2016–2019	average annual change 2019/2004 [%]
agricultural acreage [ha]						
Germany	5.93	9.48	4.1	×	×	×
Spain	8.25	7.51	0.2	×	×	×
France	8.42	10.06	1.0	×	×	×
Italy	3.32	5.66	4.0	×	×	×
Netherlands	7.66	13.21	4.4	×	×	×
Poland	4.54	5.38	2.2	×	×	×
EU	6.22	6.71	1.0	×	×	×
annual work unit [AWU]						
Germany	4.49	6.45	2.9	0.77	0.68	–1.2
Spain	2.84	3.73	1.9	0.35	0.49	1.7
France	4.38	3.98	–0.9	0.52	0.40	–1.9
Italy	2.45	2.63	0.2	0.74	0.47	–3.9
Netherlands	5.87	8.56	3.1	0.77	0.65	–1.3
Poland	2.87	2.74	–0.4	0.64	0.51	–2.6
EU	3.20	3.47	0.5	0.52	0.52	–0.5
family work unit [FWU]						
Germany	1.52	1.46	0.3	0.25	0.16	–3.8
Spain	1.16	1.23	–0.5	0.16	0.16	–0.7
France	1.43	1.55	–1.0	0.19	0.14	–2.0
Italy	1.36	1.43	–0.9	0.46	0.24	–5.0
Netherlands	1.62	1.66	–0.4	0.22	0.12	–4.8
Poland	1.65	1.63	0.4	0.35	0.31	–1.9
EU	1.34	1.40	–0.7	0.24	0.20	–1.7
fixed assets [thous. EUR]						
Germany	250.41	402.56	3.9	43.09	42.49	–0.2
Spain	190.23	287.93	2.9	22.79	38.28	2.7
France	140.25	152.52	0.6	16.67	15.17	–0.4
Italy	211.89	165.83	–2.1	63.96	29.43	–6.1
Netherlands	1039.27	1659.71	3.7	135.06	125.59	–0.7
Poland	102.29	125.84	1.8	22.72	23.39	–0.4
EU	216.92	268.99	1.4	34.91	40.08	0.4

* the valuation of fixed assets in France is understated according to the European FADN office.

Source: Authors' own study based on the EU FADN.

average annually by 1.44%, i.e. by EUR 3.5 thousand per year. In the years analysed, the value of fixed assets decreased only in Italy (by 2.1% on average per year). It indicates a worrying phenomenon of decapitalisation of horticultural holdings' assets in that country. In the remaining countries, an increase in fixed assets per farm was observed, with the highest increase in German farms (average annual by about 3.9%) and Dutch farms (average annual by 3.7%). In 2016–2019, Dutch farms were characterised by the highest nominal value of fixed assets (on average about EUR 1,659.7 thousand), followed by German farms (on average about

EUR 402.6 thousand) and Spanish farms (on average about EUR 287.9 thousand). The lowest value of fixed assets was characteristic for Polish (on average about EUR 125.8 thousand per holding) and French (EUR 152.5 thousand) agricultural holdings.

If we take into account the provision of land in fixed assets, the highest value of fixed assets per ha a.a was in 2016–2019 in Dutch farms (on average about EUR 125.6 thousand per ha a.a), followed by German farms (on average EUR 42.5 thousand) and Spanish farms (on average about EUR 38.3 thousand). The lowest value of fixed assets per 1 ha a.a was in French (on average EUR 15.2 thousand) and Polish farms (EUR 23.4 thousand). If we compare the level of land provision with fixed assets, the level in Poland was 436.8% lower than in the Netherlands, 81.6% lower than in Germany, and 63.7% lower than in Spain (Fig. 1).

In the period considered, the increase in the provision of land with fixed assets was only in Spanish agricultural holdings (on average by 2.7% per year). The high increase in fixed assets in Germany was due, on the one hand, to an increase in the value of fixed assets (by 2.9% on average per year) and, on the other hand, to a slight increase in land area (by 0.2% on average per year). In other countries, a decrease in the value of fixed assets per 1 ha a.a was observed, the highest in Italian farms (by 6.1% on average per year). In the Netherlands, a greater increase in farm area was observed than in the value of fixed assets per farm. The decrease in land endowment in Italy was due to a decrease in the stock of fixed assets per holding with a significant increase in the farm area.

The presented analysis indicates low land enhancement with fixed assets in horticultural farms in Poland. A much lower value of fixed assets per 1 ha a.a was indicated by Ziętara and Sobierajewska [2012] in their study in 2007–2009. Wigier's [2014] study shows that the low level of fixed assets and its decapitalisation characterises the whole of Polish agriculture, especially in small and medium-sized entities.

CONCLUSIONS

Poland's high and growing position in vegetable production results mainly from the high acreage of crops, their partially complementary structure, and above all from relatively low labour costs compared to other EU countries surveyed, which was also indicated in research by Ziętara and Sobierajewska [2012]. On the other hand, the improvement of efficiency is not supported by the large fragmenta-

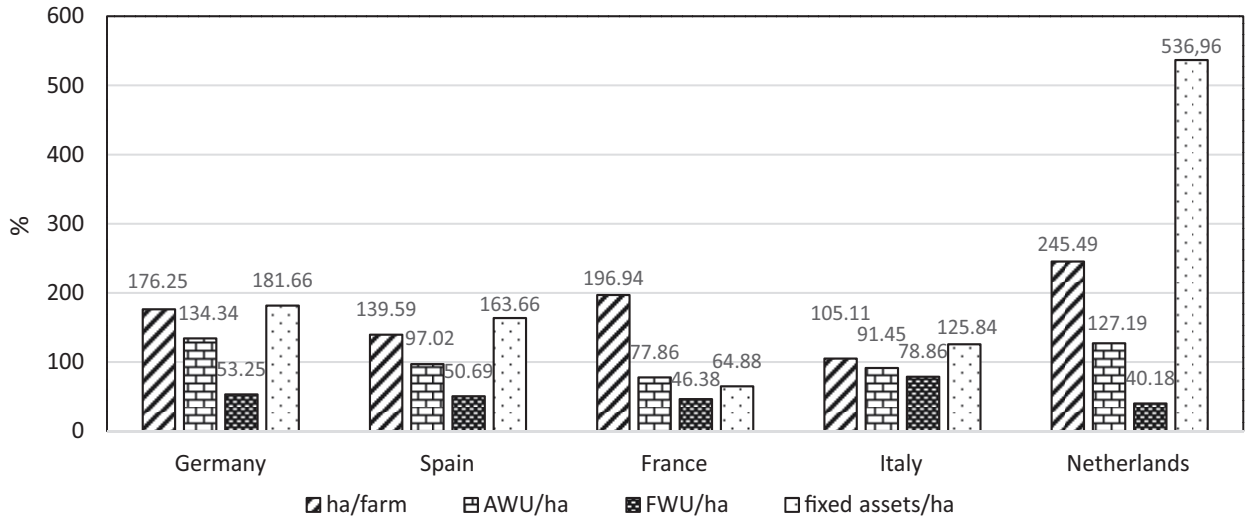

Fig. 1. Relation of inputs of production factors of farms specializing in the field cultivation of vegetables in total in Poland and selected EU countries in the years 2004–2019 [index: Poland = 100%]

Source: Authors' own study based on the EU FADN.

tion of Polish farms, although an increase in the average area of cultivation in individual farms in Poland was observed in the examined period. The average area of a vegetable farm increased in the years 2005–2016 as much as 4.6 times, while in Italy 2.03, Germany 1.73, the Netherlands 1.51, Spain 1.10 times. In France, it was an increase of 3.21%. The research shows that in most of the analysed countries there was still a large fragmentation of vegetable farms, i.e. in Italy, Spain and Poland. In 2016 an average farm grew vegetables on 3.48 ha, 2.26 ha and 2.16 ha, respectively. The increase in the production potential of the Polish vegetable industry is also evidenced by the fastest growing land productivity. During the period considered, an increase in the yields of basic vegetables was observed in selected countries. Relatively the highest increase in yields was recorded in Poland. However, still, the level of vegetable yields in Poland was much lower than in other EU countries.

The analysis of vegetable farm inputs (on the basis of FADN data) in selected countries shows that in the analysed period in the case of Poland, Italy and France a decrease in production factor resources was observed. In these farms, there was a decrease in the inputs of land, labour and fixed assets, and in the case of Poland, only the resources of own labour increased. In the case of Dutch farms, there was an increase in the area, but also a replacement of living labour with capital (decrease in total labour input with an increase in fixed assets). Labour-efficient technologies are likely to be introduced on these farms while increasing the area of the farms. At the same time, these farms had the largest manpower armament in the capital, and the largest fixed-asset equipment in the land. In German agricultural holdings, on the other hand, the increase in total assets was accompanied by an increase in total labour input, which may mean the introduction of less labour-efficient technologies. In these farms, there were the largest labour resources per farm, but these farms were also characterised by the largest area.

The largest amounts of own labour per ha of UR were observed in Polish and Italian farms. Relatively large outlays of own work per 1 ha of UAA in Poland and Italy mean that vegetable cultivation is based mainly on the farmer's and his/her family's own work. In addition, during the period considered, there was a decrease in the value of fixed assets in Italian, Polish and French holdings, indicating a worrying phenomenon of decapitalisation of vegetable holdings in these countries. In contrast, an increase in value occurred in Dutch and German holdings. Therefore, it should be stated that the Netherlands and Germany are growing competitors of Poland in terms of further growth of this sector. It should be stressed, however, that due to the growing problems with labour availability and very rapid wage growth, maintaining Poland's high position in vegetable production will be increasingly difficult.

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POTENCJAŁ PRODUKCYJNY SEKTORA WARZYWNICZEGO W POLSCE I WYBRANYCH KRAJACH UE

STRESZCZENIE

Celem badań była ocena potencjału produkcyjnego sektora warzywniczego jako czynnika konkurencyjności w Polsce i wybranych krajach UE. Ocenę produkcji warzywniczej oparto na: analizie porównawczej poziomu i zmian powierzchni ziemi przeznaczonej pod uprawę, plonów, liczby gospodarstw i średniej powierzchni upraw w gospodarstwie. Analizowano również strukturę gatunkową upraw, poziom plonów podstawowych warzyw, zasoby czynników produkcji rolnej z systemu FADN. Badania wykazały, że z jednej strony wysoka i rosnąca pozycja Polski w produkcji warzyw wynika przede wszystkim z dużego areału upraw, częściowo z ich komplementarnej struktury, a przede wszystkim z relatywnie niskich kosztów pracy w porównaniu z innymi badanymi krajami UE. Z drugiej strony za poprawą efektywności nie przemawia duże rozdrobnienie polskich gospodarstw, choć w badanym okresie zaobserwowano wzrost średniej powierzchni upraw w przeliczeniu na gospodarstwo. Z analizy nakładów w gospodarstwach warzywniczych (na podstawie danych FADN) w wybranych krajach wynika również, że w analizowanym okresie spadek zasobów czynników produkcji zaobserwowano w Polsce, we Włoszech i Francji.

Słowa kluczowe: produkcja warzywnicza, gospodarstwa warzywnicze, system FADN, Polska, EU