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THE SCALE OF PRODUCTION, EFFICIENCY AND COMPETITIVENESS OF POLISH FARMS SPECIALISING IN MILK PRODUCTION

Abstract

The article assesses the competitiveness of the Polish dairy farms compared to similar farms in Hungary, Germany, Denmark and the Netherlands. It was found that the Polish dairy farms with an economic size ranging from EUR 50 000 to EUR 100 000 of Standard Output (SO) and higher are capable of further development and have the competitive ability compared to similar farms from the surveyed countries.

Keywords: dairy farms, milk production, production scale, efficiency, competitiveness, commercial agricultural production, factors of production, economic size.

Introduction

In 2000-2011, animal production prevailed in commercial agricultural production in Poland. Its value within that period grew by 81.4%, but its share declined from 62.6% in 2000 to 53.4% in 2011. Cattle production had the highest share in animal production, amounting to 43.2% in 2011, while the share of milk totalled 32.1% (Table 1). In 2010, 526 000 farms conducted cattle production, of which 454 000 had dairy cows [15].

The second factor determining the role of milk production is the share of dairy industry products in exports. In foreign trade of milk products Poland achieves positive balance since 2003, and in 2011 it amounted to EUR 874 million and in the next year it exceeded EUR 900 million [3].

Table 1

Value of commercial agricultural production in 2000-2011 (current prices)

Specification	2000		2005		2011	
	PLN million	%	PLN million	%	PLN million	%
Commercial agricultural production	33 491.4	100.0	42 907.0	100.0	71 263.1	100.0
of which: plant production	12 541.0	37.4	16 605.6	38.7	33 239.7	46.6
Animal production	20 950.4	62.6	26 301.4	61.3	38 023.4	53.4
Milk production	6 725.4	32.1a	8 475.3	32.2a	12 205.9	32.1
Production of beef cattle	2 028.3	9.7a	2 558.3	9.7a	4 251.4	11.1a
Total cattle production	8 753.7	41.8a	11 033.6	41.9a	16 457.3	43.2a

[a] Share in animal production.

Source: [15].

The share of dairy products in agri-food product exports was also significant, amounting to 9.0% in 2011 [2]. The development potential of cattle production in Poland is high due to significant labour resources in agriculture and large area of permanent pastures, which in 2010 amounted to 3283.5 thousand ha, i.e. 21.1% of agricultural area [9]. The resources allow to increase the cattle stock by at least 42%, from 5.761 million (in 2010) to approximately 10.000 million. Such figure was recorded in 1990 [11]. The milk production potential significantly exceeds its current production level which is slightly above 12 billion litres. In 1990, milk production in Poland exceeded 15 billion litres [11].

In view of the current level of milk production and its existing production potential, research should be conducted to verify the possibility of increasing the production potential with respect to cattle production, in particular milk and live cattle production. Those products are raw materials for industry and may be exported after processing. However, the possibilities for developing milk and live cattle production for the internal market are limited due to low demand flexibility [4], thus, the development opportunities of this animal production branch consist in increasing the export of milk products. The main export destinations are the European Union countries and third markets. The markets are subject to strong competition from milk producers in the EU countries, thus the need to analyse the efficiency of Polish milk-producing farms and their comparison to producers from the EU countries. Enterprises involved in milk trading and processing compete directly on those market. Their economic efficiency is largely determined by the cost of raw material, i.e. milk and live cattle. According to A. Woś, the share of raw material cost in total cost of dairy products exceeded two thirds [14].

Therefore, improvement in efficiency of Polish dairy farms contributes significantly to competitiveness of Polish dairy products on foreign markets.

Apart from external reasons for conducting the research, some internal reasons also deserve attention. They include long-lasting trends between costs of production factors and costs of agricultural products sold by farmers. Figure 1 presents trends in the labour costs in the national economy apart from agriculture, the costs of factors of production purchased by farmers and prices of agricultural products in 1995-2011. The trends show clearly that wages in non-agricultural sectors grew over five-fold in the analysed period. Within the same period, the prices of factors of production for agriculture increased over three-fold, while the prices of agricultural products more than doubled. Such trends are permanent and occur in all countries with market economy. The figure also presents price scissors in individual years and over the entire periods. The price scissors indicator was volatile, fluctuating around 100%.

The values below 100% were recorded in: 1996-1999, 2002-2003 and 2008--2009, while in the remaining years the situation was good. Within the entire period, price scissors amounted to approximately 70% which means that the prices of agricultural products grew 30% more slowly than the prices of factors

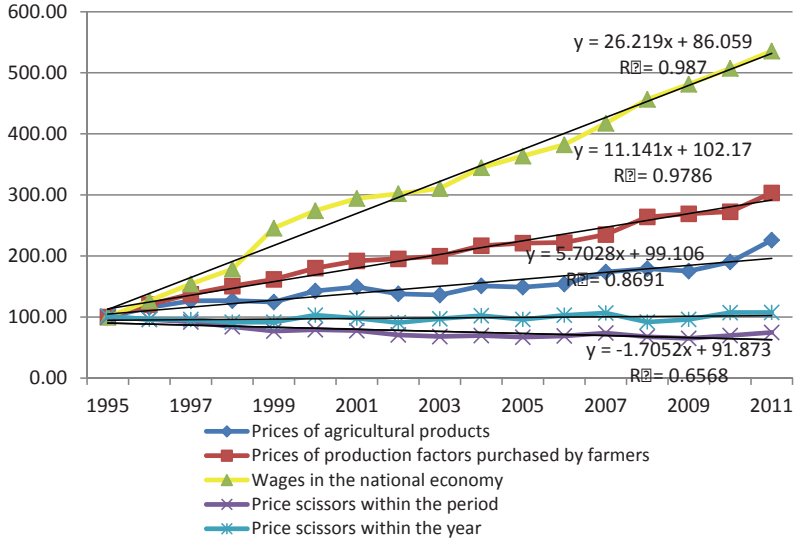

Fig. 1. Trends in the costs of factors of production.
Source: [15].

The faster growth of labour costs (wages in the national economy) and the costs of factors of production than the prices of agricultural products leads to

decreasing unit profitability of agricultural products. In consequence, farmers are forced to increase the scale of production to generate the income from their farms at the parity level[1]. This may be achieved by increasing the production intensity or, with a given production intensity, by increasing the area of plant production on a farm or the number of kept animals. Farmers will increase the scale of production, if the demand for agricultural products, which is, as earlier stated, limited, grows. Projections by A. Woś show that domestic demand for agricultural products may increase by 1% a year [13]. Therefore, export is the main factor for development of agricultural production, including milk and live cattle production.

Purpose of research, source materials and research methods

The purpose of research was to analyse the efficiency and competitiveness of Polish farms with cattle production in comparison with the same farms from the selected European Union countries with similar production conditions. The research covered dairy farms from Poland, Hungary, Germany, Denmark and the Netherlands.

It included farms from the FADN system, grouped by production volume in SO[2]. Among farms with cattle production, farms specialising in dairy cattle were separated (type 45), and the collected data cover the years between 2008 and 2010 (Table 2).

The figures from Table 2 show that not all size classes of farms are represented in the European FADN system. From among dairy farms (type 45) from Poland, the analyses covered classes 3, 4 and 5. Dairy farms from Hungary and Germany are represented by classes 3-5, from Denmark by class 5 and from the Netherlands by classes 4-5. The analysis did not cover the farms from the largest class 6, since its purpose was to compare only Polish family farms.[3] Figures in the system allow to characterise and assess the production potential of the analysed farms, their organisation of production, as well as costs and effects. Additional sources of research material included statistics from the publications of the Central Statistical Office and Eurostat, as well as from literature.

Descriptive method was used to assess the scale of production of the analysed farms, their farming efficiency and competitiveness. Tabular presentations were used to this end[4], and comparative method was also extensively employed.

Changes in the number of dairy farms, cow population and milk production

[1] Parity income is income comparable to wages in the national economy outside agriculture. The growth of wages in the national economy results in deterioration of the parity.

[2] SO – Standard Output. The European measure of the economic size of a farm in thousands of euros – average for 5 years.

[3] The largest Polish farms (class 6) were not covered by the FADN monitoring, while Hungarian farms of this class were not family farms.

[4] A detailed list of the indicators used is included in [15].

The changes in the number of farms with cattle production in 1996-2010 are presented on Fig. 2. Within that period, the number of farms with cattle declined significantly (by 61.5%), including farms with cows (by 65.4%). The structure of farms has also changed.

In 1996, farms with cows accounted for 95.2% of all farms with cattle, while in 2010 the percentage fell to 86.3%. It was most likely due to increased specialisation of farms.

Table 2

Number of surveyed farms in 2008-2010.

SO classes (ES 6) (EUR thousand)	Poland	Hungary	Germany	Denmark	Netherlands
			Dairy farms (type 45)		
(3) 25-50	500-1000	15-40	40-100	-	-
(4) 50-100	500-1000	15-40	200-500	-	15-40
(5) 100-500	100-200	15-40	1000-2000	100-200	200-500

Source: Polish and European FADN, IERiGŻ-PIB.

Greater changes in the number of commercial dairy farms occurred after 2004, i.e. after integration with the European Union and introduction of milk quotas. The milk quota system divided the suppliers into wholesale suppliers who were granted milk quotas for sale in dairy companies and direct suppliers who could conduct direct sales of milk. The number of wholesale farms and its changes in 2004-2012 are presented on Figure 3. In the 2004/2005 quota year, the number of wholesale suppliers was 311,000, while in 2012/2013 it fell by 53.4% to 145,000. The decline in the number of wholesale suppliers is best illustrated by the logarithmic function. The R2 determination rate was 0.9688, thus the function presents the actual concentration process in milk production.

Assuming that in the following year the rate of decline in the number of farms of wholesale suppliers will be similar to the current ones, by 2020 the number of suppliers should drop to around 100,000. The planned liquidation of milk quotas by 2015 may contribute to the growth of production concentration rate.

The milk quota per one supplier increased along with the decline in the number of wholesale suppliers. In 2004/2005, it amounted to 27 tonnes of milk, while in 2012/2013 it grew to 60 tonnes.

Changes in the number of cattle and cows were also recorded (Fig. 2). The number of cattle in the analysed period dropped by 17.7% and the number of cows by 23.5%. The structure of the cattle population also changed, from the share of cows amounting to 49.4% in 1996 to 45.9% in 2010.

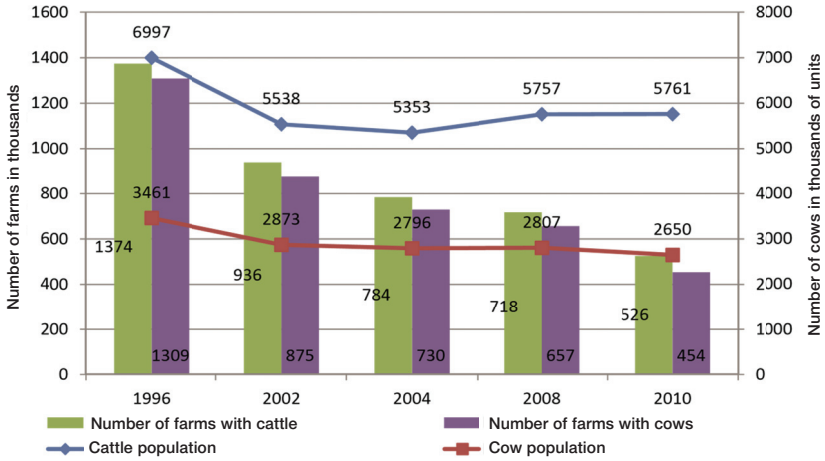

Fig. 2. Changes in the number of farms with cattle production and in the number of cattle in 1996-2010.

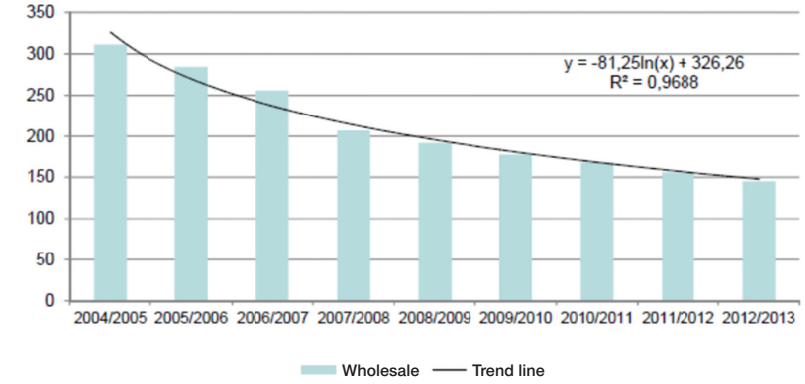

Fig. 3. Number of wholesale suppliers in 2004/2005-2012/2013 (thousand).
Source: [15].

Figure 4 illustrates changes in the number of cows, milk production and milk yield. The largest decrease in the number of cows (by 29.7%) was recorded in 1990-1996: from 4919 thousand cows in 1990 to 3461 thousand cows in 1996 and to 2469 thousand in 2012. Within the last 16 years, the number of cows fell by 28.7%, while compared to 1990 by 50.1%. Milk production in 1990-1996 declined by 26.2%, from 15 371 thousand tonnes to 11 355 thousand tonnes. In subsequent years it changed slightly, increasing to 12 300 thousand tonnes in 2012. The level

was lower than milk production in 1990 by 20%, despite a drop in the number of cows by 50%. The difference between the decline rate of the number of cows and of milk production was due to higher milk yield of cows which grew from 3125 kg of milk per cow annually to 4981 kg in 2012 (growth by 59.3%). It resulted not only from cow selection, but also from changes in milk production technology.

The years 1990-2011 saw substantial changes in spatial distribution of cows (Fig. 5). In 1990, 50.8% of cows were in the following five voivodeships: Mazowieckie (14.2%), Wielkopolskie (10.2%), Łódzkie (9.7%), Lubelskie (8.5%) and Podkarpackie (8.2%). In 2011, 65.6% of cows were kept in the following voivodeships: Mazowieckie (20.0%), Podlaskie (17.3%), Wielkopolskie

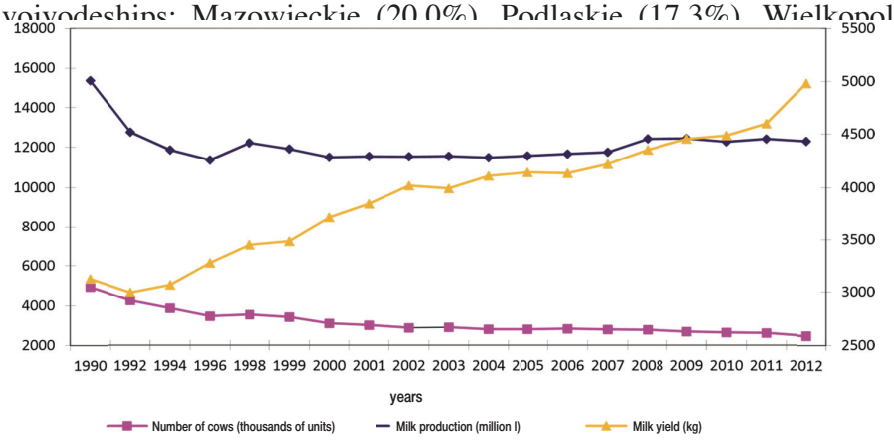

Fig. 4. Number of cattle, milk production and milk yield in 1990-2012

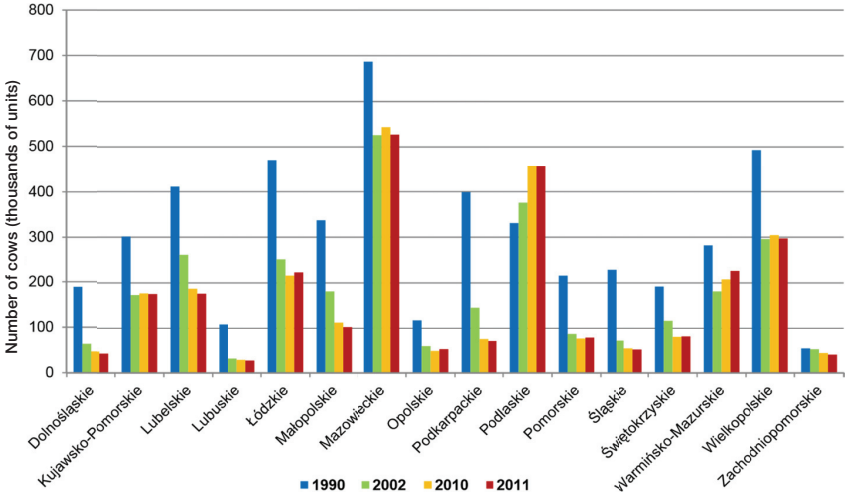

Fig. 5. Changes in the number of cows in 1990, 2002, 2010 and 2011 in spatial terms.
Source: [15].

The increased degree of diversification is also evidenced by the value of the Gini coefficient, which in 1990 was 0.153, while in 2011 it stood at 0.315. The "0" value means no diversification, while the value "1" means complete diversity, meaning that the entire population is in one voivodeship.

It should be emphasised that there was a growth in the number of cows in the Podlaskie Voivodeship – by 37.7% in the analysed period, and in the Warmińsko-Mazurskie Voivodeship when it increased after a temporary decline. The largest decreases in the number of cows were recorded in the following voivodeships: Podkarpackie (-82.5%), Dolnośląskie (-7.6%), Śląskie (-77%), Lubuskie (-75.2%) and Małopolskie (-69.5%). Significant changes also occurred in terms of the density of cows per 100 ha of utilised agricultural area (Fig. 6). The average density of cows in 1990 was 26.3 cows, while in 2011 it was only 17 cows.

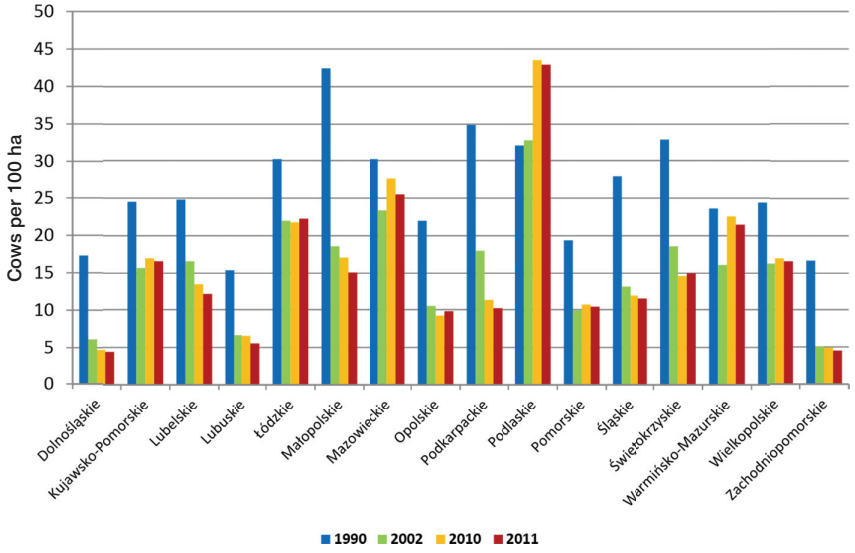

Fig. 6. Density of cows in 1990, 2002, 2010 and 2011.
Source: [15].

The highest density of cows in 2011 was recorded in the Podlaskie Voivodeship – 42.9 cows per 100 ha of utilised agricultural area. In other voivodeships, the density of cows was markedly lower and amounted to 25.5 cows per 100 ha of UAA in Mazowieckie, 22.3 in Łódzkie and 21.5 in Warmińsko-Mazurskie, while in Dolnośląskie, Zachodniopomorskie and Lubuskie it totalled 4.4-5.5 cows per 100 ha of UAA. The territorial distribution of cows and density reveal a clear con-

centration of milk production in the following voivodeships: Mazowieckie, Podlaskie and Warmińsko-Mazurskie. According to A. Parzonko, the process is to intensify further [9]. Milk processing is also concentrated in the above voivodeships. The largest and most efficient dairy cooperatives, such as "Mlekowita", "Mlekpol" and "Piątnica" are located in the Podlaskie Voivodeship, while two of the largest private milk processing companies: "Danone" and "Bakoma" are located in the Mazowieckie Voivodeship. In 2011 and 2012, the highest purchase prices of milk were recorded in the Podlaskie Voivodeship – PLN 129 and PLN 126 per 100 litres, respectively, while the lowest in the Małopolskie Voivodeship, i.e. PLN 105 and PLN 107 per 100 litres, respectively.

Competitiveness of Polish dairy farms

Competitiveness of economic operators should be understood as their ability to survive on the market competing with other market participants, which means that they should have certain advantages. They may compete e.g. with price thanks to lower production costs or with the quality of offered products or their terms of delivery. However, this refers to entities being direct participants of the markets, in particular international markets. Agricultural holdings, and among them dairy farms[5], do not compete directly on foreign markets with farms from other countries, but nevertheless have an impact on competitiveness of processing plants (dairies in this case) and commercial companies operating on domestic and foreign markets. In this article, competitiveness of dairy farms is understood as their ability to develop in a given country. Farms that are able to develop are those which generate income from governance, i.e. income from the farm, covering the alternative costs, i.e. the costs of using own factors of production (labour, land and capital). Development abilities of farms are defined in a similar way by other authors, such as W. Józwiak [5].

The research results thus far show that Polish dairy farms have competitive advantages compared to farms from other European countries. Comparative studies conducted by E. Kołoszycz show that in 2006-2009 Polish dairy farms obtained a cost advantage over leading milk producers in the European Union: German, French or Dutch farms. However, they lost this advantage in the following two years (2010-2011) [6]. According to the same author, between 2006 and 2011 Polish dairy farms incurred lower alternative costs of own factors of production (labour, land and capital). The research by W. Ziętara also reveals cost advantage of Polish dairy farms over average farms associated in the EDF[6]. They did not maintain this advantage over the best farms (upper quartile covering 25% of farms generating the best results), but obtained similar agricultural income per 100 kg of milk [16]. The results also point to a decreasing difference

[5] Agricultural holdings, including commercial production dairy farms, are enterprises although are not treated as such pursuant to the Act on economic activity. They have the legal form of a "natural person".

[6] EDF – European Dairy Farmers.

in the prices of milk purchase in Poland compared to the EU-15. In 2004, the prices were lower by 38.5% and in 2010 by 12.2%.

Scale of production on dairy farms (type 45) depending on economic size

The scale of production of the analysed dairy farms was determined using the utilised agricultural area (UAA), the number of cows, the value and structure of assets and the structure of liabilities (Table 3).

There is a relation between the utilised agricultural area and economic size in individual countries. In terms of area, Polish farms were smaller than Hungarian, but larger than German, Danish and Dutch within the given economic size classes. The area of Polish farms was between 27 and 109 ha of UAA, Hungarian from 44 to 160.5 ha of UAA, German from 21 to 77.3 ha of UAA and Dutch from 20 to 47.6 ha.

The number of cows was positively correlated with economic size of farms. It was relatively low in class 3 and 4. The number of cows was the highest on Polish farms of these classes, i.e. 20 and 35 cows, respectively, followed by Hungarian farms – 15 and 30 cows, respectively, and German farms – 14 and 25 cows, respectively. Also on Dutch farms from class 4, the number of cows did not exceed 24. In class 5, the differences were not significant – from 63 cows (Germany) to 88 cows (Hungary and Denmark).

The value of assets per 1 ha of UAA differed between farms from individual countries, but was similar within the countries. The value of assets was by far the lowest on Hungarian farms – 2700-3700 EUR/ha of UAA, while on Polish farms the figure was over two times higher – 7800-8300 EUR/ha of UAA. On German farms, the value of assets followed a downward trend along with an increase of economic size, from 19 800 EUR/ha of UAA in class 3 to 10 900 EUR/ha of UAA in class 5. This trend has been common thus far. A very high value of assets was recorded on Dutch farms – approx. 52 000 EUR/ha of Al in both economic size classes. Fixed assets represented the major part (over 80%) of assets.

The share in equity in liabilities exhibited a downward trend along with an increase of economic size. The share of equity in liabilities was the highest in class 3 with the standard output value of EUR 25 000-50 000, while in class 5 with the standard output amounting to EUR 100 000-500 000 it ranged from 48% to 83%. The lowest share of equity was recorded on Danish farms (48%).

In general, the highest production potential was recorded on Dutch and Danish farms, followed by German farms, thanks to their equity. The production potential of Hungarian and Polish dairy farms was significantly lower, but the farms were characterised by a larger utilised agricultural area [15].

Table 3

Scale of production of dairy farms (type 45) depending on economic size (SO) in 2008-2010

Countries	Economic size classes in SO (EUR thousand)		
	(3) 25-50	(4) 50-100	(5) 100-500
	Utilised agricultural area (ha)		
Poland	26.8	47.5	108.5
Hungary	43.8	77.7	160.5
Germany	20.6	31.3	77.3
Denmark	-	-	92.8
Netherlands	-	19.7	47.6
	Number of cows (cows per farm)		
Poland	19.6	35.2	76.8
Hungary	15.0	30.0	88.5
Germany	14.1	24.5	63.2
Denmark	-	-	88.2
Netherlands	-	23.9	77.1
	Value of assets (EUR thousand per ha of UAA)		
Poland	7.8	8.3	7.8
Hungary	2.7	3.2	3.7
Germany	19.8	15.8	10.9
Denmark	-	-	27.9
Netherlands	-	52.0	51.9
	Share of equity in liabilities (%)		
Poland	92	87	83
Hungary	90	90	80
Germany	97	93	80
Denmark	-	-	48
Netherlands	-	90.4	69.8

Source: own elaboration based on European FADN.

Organisation of production on dairy farms (type 45) depending on economic size

The organisation of production on dairy farms was characterised using livestock density LU per 100 ha of UAA and the share of animal production in total

production. Livestock density followed an upward trend along with the growing economic size in all analysed farms. However, differences in livestock density between individual countries were recorded. On Polish farms, livestock density amounted to 111 LU/100 ha of UAA in class 3, 116 and 115 LU/100 ha of UAA in class 4 and 5. It was the lowest on Hungarian farms when it ranged from 47 LU/100 ha of UAA to 82 LU/100 ha of UAA in subsequent size classes. On German, Danish and Dutch farms, livestock density was significantly higher, from 120 LU/100 ha in class 3 (German) to 242 LU/100 ha of UAA in class 5 (Dutch).

The share of animal production in total production was the lowest on Hungarian farms where it amounted to 65-70%. On other farms, it exceeded 70% (Danish) and even 84% in two highest classes [18] in Dutch farms.

Intensity of production on dairy farms (type 45) depending on economic size

The level of costs per one unit of utilised agricultural area measures the production intensity. The level and structure of costs were characterised using total costs and direct costs in EUR thousand per ha of UAA and costs of external factors (labour, capital and land).

As the economic size of farms increases, total costs and direct costs exhibit an upward trend. This trend differs from the previous one where intensity of production declined along with the increase in the size (area) of a farm [8]. Labour and capital were limiting factors at that time. However, in the analysed dairy farms, land proved to be a limiting factor. Therefore, the scale of production could be increased by means of increased production intensity. The lowest production intensity was recorded on Hungarian farms – from 700 EUR/ha (in class 3) to 1400 EUR/ha of UAA (in class 5) and on Polish farms – from 1000 EUR/ha (in class 3) to 1400 EUR/ha of UAA (in class 5). On German farms, production intensity grew from 1800 EUR/ha (in class 3) to 2500 EUR/ha of UAA (in class 5) and on Dutch farms it was the highest in class 5 – 48 000 EUR/ha of UAA (Table 4).

Similar relations were observed in direct costs. Their share in total costs in Polish and Hungarian farms amounted to approximately 50%. On German, Danish and Dutch farms it was lower (40%, 35%, 35%, respectively) due to higher costs of external factors on those farms.

The costs of hired labour also varied significantly between economic size classes, increasing along with the growth of the size of farms. They were the lowest on Polish and German farms from class 3 and 4 (from 6 EUR/ha to 20 EUR/ha of UAA). On Hungarian farms, the costs grew along with an increase of farm size from 33.6 EUR/ha in class 3 to 113.8 EUR/ha of UAA in class 5. The highest costs of hired labour were recorded on Danish farms from class 5 (217.9 EUR/ha of UAA).

Table 4

Intensity of production on dairy farms (type 45) depending on economic size

Countries	Economic size classes in SO (EUR thousand)		
	(3) 25-50	(4) 50-100	(5) 100-500
	Total costs (EUR/ha)		
Poland	1043.1	1200.7	1378.9
Hungary	684.1	751.2	1379.4
Germany	1839.9	2143.9	2537.1
Denmark	-	-	4537.4
Netherlands	-	3719.3	4827.9
	Direct costs (EUR/ha)		
Poland	532.7	643.4	729.9
Hungary	340.2	377.9	735.7
Germany	573.3	764.1	1025.0
Denmark	-	-	2094.9
Netherlands	-	1330.8	1748.9
	Costs of hired labour (EUR/ha)		
Poland	6.0	18.4	81.3
Hungary	33.6	42.9	133.8
Germany	11.7	20.0	69.4
Denmark	-	-	217.9
Netherlands	-	59.0	74.7
	Costs of interest (EUR/ha)		
Poland	18.1	28.7	36.2
Hungary	8.8	13.2	42.6
Germany	37.7	48.4	86.3
Denmark	-	-	798.9
Netherlands	-	197.2	668.6
	Costs of lease (EUR/ha)		
Poland	14.0	19.4	20.1
Hungary	14.3	19.0	33.0
Germany	71.6	90.3	160.1

Denmark	-	-	120.1
Netherlands	-	288.4	238.4

Source: own elaboration based on European FADN.

The costs of interest followed a similar trend. They were very small in Polish and Hungarian farms (9-29 EUR/ha), ranging from 38 to 86 EUR/ha on German farms and were the highest on Danish farms, i.e. 799 EUR/ha. In Dutch farms of class 4 and 5 they amounted to 197 and 669 EUR/ha of UAA, respectively.

Significant differences were also recorded in the costs of lease, which grew slightly along with an increase of economic size. On Polish farms, the costs grew from 14 EUR/ha of UAA in class 3 to 21 EUR/ha of UAA in class 5, while on Hungarian farms from 14.3 EUR/ha in class 3 to 33 EUR/ha of UAA in class 5. They were significantly higher on German and Danish farms (from 72 to 160 EUR/ha of UAA), and the highest on Dutch farms (from 238 to 288 EUR/ha of UAA) [18].

Production and income efficiency on dairy farms (type 45) depending on economic size

Efficiency of dairy farms may be understood as production outcomes and thus incomes of farms. Productivity in this article was characterised using such indicators as milk yield of cows, land productivity and labour productivity. The relevant figures are presented in Table 5. The lowest milk yield of cows was recorded on Hungarian farms (from 3863 kg/cow in class 4 to 4507 kg/cow in class 5). In Polish farms, it amounted from 5008 kg/cow in class 3 to 6644 kg/cow in class 5, and was similar to figures obtained on German farms in analogous classes. The highest milk yield of cows was recorded on Danish farms (8241 kg/cow in class 5), and only slightly lower on Dutch farms.

Land productivity was determined by economic size of farms. It was the lowest on Hungarian farms (800 EUR/ha in class 3 to 1500 EUR/ha in class 5), slightly higher on Polish farms (from 1400 EUR/ha in class 3 to 1800 EUR/ha in class 5), while on German farms it was relatively stable (from 2000 to 2600 EUR/ha). The highest land productivity was achieved by Dutch farms, where it exceeded 5000 EUR/ha in class 5.

The data on labour productivity also revealed some differences: from 18 700 EUR/AWU on Polish farms from class 3 to 47 300 EUR/AWU on class 5 Hungarian farms. It was higher on German farms (from 32 700 EUR/AWU in class 3 to 107 500 EUR/AWU in class 5), while the largest figures were achieved by Danish farms – over 200 000 EUR/AWU.

In general, Polish farms generated better results in terms of milk yield, productivity and labour productivity than Hungarian ones, but worse than German farms, and significantly worse than Danish and Dutch holdings.

Income efficiency of dairy farms was evaluated using the following indicators: land and labour productivity, income from management, share of subsidies in the income from a farm, income parity and net investment rate (Table 6).

Land productivity of Polish farms was similar to that of German farms and significantly higher than on Hungarian farms. It amounted to 580 EUR/ha (93% more) in class 3 of economic size. In class 4 and 5, the difference was 76% and 30%, respectively. Land productivity was definitely the highest on Dutch farms (from 520 EUR in class 4 to 800 EUR in class 5). Danish farms recorded negative land productivity.

Table 5

Productivity of dairy farms (type 45) depending on economic size

Countries	Economic size classes in SO (EUR thousand)		
	(3) 25-50	(4) 50-100	(5) 100-500
	Milk yield (kg/cow)		
Poland	-	5943.2	5008.4
Hungary	-	3862.0	4507.2
Germany	5797.2	6198.3	7431.2
Denmark	-	-	8241.1
Netherlands	-	7246.6	7908.6
	Land productivity (EUR thousand/ha)		
Poland	1.4	1.6	1.8
Hungary	0.8	0.8	1.5
Germany	2.0	2.3	2.6
Denmark	-	-	4.0
Netherlands	-	4.0	5.2
	Labour productivity (EUR thousand/AWU)		
Poland	18.7	33.8	45.7
Hungary	20.5	28.8	47.3
Germany	32.7	51.8	107.5
Denmark	-	-	210.5
Netherlands	-	67.4	145.5

Source: [15].

Own labour productivity grew in all groups of farms along with the growth of economic size, as on German farms from those classes. On Polish farms, it ranged from 8100 EUR/FWU in class 3 to 31 600 EUR/FWU in class 5. On class 4 and 5 Dutch farms, it was lower than on German farms, while on Danish holdings it was negative. The highest own labour productivity was recorded on Hungarian farms (from 9 800 EUR/FWU in class 3 to 58 800 EUR/FWU in class 5).

Income from management, which is the ultimate measure of the efficiency of management, was negative in all groups of farms in class 3. In class 4 and 5, only Polish and Hungarian farms generated positive income, while German, Danish and Dutch farms had negative incomes, deteriorating along with an increasing economic size.

Table 6

Profitability of dairy farms (type 45) depending on economic size

Countries	Economic size classes in SO (EUR thousand)		
	(3) 25-50	(4) 50-100	(5) 100-500
	Land profitability (EUR thousand/ha)		
Poland	0.58	0.67	0.64
Hungary	0.30	0.38	0.49
Germany	0.61	0.65	0.58
Denmark	-	-	-0.11
Netherlands	-	0.52	0.80
	Profitability of own labour (EUR thousand/FWU)		
Poland	8.1	15.41	31.8
Hungary	9.8	18.44	58.8
Germany	10.4	15.15	28.1
Denmark	-	-	-7.9
Netherlands	-	9.31	24.3
	Profit from management (EUR thousand/farm)		
Poland	-3.16	1.11	12.5
Hungary	-3.20	0.94	24.9
Germany	-21.16	-23.9	-15.3
Denmark	-	-	-137.7
Netherlands	-	-59.11	-89.9
	Share of subsidies in income from a farm (%)		
Poland	50.7	40.0	40.1
Hungary	82.1	79.8	75.1
Germany	86.2	80.8	89.6
Denmark	-	-	*
Netherlands	-	92.4	120.9
	Income parity (%)		
Poland	77.5	147.2	304.0
Hungary	90.4	169.6	540.7
Germany	20.2	29.3	54.3

Denmark	-	-	-13.3
Netherlands	-	17.7	46.1

* Income from the farm was negative.

Source: [15].

Subsidies were an important factor influencing the income from farms. Their role is defined by their share in income from a farm. It was the lowest on Polish farms (from 50.7% in class 3 to 40.1% in class 5), and by far the highest on Hungarian and German farms (approximately 82-89% in classes 3-5). On Dutch farms it amounted to 121% in class 5. This means that subsidies were the main source of income of dairy farms, in particular Hungarian, German, Danish and Dutch ones. On Danish farms, income from a farm was negative despite the subsidies.

From among the analysed farms, only Polish and Hungarian holdings in class 4 and 5 generated income from farm per unit of labour (FWU) exceeding the parity income. On other farms, income was lower than wages in the national economy of the respective countries.

Taking into account the income form management, the parity income and the net investment rate, the conclusion must be that only Polish and Hungarian farms in class 4 and 5 of economic size had full competitive capabilities. Other farms (German, Danish and Dutch) had limited capacity in this regard.

Summary and conclusions

After system transformations in 1989, overall milk production fell from over 15 billion kg in 1990 to 12 billion kg in 2012. This was due to a decline in the number of cows from 5 million (1990) to approx. 2.6 million (2012), accompanied by an increase in milk yield from approx. 3500 kg/cow to around 5,000 kg/cow. The number of farms with cows dropped significantly, from 1 309 000 in 1996 to 454 000 in 2010. At the same time, the concentration increase, as demonstrated by a drop in the number of wholesale suppliers of milk from 311 000 in 2004/2005 quota year to 145 000 in 2012/2013. Within that period, milk production per one supplier doubled and amounted to approx. 60 tonnes of milk in the last quota year. Changes in spatial distribution of cow population were also observed. In 1990, around a half (50.8%) of the cow population was located in the following voivodeships: Mazowieckie, Wielkopolskie, Łódzkie, Lubelskie and Podkarpackie, while in 2011 the majority (65.6%) of cows were kept in the following voivodeships: Mazowieckie, Podlaskie, Wielkopolskie, Warmińsko-Mazurskie and Łódzkie. The Gini coefficient increased from 0.153 in 1990 to 0.315 in 2011.

The concentration of cows (on average in the country) on Polish farms was significantly lower than in Hungary, Germany, Denmark and the Netherlands. In Poland, in 2010 the average number of cows on a farm was 6, while on Hungarian, German, Danish and Dutch farms it amounted to: 22, 46, 132 and

75, respectively. On Polish and Hungarian farms, the commercial production of milk accounted for 72% and 70% of total production, respectively, while in the remaining countries it was between 97% and 98%.

Farms covered by FADN monitoring recorded a positive correlation between the utilised agricultural area and their economic size and a negative correlation between labour input per 100 ha of UAA and share of own labour in total labour input and the economic size of farms. However, there was no clear correlation between the value of assets per 1 ha of UAA and economic size. The share of equity decreased along with an increase in economic size.

Livestock density in LU/100 ha of UAA and number of cows on a farm exhibited an upward trend along with a growth of economic size. In all groups of farms, regardless of their economic size, animal production dominated the production structure, representing from 65% (Hungary) to 92% (the Netherlands).

Total costs and direct costs per 1 ha of UAA also grew along with an increase in economic size of farms, as did the costs in hired labour, lease and interest.

The increase of economic size also had an impact on land productivity, but it affected asset productivity only on Hungarian farms, whereas other farms did not record any clear regularities. However, there was a significant positive correlation between labour productivity and economic size of farms.

Land profitability varied, but no correlation between land profitability and economic size was found, except for Dutch farms where the correlation was positive.

Apart from Poland, various types of subsidies for operating activity were the main source of income on dairy farms. On Polish farms, the share of subsidies in income ranged from 40% to 50%, while on other farms from 75% (Hungary) to 121% (Netherlands).

Profitability of own labour was positively correlated with economic size, except for Danish farms, where it was negative. The income parity was achieved only by Polish and Hungarian farms in class 4 and 5 of economic size. They also obtained positive income from management and exhibited competitive capabilities, while dairy farms from other classes in the analysed countries lacked such capabilities.

Summing up, it may be concluded that Polish dairy farms with a higher production scale, from class 4 and 5 of economic size, with over 35 dairy cows with milk yield of 6,500 kg of milk, have development opportunities and are competitive in comparison with analogous dairy farms from other European Union countries.

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