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SUPPLY CHAIN IN THE MILK MARKET IN THE EU COUNTRIES *

Piotr Borawski[1], Associate Professor; **Marta Guth**[2], PhD, Assistant Professor and **James W. Dunn**[3], Emeritus Professor
[1]University of Warmia and Mazury in Olsztyn, Poland; [2]Poznań University of Economics and Business, Poland; [3]Pennsylvania State University, the USA

Abstract. The aim of the paper was to present milk supply chain in Poland on the background of the EU in the years 2004-2017. The authors used tabular and descriptive methods to present the changes in the supply chains. We have measured three stages of supply chain of milk: production, wholesale supply and consumption in the years 2013-2017. The survey proved that the biggest wholesale supply of cow's milk in the EU in 2017 was in Germany (31 939 thousand tons), France (24 539), the Netherlands (14 297) and the United Kingdom (15 134).

Key words: milk market, supply chains, the EU.
JEL code: Q12, Q11.

Introduction

The current socio-economic development is largely determined by supply chains and the associated logistics. There are many definitions of supply chains. According to Dyczkowska (2012), „a supply chain is the cooperation between numerous processing, trade and logistic enterprises and enterprises involved in the flow of products, information, and financial resources". As reported by Pietrzak et al. (2010), logistics involves the „management of handling and storage operations that are to enable the flow of products from the places of origin to the places of consumption". It follows from this definition that logistics in the daily sector also concerns the transport of raw material from an agricultural farm to the points of sale. Logistics in agriculture vary depending on the type of products. It follows from this definition that enterprises should cooperate with one another within the supply chain, so that it could operate efficiently. From the perspective of both an enterprise and an agricultural farm, supply logistics play an important role. This process is related to the timely delivery of raw materials. Both an enterprise and an agricultural farm should maintain the purchase stocks at an appropriate level to enable the production process. Supply logistics comprise a cycle of operations associated with the purchase of products or services needed by an enterprise and conforming to the requirements.

The supply chain is of particular importance on the milk market. Milk is a food product that needs to be stored properly. In Poland, milk may be collected in two ways: either collected directly from a farm or delivered to a collection centre, with the first way being particularly preferred by large farms (Falkowski et al., 2008). In dairy farms, milk is stored in low-temperature milk tanks help prevent the development of microorganisms. Most frequently, milk is collected every second day from agricultural farms in tank trucks specially dedicated to this purpose. Then, milk is transported to processing plants where it is processed. The second way of milk collection was important in times of the centrally planned economy. This was the only way for a farmer to deliver milk to a collection centre operated by a dairy enterprise (Falkowski, 2012).

Production logistics involves the flow of information and materials within the entire production process. According to Dyczkowska (2012), the tasks of „production logistics include organisation, control and planning of the flow of raw materials, parts of cooperative elements, and the materials needed by an enterprise". Production logistics is aimed at reducing production costs.

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[1] pboraw@uwm.edu.pl
[2] marta.guth@ue.poznan.pl
[3] jwd6@psu.edu

The aim of distribution logistics is to coordinate processes at each stage of distribution related to the supply of a final product to a consumer via distribution channels. The longer the distribution channels, the longer the duration of delivery of a final product, and the greater the losses of products. Moreover, longer distribution channels result in greater differences in the prices paid by a consumer and received by an agricultural producer. Distribution logistics involves the delivery of the right product within the right time limits to the right customer. In this process, both the customer service process and the flow of information in both directions are important.

Not only do the changes in organisation of supply chains result in an increase in requirements but also create opportunities for gaining access to new markets and vertically organised supply chain systems. In addition, the liberalisation of Polish trade, and the privatisation of milk processing enterprises have opened the Polish dairy sector to greater foreign competition. These actions have contributed to an increase in investment in the Polish dairy sector (Dries et al., 2009). A study of changes in milk supply chains was conducted by Robinowitz and Liu (2014). Its results show that the processing and retail trade create a need for investments in agricultural farms, and affect the retail price of milk. An analysis of prices of products of agricultural origin within the food chain is a complex issue as agricultural raw materials are, as a rule, processed and differentiated through the process of adjustment to the consumers' requirements (Seremak-Bulge, 2006).

The milk product supply chain refers to the complete chain of values, retail sales, with the consumer as the final link. The milk supply chain comprises primary food production, feed component production, cattle feed production, livestock production and milk production, milk processing, wholesale and retail sales, and consumption (Jarzebowski, 2013).

The objective of the research was to recognize the supply chain in milk markets in Poland and other EU countries in the years 2004-17. The authors address the following questions.

1. What are the wholesale deliveries of cow's milk in EU countries?
2. What is the cow's milk production in the EU countries?
3. What are the indicators of changes in milk supplies to dairies in the European Union countries in 2004-2017?
4. What is the number of dairy cows in the European Union?

The authors used data in the years 2013-2017 and descriptive statistical analysis to describe the changes.

Research results and discussion

Our initial analysis presents the cow's milk production in the EU countries. As we can see the highest milk production was observed in 2016 in Germany (36 672 thousand tons), France (24 482 thousand tons), the United Kingdom (14 946 thousand tons), the Netherlands (14 324 thousand tons) and Poland (13 253 thousand tons). These countries have a surplus in milk production and must find consumers in other countries (Borawski, Dunn, 2016).

The overproduction of milk production is a problem that was an effect of good conditions and the Common Agricultural Policy. The quota system was introduced in 2003 and it was the incentive for production increases. Another incentive was the direct support payments linked to milk production. Finally, the quota system ended in 2014 and the support prices for butter and milk powder were eliminated. The EU prepared new incentives for the development of milk production, for example: formal conventions between producers and dairy enterprises, creation of multibranch organizations, negotiation of milk prices, and support of cheese production (Guba, Dabrowski, 2012).

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An important factor determining the development of milk production is the number of dairy cows. The number of cows has decreased in the EU. The dairy herd in December 2017 was 23 299 thousand head and was 1 % smaller compared to 2016. The decrease of the dairy herd was particularly in the EU-13 because of restructuring processes. The highest decrease of cows numbers in these countries group in December 2017 compared to 2016 was observed in Bulgaria (6,7 %), Croatia (5,4 %) and Lithuania (4,5 %). The highest increase was in Poland (1,1 %) and Slovenia (0,9 %) in the same period. In the same period the reduction of milk cows in the EU-15 was smaller and accounted 0,9 % (number of dairy cows 18 193 thousand head).The decrease of cow numbers was particularly seen in such countries as: Holland (7,2 %), France and Italy (decrease 1 %) and Germany (0,4 %). In the same period the increase of dairy cows was seen in Ireland (3,7 %), Denmark (1,8 %), Austria (0,6 %) and Great Britain (0,2 %). According to the prognosis of European Commission, the decrease of cow number in 2018 will be smaller and will account to 0,4 % (23 million heads). The decrease of cows was offset by the milk yield which increased to 7074 kilograms per cow in 2017 (Milk market-state and perspectives, 2018). The smaller dairy farms will have problems staying competitive in the milk market. That is why the owners of these farms have to make investments to increase the production and to decrease production costs (Zekalo, 2014).

Milk production is determined by two main factors: cow numbers and milk yield. According to information presented in Table 1, milk production was the highest in 2016 in Germany (32 667 thousand tons), France (24 482), the United Kingdom (14 946), the Netherlands (14 324) and Poland (13 253). These results prove the scope of milk production of the EU. These countries have excess milk and have to find markets for the products in other countries (Borawski and Dunn, 2016; Soczewka and Ginter, 2013).

Milk production increased the most in the years 2013-2016 in Ireland (22,3 %), Germany (17,1 %) and the Netherlands (15,4 %). This was the effect of specialization and concentration by dairy farms in the EU countries. The milk production decreased the most in the same period in: Spain (-30,3 %), Hungary (-23,9 %), Latvia (-15,1 %) and Bulgaria (-11,3 %). According to the European Commission, the milk production in 2017 increased 1,5 % to 165,4 million tons. The increase of milk production was particularly seen in the EU-13 (1,7 % increase) and a little lower in the EU-15 (1,4 %). In 2018, according to the milk production forecast in the EU is an increase of 1,2 % to 167,4 million tons. In the same year, the milk yield per cow in the EU will increase to 7192 kilograms. Milk is the primary source of income for dairy farmers. The economic situation of dairy farms is diversified regionally in the EU. According to Smigla (2014), eastern EU countries such as Poland, Bulgaria and Romania achieved weaker economic results, whereas dairy farmers from western EU achieved higher production and better economic results.

Table 2 presents the wholesale supply of cow's milk in the EU in the years 2013-2017. It decreased in Greece (-5,8 %), Croatia (-5,4 %), Sweden (-1,8 %) and Slovakia (-0,1 %). It increased in the remaining countries of the EU. The biggest wholesale production of cow's milk in 2017 was in Germany (31 939 thousand tons), France (24 539 thousand tons), the United Kingdom (15 134 thousand tons) and the Netherlands (14 297 thousand tons).

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Table 1

Production of cow's milk in the EU (thousand tons)

Country	Production (Thousand tons)		Median	Standard deviation	Coefficient of variation	Skewedness	Kurtosis	Changes 2013-2016 (%)
	2013	2016						
Austria	3 393	3 628	3 526.5	97.3	2.8	-0.27	-1.06	+10.0
Belgium	3 528	3 882	3 816.5	205.8	5.4	-0.33	-1.21	+8.5
Bulgaria	1 149	1 019	1 121.5	71.9	6.4	-0.37	-1.29	-11.3
Cyprus	163	165	164.0	3.8	2.3	0.95	-0.85	+1.2
Croatia	588	671	640.5	51.7	8.1	0.05	-1.71	+14.1
Czech Republic	2 849	3 065	2963.0	107.4	3.6	-0.03	-1.87	+7.6
Denmark	5 082	5 355	5 245.5	128.3	0.0	-0.19	-1.67	+5.0
Estonia	772	783	788.5	20.6	2.6	0.54	-1.09	+1.4
Finland	2 328	2 400	2 399.5	45.9	1.9	-0.58	-0.92	+3.1
France	24 426	24 482	25 087	737.7	2.9	0.05	-1.91	+0.2
Germany	31 324	36 672	32 667	2 322.7	7.0	0.87	-0.84	+17.1
Greece	731	775	746	35.8	4.8	-0.41	-1.33	+6.0
Hungary	1 773	1 349	1 832.5	274.1	15.7	-0.89	-0.88	-23.9
Ireland	5 601	1 624	6 215	595.6	9.5	0.01	-1.78	+22.3
Italy	11 281	10 773	11 190	456.2	4.1	0.44	-1.05	-4.5
Latvia	912	774	942.0	99.8	10.9	-0.75	-1.02	-15.1
Lithuania	1 720	1 624	1 757	95.3	5.3	-0.33	-1.31	-5.6
Netherlands	12 408	14 324	13 097	871.0	6.6	0.34	-1.46	+15.4
Poland	12 718	13 253	13 293	358.5	2.7	-0.69	-0.92	+4.2
Portugal	1 848	1 959	1 948.5	91.2	4.7	0.19	-1.03	+6.0
Romania	3 966	3 954	3 960	309.2	7.6	0.87	-0.83	-0.3
Slovakia	934	957	953	10.3	1.1	-1.04	-0.74	+2.5
Slovenia	596	653	627.5	26.2	4.2	-0.12	-1.64	+9.6
Spain	6 559	4 569	6 515.5	1 054.1	17.2	-1.04	-0.74	-30.3
Sweden	2 870	2 862	2 902	39.4	1.4	-0.02	-1.97	-0.3
United Kingdom	13 943	14 946	15 026	650.3	4.4	-0.76	-0.89	+7.2

Source: authors' calculations based on Milk market. State and perspectives 2017

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Table 2

Wholesale supply of cow's milk in the European Union in the years 2013-2017 (thousand tons)

Country	Wholesale supply (Thousand tons)		Median	Standard deviation	Coefficient of variation	Skewedness	Kurtosis	Changes 2013-2017 (%)
	2013	2017						
Austria	2 933	3 200	3 091	95.94	3.11	-0.41	-0.54	9.1
Belgium	3 474	4 013	3 882	226.72	5.95	-0.59	-1.15	15.5
Bulgaria	495	592	510	38.82	7.37	1.13	-0.28	19.6
Cyprus	157	216	164	25.93	14.47	0.58	-1.40	37.6
Croatia	504	477	504	18.26	3.64	-0.20	-1.29	-5.4
Czech Republic	2 382	2 979	2 500	260.81	9.97	0.52	-1.41	15.1
Denmark	5 025	5 479	5 278	186.02	3.54	-0.07	-1.45	9.0
Estonia	706	727	720	9.61	1.33	-0.34	-1.19	3.0
Finland	2 287	2 366	2 366	43.08	1.83	-1.03	-0.36	3.5
France	24 191	24 539	24 539	553.16	2.16	0.23	-1.70	1.4
Germany	30 301	31 939	31 879	709.4	2.25	-1.13	-0.36	5.4
Greece	652	614	619	16.39	2.63	1.37	0.08	-5.8
Hungary	1 364	1 525	1 525	75.59	5.08	-1.02	-0.52	11.8
Ireland	5 581	7 475	6 585	772.48	11.95	-0.09	-1.37	33.9
Italy	10 397	11 375	10 773	375.30	3.45	-0.32	-1.05	9.4
Latvia	736	813	808	33.30	4.19	-1.45	0.19	10.5
Lithuania	1 339	1 403	1 416	40.38	2.87	-1.05	-0.37	4.8
Netherlands	12 213	14 297	13 331	988.08	7.41	-0.03	-1.71	17.1
Poland	9 921	11 647	10 869	641.73	5.93	-0.20	-0.90	17.4
Portugal	1 777	1 851	1 851	53.86	2.91	0.01	-0.59	4.2
Romania	879	1 028	953	59.64	6.25	-0.01	-1.36	17.0
Slovakia	827	826	827	17.68	2.11	0.87	-0.82	-0.1
Slovenia	517	579	554	26.86	4.87	-0.20	-1.54	12.0
Spain	6 300	7 014	6 720	271.89	4.06	-0.41	-0.93	11.3
Sweden	2 868	2 817	2 868	49.56	1.72	-0.09	-1.41	-1.8
United Kingdom	13 687	15 134	14 829	611.19	4.16	-0.90	-0.59	10.6

Source: authors' calculations based on Milk market. State and perspectives 2017

The smallest wholesale supply of cow's milk in 2017 was found in Cyprus (216 thousand tons), Croatia (377 thousand tons) and Slovenia (579 thousand tons). The wholesale supply of cow's milk decreased in 2017 compared to 2013 in Croatia (-5,4 %), Sweden (-1,8 %) and Slovakia (-0,1 %). It increased in the remaining EU countries. The biggest increase of wholesale supply of cow's milk in the EU in 2017 compared to 2013 was observed in Cyprus (37,6 %), Ireland (33,9 %) and Bulgaria (19,6 %). Coefficient of variation describes changes in the wholesale supply of cow's milk in the EU. The biggest coefficient of variation was observed in Cyprus (14.47 %), Ireland (11.95 %) and the Czech Republic (9.97 %).

Milk production is an important part of the economy because it is profiTable and it employs many farmers and their families (Poczta et al., 2008). Another part of the dairy supply chain is the overall dairy industry. The production of dairy products is diversified in the EU countries. A. Parzonko (2013) recognizes that large differences in the level of dairy development in individual countries of the European Union result primarily from their differing level of economic development. The differences between EU-15 countries and the EU-10 countries accessed in 2004 differ greatly. These differences are even deeper for Bulgaria and Romania who joined in 2007. However, these dependencies did not

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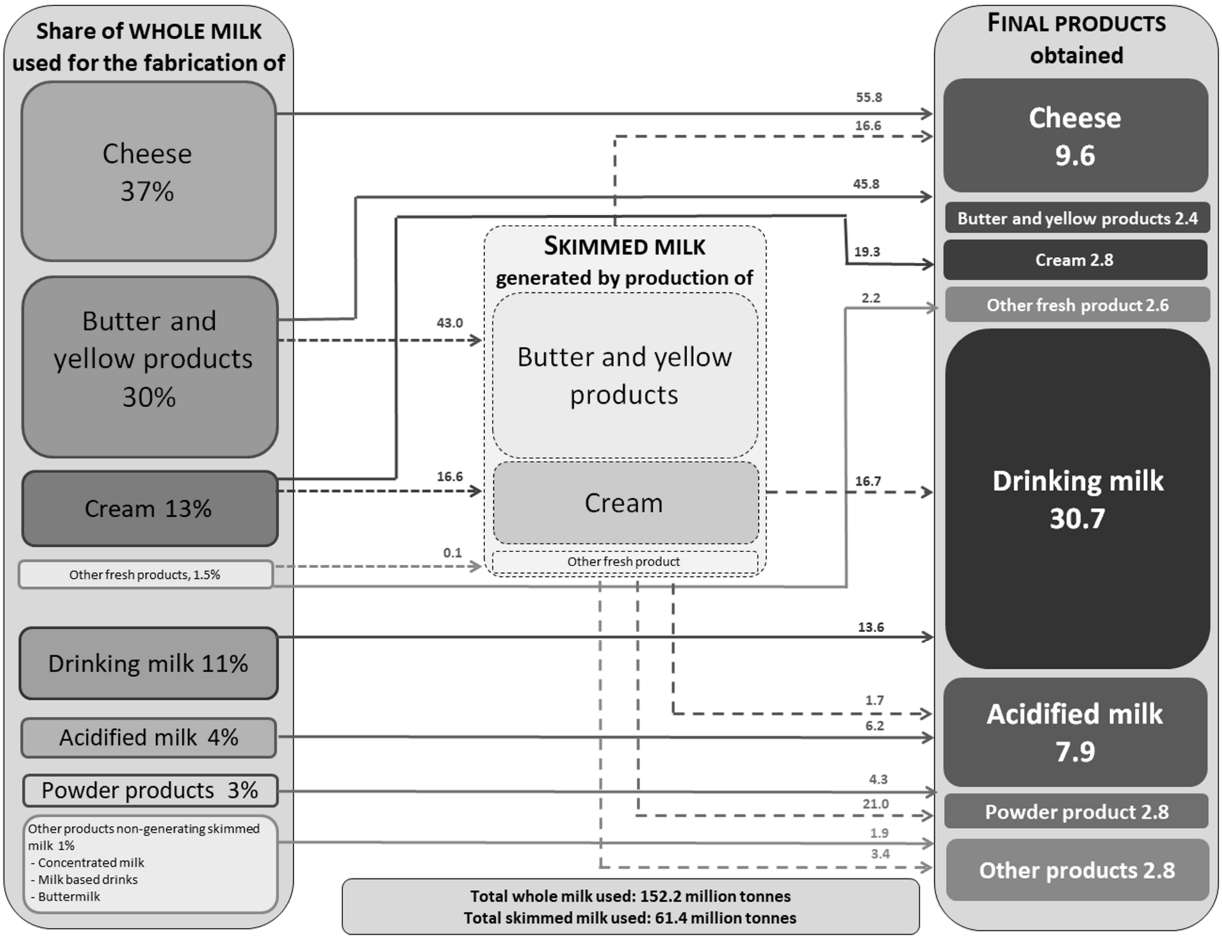
apply to domestic sector leaders who, due to their investments, the implementation of know-how, quality management systems, achieved significantly better results than the average ones.

According to Ihle et al. (2017), the main dairy countries in the EU, based on the annual volume of milk being processed, are Germany and France, where more than 25 million tons of milk are processed each year. More than 10 million tons of milk are processed annually in the United Kingdom, the Netherlands and Italy. Apart from Italy, Spain is the largest dairy producing country in the EU-S (more than 7 million tons). Among EU13 MS, Poland and the Czech Republic have the largest dairy sector (3.5 and 2.5 million tons, respectively). The structure of the processing chain of the EU dairy sector differs substantially between MS and between regions. The dairy processing in EU-N MS is based primarily on large-scale dairy companies that process more than 100,000 tons of milk per year. An exception is Ireland, where large-scale dairies process less than 60 % of the total milk volume. In the EU-S and the EU13 MS, a larger share of milk is processed by medium- or small-scale dairy companies. This structure holds especially in countries such as Bulgaria and Romania, where the sector is dominated by small dairy companies that process less than 50 thousand tons of milk annually.

The dairy industry has an accelerated process of concentrating capital. As a result, the number of milk processing enterprises is decreasing year by year. Large, both cooperative and private dairy companies increase the scale and scope of their commercial offer by purchasing declining, mostly cooperative companies. The concentration ratio of the four largest EU dairy companies increased in the period between 2008 and 2013 from 32 % to 36 % of the total turnover in the dairy sector. Concentration ratios in dairy product markets differ substantially between Member States. They are the highest in the Scandinavian countries with a single dairy company dominating the market: Arla Foods holds between 40 % and 73 % of the market share for different dairy products in Sweden and Denmark; Valio provides 27 % to 52 % of the dairy retail value in Finland (Ihle et al 2017; Niemi, Ahlstedt 2008). The International Dairy Federation predicts that the concentration of structures in milk processing will continue in other Member States. According to the expertise of the International Dairy Federation, in 2013, among 27 milk processing companies in the world, which achieved an annual turnover of USD 3 billion, there were as many as 10 companies from the European Union (13 from all of Europe), the largest of which are: French Lactalis and Danone, with annual turnover of 21.2 billion and 15.7 billion dollars respectively, Dutch Friesland Campina (15.1 billion USD), Danish-Swedish Arla Foods (13.1 billion USD) and German DMK (6.4 billion USD) (Bulletin of International Dairy Federation 476/2014). EU15 dairy companies, such as Danone, Lactalis, Meggle and Hochland, have invested in the dairy markets of the EU13 MS. Nevertheless, important market shares remain with domestic producers (Vindija, Croatia; Madeta, Czech Republic; Mlekpol, Poland). The domestic dairy processor Mlekpol holds a 12 % overall market share in the Polish dairy market.

An important process, taking place in the background of changes in the production structure, that enables cost reduction, is to reduce the amount of raw material used to produce final products. This is mainly the result of technological progress and the introduction of micro- and nanofiltration on an increasingly large scale, which allows for more efficient recovery of whey proteins. In addition, according to J. Seremak-Bulge (2005), striving to increase value added significantly increases the turnover of semi-finished products between enterprises dealing in milk processing and packaging of milk products (including milk powder, cheese, cream). It can be assumed that these trends will additionally increase as capital is consolidated and the production structure is simplified in production plants in order to reduce labour consumption and reduce production costs.

The dynamic development of raw milk production in the world in 1990-2010 also indirectly determined changes in its distribution, which were a response to the changing demand for dairy products. According to Baer-Nawrocka et al. (2012), in relation to 1990, the share of butter in 2010 decreased by 3.4 percentage points, skimmed milk powder by 2.1 percentage points in the use of raw milk as the share of cheeses increased by 1.2 percentage point, and whole milk powder by 1.5 percentage points. The share of fresh products in the distribution of global milk production increased from 74.6 % in 1990 to 77.2 % in 2010 (at the expense of a drop in the share of dairy products from 25.4 % in 1990 to 22.8 % in 2010). In Europe in 2010, fresh products accounted for 66.7 % of the use of raw milk, and fixed products 33.3 %, of which up to 17.1 % was used for cheese production, 8.2 % for butter production, 4.7 % for skimmed milk powder and 3.2 % for whole milk powder. These trends even deepened in 2016 (Figure 1).



Source: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=File:Utilisation_of_milk_and_dairy_products_obtained,_EU-28,_2016-Fig. png

Fig. 1. **Utilisation of milk and dairy products obtained, EU-28, 2016**

The production of butter in the world after a deep decline in the 1990s (almost 26 %, in Europe 24.5 %) was systematically growing to stabilize between 4.7 and 4.9 million tonnes in the decade 2001-2010. The European Union has over a 41 % share of global production. The second in the order the United States has only 15 % share, and the third New Zealand 8 %. In the European Union, butter production in 2004-2011 decreased slightly, mainly due to low price competitiveness with declining market support. The reform of the Common Agricultural Policy has limited export subsidies, expenditure on intervention purchases and aid for private storage of butter.

Conclusions, proposals, recommendations

1) The milk supply chain is a very important part of the agricultural economies of EU countries. The survey proved its development.
2) Most milk in the EU countries is delivered by the biggest producers among which are Germany, France, Great Britain, Holland and Poland. The EU is a big producer of milk and a very important player on world markets.
3) There is a strong process of capital concentration in milk processing.
4) Small milk producers have to improve production and milk yields.

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