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STRUCTURAL CHANGES IN THE MILK PRODUCTION SECTOR AND FOOD SECURITY – THE CASE OF POLAND

Key words: milk production, milk balance sheet, food security, food self-sufficiency

ABSTRACT. The aim of the work was to find an answer to the question of how the changes in the milk production sector in Poland, following the marketization of the economy, influenced the country's food security in the context of food self-sufficiency. The paper uses cow milk balances developed by the Central Statistical Office and data concerning the distribution of domestic milk production from the Institute of Agricultural and Food Economics National Research Institute. The study used a comparative analysis over time, indicators as well as descriptive and graphic methods. The indicators used concerned milk market output, food self-sufficiency and the milk balance structure. During the first few years of transformation, there was a sharp drop in domestic milk production. Since 2004, there has been, with minor exceptions, a systematic increase in production with a previous general fall in production volume. These processes were accompanied by changes resulting from the transformation of the economy in the milk production sector. These were associated with a drastic reduction, since 1990, of the number of farms involved in milk production and the decline in the number of dairy cows, albeit with a simultaneous increase in milk yield. The milk market output index increased. In 2015, resource in the milk balance returned to the level of 1991, i.e. over 14.5 bln liters. In 2017, this figure amounted to 15 bln liters. Domestic milk production is the main source of resource, though the volume of imports is significantly increasing. Despite dynamic growth of exports, milk is mainly used for domestic consumption. From 1990 onwards, Poland has significantly improved its self-sufficiency in milk production. Changes in milk production have significantly influenced food security in the country.

INTRODUCTION

The basic element in the definition of food security, adopted at the UN World Food and Agriculture Summit in 2009, is the continuous physical access of people to food [FAO 2009]. Food available physically means that the national food economy guarantees coverage of at least the minimum physiological demand, while imports provide food over this minimum [Małysz 2008]. Physical availability at the national level is determined by the size of domestic production of agricultural raw materials and food, as well as its distribution, food supply, food stocks and possibilities of food imports [Gulbicka 2003]. Food security, in the national dimension, in the medium term, is identical with the continuity of the supply stream of food products. The main place, among the group of conditions for the physical availability of food, is held by the production and distribution system of

the food economy [Małysz 2008]. Food security is associated with food self-sufficiency, which in its narrow sense is understood as fully covering the demand for food from domestic production [Sapa 2010] and, in open economies, means the economic and physical availability of food on the internal market, regardless of whether it comes from domestic production or through imports [Mikuła 2012]. Furthermore, the self-sufficiency ratio means the ratio of domestic production to domestic use of agricultural products (regardless of product origin), e.g. milk and other dairy milk products [Kwasek 2009].

Over the last 26 years, the consumption of milk and milk products has decreased by 5.6% (to 218 liters per capita). Still, since 2005, a general growing trend has been observed, and the consumption of milk has begun to re-approach the level of 1991. Growing domestic milk production provides domestic demand. Although Poland is the fifth highest producer of cow's milk in the EU (9.7% in 2017), its imports are increasing. The volume of milk production in 2017 (13.3 bln liters) only accounted for 86.7% of production noted in 1990. The aim of the work is to find an answer to the question of how the changes in the milk production sector in Poland, following the marketization of the economy, influenced the country's food security in the context of food self-sufficiency.

MATERIAL AND ETHODS

The paper uses food balances developed by the Central Statistical Office (CSO) for cow milk (including stocks in industrial processing and trade), found in the *Statistical Yearbook of Agriculture* for particular years. The fresh cow milk balance sheet shows that the resource and use of milk are equal:

$$Resource_t = Production_t + Imports_t + Decrease\ in\ stocks_t^*$$

$$Use_t = Domestic\ uses_t + Exports_t + Increase\ in\ stocks_t^*$$

$$Domestic\ uses_t = Consumption_t + Feeding_t + Losses_t$$

$* Stocks\ in\ industrial\ processing\ and\ trade$

The data of the Institute of Agricultural and Food Economics National Research Institute (IAFE NRI), presented in the *Milk Market* journal for particular years, were used to analyze the distribution of domestic milk production [IERiGŻ-PIB 2019]. The classical market output index shows the relation between market output and global production [Kulikowski 2013]. The author of this paper has modified the indicator counter to show the share of sales to the dairy industry in milk production (Table 1). Poland's self-sufficiency in terms of milk, has been ascertained by way of several indicators. In the most general dimension, the absolute difference between domestic production and domestic use is a measure of self-sufficiency [FAO 1999] and the basic self-sufficiency ratio (SSR) is the relationship between domestic production and domestic use. Considering that people are the main recipients in domestic milk use, the author proposes a narrower approach to this indicator (SSR_{II}).

Table 1. Indicators used in the paper concerning the milk market

Market output index	$\frac{Sales\ to\ the\ dairy\ industry_t}{Milk\ production_t}$	Import dependency ratio (IDR)	$\frac{Imports_t}{Domestic\ use_t}$
Self-sufficiency ratio [SSR] [%]	$\frac{Production_t}{Domestic\ use_t}$	Coverage ratio (CR)	$\frac{Exports_t}{Imports_t}$
Self-sufficiency ratio II [SSR_{II}] [%]	$\frac{Production_t}{Consumption_t}$	Share of consumption in use [%]	$\frac{Consumption_t}{Use_t}$
Share of imports in resource [%]	$\frac{Imports_t}{Resource_t}$	Share of export in use [%]	$\frac{Exports_t}{Use_t}$

Source: own study

When analyzing the food situation of a country, a vital aspect is knowing how much of the available domestic food supply has been imported. In this work, the impact of imports on food security has been shown using three indicators. One shows the share of imports in resource. Another indicator is the so-called import dependency ratio (IDR), which is the relation of import volume to production increased by import and decreased by export, i.e. to domestic use [FAO 2001]. The complement of this ratio to 100 would represent that part of the domestic food supply that has been produced in the country itself, i.e. SSR. There is, however, a caveat to be kept in mind: these ratios hold only provided imports are mainly used for domestic utilization and are not re-exported [FAO 2001]. Acknowledging this, the coverage ratio (CR) can be a supplement – showing whether the country specializes in a given production and has an advantage over its partners [Pawlak 2013]. Yet, from the point of view of food self-sufficiency, consumption should be the main position in the use in the balance sheet. This is why the author of this paper proposes an indicator showing this relationship. As the surplus of production and import over domestic use is exported, the share of export in the use is an important indicator.

RESULTS

In 2017, resource in the milk balance sheet amounted to 15 bln liters and exceeded the level from 1991 by 3.1% (Figure 1). During the first few years of transformation, there was a sharp drop in milk resource (by 21.5%), caused by a breakdown in domestic milk production (by 20.4%). In the first years of transformation, there were phenomena unknown to Poland's farmers: growing inflation, an increase in the interest rate on loans, the abolition of subsidies to the prices of production resources, the abolition of subsidies for products produced by dairies, the termination of the purchase guarantee and the disintegration of the traditional structure of institutions servicing agriculture [Woś 2004]. The liquidation, in 1989, of the subsidies paid to dairy cooperatives (the only milk processing companies at the time), due to the difference of low prices for consumers and higher for milk producers, additionally deepened the recession of food demand caused by the decrease in real income of the population and high unemployment.

In the years 1990-1995, compared to 1989, real dairy prices increased by 134%, while real prices of food decreased by 20%. The price competitiveness of milk production in relation to other products was small (cereals) or none (beef or pork). Milk farms were in a very difficult situation. State-owned farms most often could not withstand these changes, went bankrupt and underwent privatization or changed the direction of production to opt for production which was less labor-consuming and more capital-intensive, i.e. plant production [Parzonko 2009]. The situation of family farms was similar. As of 1990, dairy cooperatives, having problems selling their products on the market, had limited milk purchase from farmers. As a result of these unfavorable conditions, between 1990 and 1995, milk production decreased by as much as 20%, due to the resignation of over 28% (to 1.31 mln) of milk-producing farms, resulting in a decrease in the number of dairy cows by 27% (to 3.58 mln).

From 1995 onwards, in conditions of economic growth, there has been a slow increase in the production and purchase of milk. It did however, come to a halt in 1998-1999, as a result of unfavorable internal and external conditions (export restrictions on dairy products to the EU and Russia resulting in a drop in milk purchase prices). Since Poland's accession to the EU, milk production in the country has returned to slow but steady growth. In 2005, milk production amounted to 11.6 bn, and, in 2017, up to even 1.7 bln more.

Until 2015, milk production was limited by the EU milk quota system, the most important instrument for regulating the milk market. The system was aimed at maintaining market equilibrium and guaranteeing milk producers adequate income by influencing the supply of milk to the market. On the other hand, the administrative determination of the size of production is contrary to the principles of a market economy. Milk quotas also made it difficult for farms and dairies to make decisions and adapt quickly to the changing market situation. Poland has exceeded the limit granted for milk production twice and farmers who went beyond the amounts granted had to pay a fine. This was because the level of milk quota negotiated with the EU by Poland was only 2/3 of the postulated level.

This system did not allow for the full utilization of production and processing potential, as well as price and cost advantages of Polish production [Szajner 2009]. Herein, the costs of milk production in Poland before joining the EU were on average lower by 41% than in EU countries. This was due to lower labor costs of domestic farmers, the extensive milk production system made possible due to the moderate climate of Poland [Gornowicz 2003] and relatively large grassland resources (12.3% of the country's area). In addition, there was a price advantage in purchase milk in the country. Upon inclusion into the common market, this price was 64% of the average EU price, but this advantage decreased and amounts to just under 10%.

The production of milk is determined by two basic factors, i.e. the population of dairy cows and their milk yield. Since 1993, the milk yield of dairy cows has systematically been increasing. In 2017, it amounted to 6,235 liters, i.e. more than twice as much as in 1993. At the same time, from 1991 to 2016, the number of dairy cows systematically decreased by 53% to 2,146 (except for 1996-1998 – when there was a slight increase of 1.5%). It was not until 2017 that the number of dairy cows increased (by 0.4%). Besides improvements in breeding technology, including the genetic potential of animals and better nutrition quality, the growing scale of milk production contributed to better milk yield.

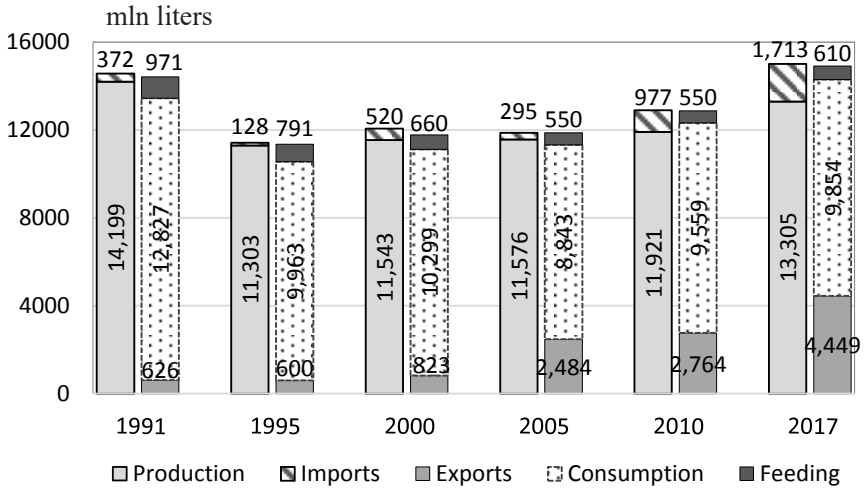

Figure 1. Milk balance* in Poland in 1991-2017 (including milk designated for processing)

* In 2005, stocks decreased in resources (27 mln liters). However, in the years 1991, 1995, 2000, 2010 and 2017, an increase in stocks was observed in use (117, 57, 260, 1 and 79 mln liters, respectively). Losses (in subsequent years at levels of 30, 20, 21, 21, 24 26, 26 mln liters) account for a small share in use

Source: own study based on CSO data [GUS 2019]

While, in 2004, 91% of all farms (i.e. 668.6 thous.) had less than 10 cows (1.5 mln head, i.e. 54% of all), in 2016, the equivalent figure constituted only 72% of all farms (i.e. 191.6 thous.), in which there were 0.53 mln cows (23.8% of the total) [GUS 2017]. In 2015, the average herd of cows increased to 8.6 head (from 3.9 in 2005), but still the gap between Poland and EU countries leading in milk production is growing in this regard. From 2005 onwards, the average size of a herd in Germany has increased by 15.6 head, up to 53.9; in France, by 3 head, up to 40.3; in Italy, by 6 head, up to 44.5; in the Netherlands, by 22.3 head, up to 60.9 and in the UK, by 4.5 head, up to 83. This enhanced milk production scale is considered one of the most important factors leading to a reduction in production costs and improved competitiveness of milk production and processing [Sznajder 1999, Parzonko 2013]. The concentration of milk production in Poland will continue to progress due to an increase in milk production, which is determined by the amplified in-demand for dairy products [Ziętara, Adamski 2014], as well as the growing export of dairy products.

The main source of resource is the domestic production of milk, but more than a 4.5-fold increase in the volume of imports, in the period 1991-2017, was noted (Figure 1). Domestic use, i.e. consumption is the main destination of milk, has dropped significantly in the analyzed period (by 24.2% to 9.85 bln liters), only showing an increase in certain years. In contrast, in the last 26 years, the export volume has grown over 7 times and has been especially dynamic since Poland's accession to the EU. In the period 1991-2017, the consumption of milk in farms also diminished (by 57.9% to 1.68 bln liters), both for fodder and farmers' own-consumption. Direct sales of milk by farmers also decreased

Table 2. Distribution of domestic milk production in Poland in 1991-2017

Specification	1991		1995		2000		2005		2010		2017	
	bln l	%	bln l	%	bln l	%	bln l	%	bln l	%	bln l	%
Consumption on the farm:*	3.99	28.11	3.53	31.23	3.28	28.42	2.55	22.05	2.40	20.13	1.68	12.60
- for feed	0.97	6.84	0.75	6.64	0.65	5.63	0.55	4.76	0.55	4.61	0.55	4.13
- for consumption	2.89	20.36	2.75	24.33	2.62	22.70	2.00	17.29	1.85	15.52	1.13	8.48
Sales total:**	10.21	71.89	7.77	68.77	8.26	71.58	9.02	77.95	9.52	79.87	11.65	87.40
- to the dairy industry	7.84	55.24	6.06	53.61	6.49	56.20	8.36	72.29	8.73	73.19	11.31	84.85
- to other industries	0.07	0.51	0.08	0.71	0.10	0.83	0.22	1.93	0.04	0.30	0.03	0.23
- other sales (direct)	2.29	16.13	1.63	14.46	1.68	14.55	0.43	3.74	0.76	6.38	0.31	2.33
Milk production	14.20	100.0	11.30	100.0	11.54	100.0	11.57	100.0	11.92	100.00	13.33	100.0
Market output index [%]	55.2		53.6		56.2		72.3		73.2		84.9	

* until 2000, in farm consumption "other outgoings" was included, so the sum of consumption is greater than its components

** the sum of the components is not always equal to the "sales total" due to independent rounding

Source: own study based on IAFE NRI data

systematically (by 86.5% to 0.31 bln liters) in favour of an increase in the volume of milk purchase mainly to the dairy industry (Table 2).

The share of sales to the dairy industry in total milk production increased in the period 1991-2017 by almost 30 percentage points (p.p.) – up to 84.9%. Despite the enhanced market output index, it is still significantly lower than in EU-15 countries, where it is 96-99%. Particularly fast growth in the country has, however, occurred since the late 90's, as a result of the acceleration of restructuring processes, as well as the improvement of production conditions and milk processing so as to align with EU standards and be prepared for the implementation of the milk quota system [Seremak-Bulge 2005]. From the beginning of market changes in improving the quality of raw material, dairies have perceived the possibility of producing highly processed products that would compete with those imported and aid in the acquisition of external markets. Hence, dairies have modernized the organization of milk purchase, credited the purchase of milk cooling and milking equipment by farmers, paid for milking hygiene consultancy, covered the costs of farmers' cooperation with veterinary surgeons and used price bonuses (up to 40%) for extra-class milk (admitted to trading on the European market).

Farmers involved in dairy cattle breeding could also count on preferential loans launched in 1995 to restructure the entire dairy industry from the state budget, which covered ¾ of the interest rate. In the period of 1995-2005, the value of granted preferential credits for farmers in this industry amounted to PLN 1.07 bln. Additionally, from the

SAPARD pre-accession programme, farmers received PLN 77.6 mln for the modernization of farms, of which 82% was allocated to the purchase of machinery and equipment for production and 10% to the purchase of milk cows (more efficient breeds). These activities resulted in a very rapid improvement of raw material quality, which is confirmed by the fact that, in 1998, only 15% of milk in purchase was of extra-class, however, in 2005, it amounted to almost 93% [Seremak-Bulge 2005].

As a result of restructuring the milk production sector, Poland is self-sufficient in the production of milk and dairy products, as evidenced by the surplus of production over domestic use. However, the degree of this self-sufficiency has changed over the last 26 years (Table 3). The highest degree of food self-sufficiency measured by the ratio of domestic production to domestic use (SSR almost 123%) was achieved by Poland at the time of its entry into the EU. Then, the consumption of dairy products was the lowest after 1990 (173 l per person in 2005). This was largely due to domestic dairies wanting to take advantage of the opening of the EU market, hence, dynamically increasing exports at the expense of the internal market. In 2004, the export of Polish dairy products (in the raw material equivalent) increased by 45% when compared to the previous year, and by a further 30% in the following year. However, in 2006, exports fell by 12%, among others, due to unfavorable exchange rates for exporters, a drop in world prices of butter, casein, powdered milk, as well as the EU's resignation from support for the export of skimmed milk powder. Still, supply on the domestic market has improved and domestic consumption has begun to grow. Since 2005, consumption has increased (by 11.4%), which in combination with a larger increase in milk use (26.2%), has made the share of consumption in use decrease by 8.7 p.p. up to 65.6% (Table 3).

In 2010, the self-sufficiency ratio (SSR), as well as the degree of satisfying domestic consumption by domestic production (SSRII) decreased due to the slower growth rate of production (by 3%) in comparison to the growth rate of domestic use (7.6%), including consumption (8.1%). Thus, the concerns of agricultural economists were confirmed, when the milk quota granted to Poland limited the development of milk production in this country.

Table 3. Poland's self-sufficiency with regard to milk in 1991-2017

Specification	Years					
	1991	1995	2000	2005	2010	2017
Production/Domestic use [mln liters]	371	529	563	2162	1788	2815
SSR [%]	102.68	104.91	105.13	122.96	117.65	126.84
SSR_{II} [%]	110.70	113.45	112.08	130.90	124.71	135.02
Imports/Resource [%]	2.55	1.12	4.31	2.48	7.57	11.41
IDR [%]	2.69	1.19	4.74	3.13	9.64	16.33
CR	1.68	4.69	1.58	8.42	2.83	2.60
Exports/Use [%]	4.30	5.25	6.82	20.88	21.43	29.62
Consumption/Use [%]	88.03	87.16	85.38	74.32	74.11	65.61

Source: own study

High levels of self-sufficiency indicators in 2017 result from an increase in milk production from 2015 by 3.5% (0.5 bln liters), with a decrease in domestic use (5%), including consumption (5.5%). Import plays an increasingly important role in milk resource. In the period of 1991-2017, its share increased more than 4 times to 11.4%, accelerating significantly since 2005. A worrying increase in the share of imports, in the Polish milk market, is also visible through a dynamic increase in the share of imports in covering domestic use, which, since 2005, has increased by 13 p.p. up to 16.3%. Thus, the penetration of the Polish market by imports is increasing, while the surplus of production and imports over domestic use is exported. What is more, the share of exports in use is systematically growing and now amounts to almost 30%. The index recorded particularly dynamic growth in the period of 1991-2005 (almost 5 times), which resulted from a decrease of use (by 18.3%) and a 4-fold increase in the volume of exports. Since Poland's EU accession, until 2017, the growth rate of exports had already lowered (79.1%), which, with a 26.2% increase in use, resulted in a slower increase in this indicator. Until Poland joined the EU, the surplus of exports over imports increased more than five times (up to 8.42). This was caused by the increase in the volume of exports (4 times) and fluctuating levels of imports. However, since 2005, this surplus has been decreasing due to a very dynamic increase in the volume of imports (5.8-fold), with a lower increase in exports (by 79.1%).

SUMMARY

Changes in milk production have significantly influenced food security in the country. After the transformation of the economy, due to very difficult macroeconomic conditions, milk production decreased in the first five years by as much as 20%. This came about as a result of the resignation of almost 29% of farms from milk production, resulting in a decrease in the number of dairy cows by 30%. The pre-accession period significantly affected the restructuring of agricultural holdings, which were supported by funds from the state budget, the EU, as well as by the training, consulting, organizational and credit activities of dairies. Thanks to the modernization of farms, including the purchase of modern machinery and equipment for the production or purchase of milk cows of more efficient breeds, the scale of milk production and the quality of raw material, priced strongly by dairies, improved. Since Poland's accession to the EU, milk production in the country has systematically been growing, although it was limited before 2015 by a milk quota system that did not allow the country to take advantage of its domestic cost-price advantages. The process of concentration of milk production is continuous. As of 1991, the milk market output index increased from 55% up to 85% in 2017. An increase in milk sales to the dairy industry resulted, among others, from a decrease in milk consumption in farms (both for fodder and farmers' own-consumption) and a decline in direct milk sales by farmers. In 2015, resource in the milk balance returned to the level in 1991, i.e. over 14.5 billion liters. In 2017, this figure amounted to 15 billion liters. Domestic milk production is the main source of resource, however, an over 4.6-fold increase in the volume of imports and an increase in its share in resource to 11.4% has been observed. The latter has accelerated significantly since 2005. Domestic use is the basic direction of milk destination. However, exports account for almost 30% of use, as they have grown 7 times in size over 26 years,

being more dynamic upon Poland's accession to the EU. From 1990 onwards, Poland has significantly improved its self-sufficiency in milk production, especially since EU accession. In 2010, the self-sufficiency ratio (SSR), as well as the degree of satisfying domestic consumption by domestic production (SSRII) decreased due to the slower growth rate of production (by 3%) in comparison to the growth rate of domestic use, including consumption. The abolition of milk quotas favours the development of milk production in the country and the improvement of self-sufficiency levels. Poland is self-sufficient in milk, the internal market remaining to be the main direction of production.

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ZMIANY STRUKTURALNE W SEKTORZE PRODUKCJI MLEKA A BEZPIECZEŃSTWO ŻYWNOŚCIOWE – PRZYPADEK POLSKI

Słowa kluczowe: produkcja mleka, bilans mleka, bezpieczeństwo żywnościowe, samowystarczalność żywnościowa

ABSTRAKT

Celem badań było znalezienie odpowiedzi na pytanie, jak zmiany w sektorze produkcji mleka w Polsce, które nastąpiły po urynkowieniu gospodarki, wpłynęły na bezpieczeństwo żywnościowe kraju w wymiarze samowystarczalności żywnościowej. W ykorzystano bilanse mleka krowiego prezentowane przez GUS oraz dane IERiGŻ-PIB, dotyczące rozdysponowania krajowej produkcji mleka. Zastosowano analizę porównawczą w czasie, wskaźnikową, opisową i graficzną. Wykorzystane wskaźniki dotyczyły towarowości produkcji mleka, samowystarczalności żywnościowej, struktury bilansu mleka. W ciągu kilku pierwszych lat transformacji gospodarki nastąpiło załamanie produkcji krajowej mleka. Od roku 2004 trwa prawie systematyczny wzrost wielkości produkcji przy wcześniejszej ogólnym spadku produkcji. Tym procesom towarzyszyły wynikające z przemian transformacji gospodarki zmiany w sektorze produkcji mleka. Związane były one z drastycznym zmniejszeniem od 1990 roku liczby gospodarstw zajmujących się produkcją mleka, ze spadkiem pogłowia krów mlecznych przy jednoczesnym wzroście wydajności mlecznej krów mlecznych. Wzrosła towarowość produkcji mleka. W 2015 roku przychody w bilansie mleka wróciły do poziomu z 1991 roku, tj. ponad 14,5 mld l, a w 2017 roku wyniosły 15 mld l. Głównym źródłem przychodów mleka jest krajowa produkcja, ale rośnie znacząco wielkość importu. Pomimo dynamicznego wzrostu eksportu, podstawowym kierunkiem przeznaczenia mleka jest zużycie krajowe. Od 1990 roku poprawiła się samowystarczalność w zakresie produkcji mleka. Zmiany w produkcji mleka wpłynęły w istotny sposób na bezpieczeństwo żywnościowe kraju.

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