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Source / Izvornik: **Poslovna izvrsnost, 2022, 16, 55 - 55**

Journal article, Published version

Rad u časopisu, Objavljena verzija rada (izdavačev PDF)

<https://doi.org/10.22598/pi-be/2022.16.1.33>

Permanent link / Trajna poveznica: <https://um.nsk.hr/um:nbn:hr:151:618014>

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Download date / Datum preuzimanja: **2024-11-26**



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PRICING MANAGEMENT IN MILK PRODUCTION

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UDC / UDK: 005:338.5:637.1(497.5)(4-6EU)

JEL classification / JEL klasifikacija: Q11, Q14

DOI: <https://doi.org/10.22598/pi-be/2022.16.1.33>

Original scientific paper / Izvorni znanstveni rad

Received / Primitljeno: December 20, 2021 / 20. prosinca 2021.

Accepted for publishing / Prihvaćeno za tisak: March 7, 2022 / 7. ožujka 2022.

Summary

Pricing management is part of farm management with the purpose of increasing profitability and competitiveness. It is based on the production cost and purchase price which difference affects to the financial result. The aim of this research is to identify milk price volatility at the Croatian and EU level, international trade, as well as to identify trends for the period from 2016 to 2020 and to simulate changes for the next period from 2021 to 2025. The analyzed data were taken from the Eurostat and processed using time and harmonized index. Milk production in the EU-27 for 2020 is 23 mil. tons of milk and averages 65 kilograms milk consumption per capita. The lowest average production price of milk in the analyzed period at the EU-27 level was in 2016 (28 € per 100 kg of milk) and in following years it is up to 35 € per 100 kg. The market situation reflects the consequence of the abolition of quotas in the dairy industry (2015) and the impact of the

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*This paper is based on the part of the master thesis titled “Management of milk and beef prices“ written by Sanja Antunović (Faculty of Agrobiotechnical Sciences Osijek, Josip Juraj Strossmayer University of Osijek).

COVID-19 pandemic. In period from 2021 to 2025, a slight growth and slowdown in milk production of 2.83% compared to 2020 and an increase in the average producer milk prices in 2025 by 9.6% compared to 2020 are projected. This research contributes to identifying the sources of difficulties in managing prices. The guidelines have been developed for more efficient price management in order to improve the competitiveness and market positioning.

Keywords: *pricing management; production and purchase prices; volatility; milk production.*

1. INTRODUCTION

Farm managers have intention to harmonize prices as well as possible in order to increase the level of profitability and competitiveness of milk production. Pricing management in milk production is extremely important for producers due to the technological specifics of production, agricultural policy measures and market factors to which producers have to adapt.

The European dairy market is characterized by strong oscillations in production, imports and exports, caused by global factors: climate change, the global economic crisis caused by the COVID 19 pandemic and geopolitical disruptions (tensions between the EU and Russia). These disturbances occasionally cause market surpluses of milk, which then spill over into poorer EU-28 countries, including Croatia. The disturbance on the EU market was caused by the abolition of milk quotas due to the opening of new markets - Russia and China. In the long run, this causes a decline in domestic production that cannot cope with dumped prices. This situation was accelerated by the political crisis between Ukraine and Russia and the cessation of milk exports to Russia.

The aim of the research is to identify price relations and volatility in the production of cow's milk at the European and national level over a five-year period from 2016 to 2020, to identify trends and to simulate changes for the future five-year period from 2021 to 2025. This research shows international trade balance, comparative results of producer prices and projections of future trends in milk production.

2. MATERIALS AND METHODS

Materials for the paper are scientific papers, books, Internet sources, databases from the European Commission and Eurostat, as well as publications of the Croatian Ministry of Agriculture and the European Milk Board. The methods used for data

processing are individual time indices and harmonized indices. Individual time indices are divided into chain and base indices (Šošić, 2009). Chain indices (v_t) are relative numbers that show a change in the situation in a consecutive period:

$$v_t = \frac{y_t}{y_{t-1}} \times 100$$

Y_t presents the value from period t , while Y_{t-1} denotes the value from the previous period. The chain index shows how many units of occurrence we have in period t in relation to one hundred units of period $t-1$. The chain index can also be measured in percentages using the rate of change:

$$S_t = v_t - 100$$

The rate of change is the percentage change in the current period compared to the previous period.

Base indices are relative changes of the current period in relation to the selected base period (ibidem):

$$b_t = \frac{y_t}{y_b} \times 100$$

Y_t denotes the value of the current period, while y_b denotes the value of the base period. Base index values can be 100, higher or less than 100.

Harmonized index of consumer prices (HICP) provides a statistical basis for international comparisons of consumer price inflation and as an indicator of price stability, which is important for the definition and implementation of monetary policy (European Commission, 2021). HICP is an index of the goods and services cost, ie it measures the variable price of a fixed consumer basket of goods and services over time and is expressed via an annual chain-linked index of the Laspeyres type. Laspeyres price index is a price index that measures the average change in prices from the reference period compared to the period using the shares of expenditures from the period before the reference period. The shares of expenditures are adjusted to reflect prices of the reference period. From 2016, the reference period of the index is 2015 = 100. An index of type Laspeyres is defined as:

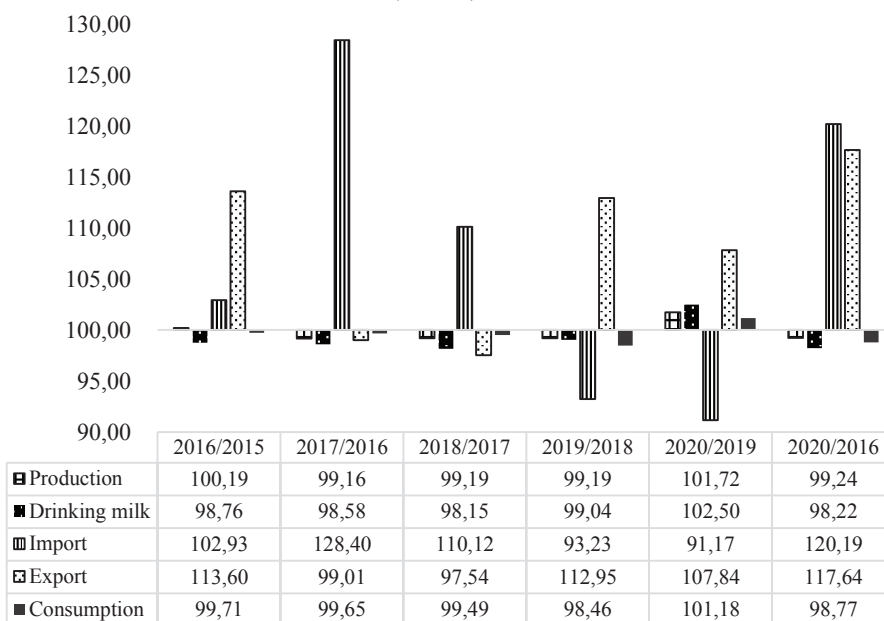
$$p^{o,t} = \sum \frac{p^t}{p^o} w^{o,b}$$

In the formula, the product price is denoted by p , the reference price period is denoted by o , and the comparison period is denoted by t . Weights (w) are the shares of expenses of period b before the reference period of the price and are adjusted to reflect the prices of the reference period of prices o . The reference period of price (o) is compared to the compared period of price. For monthly indices of the reference period presents the price in December of the previous year (b) and at the same time the comparative period (t) means the period for which the index is calculated. The reference period of weighting (b) indicates the previous year.

3. MILK PRODUCTION, INTERNATIONAL TRADE AND PRICE VOLATILITY

In the production of cow’s milk for better management and increase profitability, the market situation, production parameters should be observed and cause-and-effect relationships for better and faster adjustment of production should be recognized. European Union data on production, imports, exports, consumption and purchase prices of milk were used for the analysis. Furthermore, production costs are calculated and compared with the purchase price. By linking the values of previous periods, the balance for the future five-year period is projected. To track changes in previous periods, base and chain indices are calculated. For the base period, the values from 2016 are used, which can be seen in the following chart with chain and base index.

Figure 1. Chain and base index for milk production, consumption, import and export (EU-27)



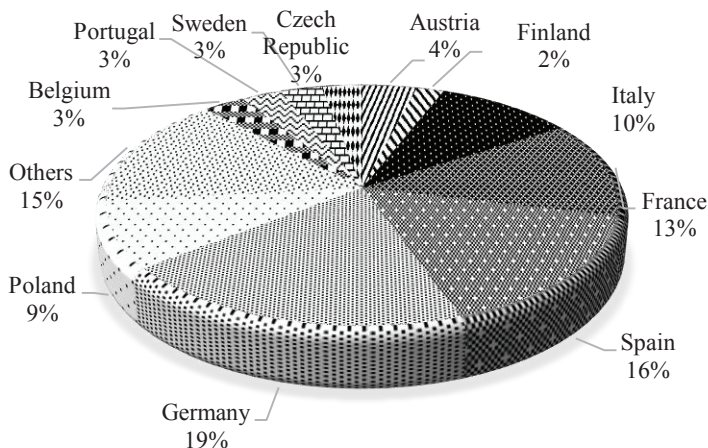
Source: Author’s calculation from the European Commission (2021) data

Chain index show the rate of change compared to the previous period, and total production fell in each year except in the period 2020/2019, where there was an increase in production. The base index (2020/2016) is less than 100, which means that in 2020,

compared to 2016, there was a decline in production. In the production of drinking milk every year until 2020/2019, there is a decline in the production of drinking milk and increases only in 2020/2019. The base index for 2020/2016 is 98.22, which is a decrease in production compared to the base year. With the previous amounts, it is logical that milk imports increased, which is evident from the values in the Figure 2. The decline in imports was recorded in the period 2019/2018 and 2020/2019, but in the same time milk production was declining or stagnated (99,19 and 101,72). Oscillations in imports are the result of shortages of milk and processed products on the EU market, as well as a reduction in domestic consumption. The base index for milk imports increased in the selected period. Furthermore, milk exports in 2017/2016 and 2018/2017 recorded a decline in exports due to lower production, but in the next period 2019/2018 and 2020/2019 there was an increase in milk exports. The base index for milk exports is higher than 100, which means that milk exports increased in the observed period. Milk consumption at EU-27 level declined in all periods except 2020/2019. Therefore, the base consumption index for this period is negative, this is possible due to reduced production and higher market prices, and the adjustment of consumers to newer trends and dairy alternatives (FAO 2021).

In some Member States, milk production is high, and in some it is underdeveloped (Eurostat, 2021). The following chart shows the structure of Member States by milk production for 2021.

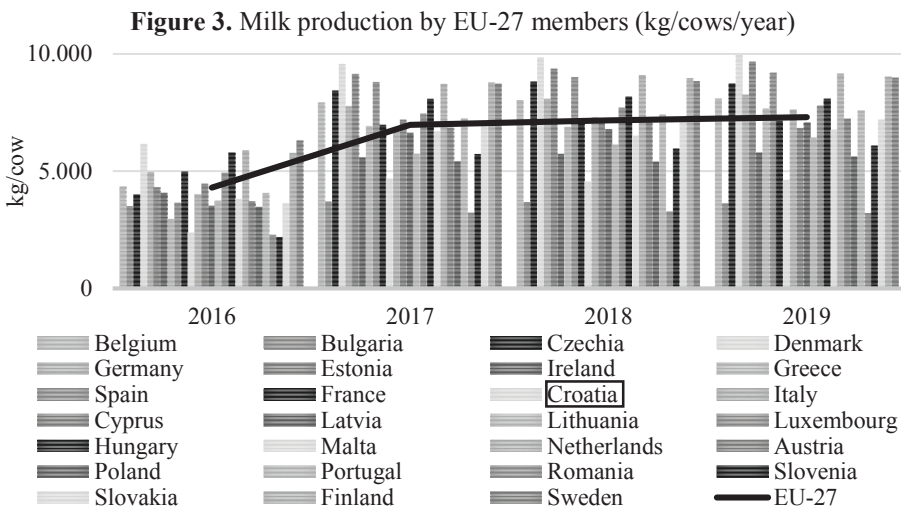
Figure 2. Drinking milk production by EU-27 members in 2021



Source: Author's calculation from the European Commission (2021) data

The total production of drinking milk in the EU-27 is 23,028,248 tons. In the EU-27, most milk is produced by Germany with 19% or 4,565,858 tons of drinking milk, followed by Spain with 16% or 3,583,360 tons, followed by France with 13% or 3,067,980 tons, Italy 10% or 2,313,830 tons and Poland with 9% and 1,986,720 tons. According to the previous Figure, Croatia is classified in the Other group with 1% of total production, ie 230,600 tons of drinking milk.

With the abolition of milk quotas, the number of milk-producing farms is also decreasing, but it is interesting to observe an increase in the volume of production and milk production per cow per year. Farms that remain in production introduce better technologies and management, which results in better production results, which can be seen in the figure.



Source: Author's calculation from the European Commission (2021) data

The previous figure shows the quantities of milk produced per cow per year, and it is noticeable that milk production per cow increases, which with the increase of the herd results in better profitability and lower unit costs. The total average milk production per cow in 2016 was 4,306, in 2017 it was 6,977, in 2018 it was 7,162 and in 2019 it was 7,302 kg / cow. The rate of change compared to the base period is 69.58%. Sweden has the highest milk production per cow in 2016 with 6,305 kilograms and production is growing in the following years. Denmark, the Netherlands, Finland and Spain are also growing milk production. It stands out Denmark, which in 2016 had 6,166 kilograms and the following year production was increased to 9,569 kg / cow, in 2018 milk production

is 9,851 kg / cow and in 2019 it is 9,973 kg / cows. The rate of change compared to the base period is 61.74%. In the Netherlands, in 2016 the production was 5,887 kg, the following year it was 8,709. In 2018, the production is 9,079 kg, in 2019 it is 9,154 kg / cow. The rate of change compared to the base period is 55.50%. In 2016, Spain had a production of 3,651 kg / cow, while it ended the observed period with 9,178 kg / cow. Rate of change 2019/2016 for Spain it was 51.38%.⁷

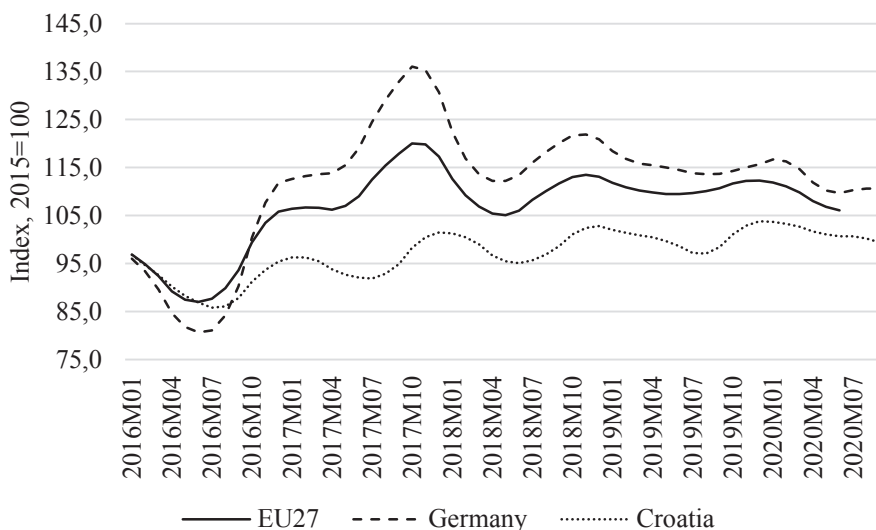
3.1. Price volatility of fresh whole milk

According to Daryanto et. al., (2020) the results of their research shown that fresh milk prices in West Java was volatile and it was influenced by the volatility of the previous period. Climate change and feed prices yielded positive responses on the volatility of fresh milk price in West Java. Subsequently, it achieved a stable price level in the long run. In the short run, the highest response of the milk price volatility shock was shown by the West Java's fresh milk price volatility itself.

In the EU-27, per capita consumption of drinking milk is 65 kilograms (European Commission, 2020). It is important to monitor and analyze the prices of fresh whole milk as it is a raw material for the dairy processing industry. The price of goods is the value of goods on the market and will be determined by the law of supply and demand. The next Figure shows the price index of fresh whole milk for the EU-27, Germany and Croatia.

⁷ In Croatia, milk production per cow in 1990 was 2,369 kg / cow, in 2017 it was 4,662 kg / cow, in 2018 it was 4,544 kg / cow, and in 2019 it was 4,608 kg / cow (European Commission, 2021. Milk and milk products www.ec.europa.eu/info/food-farming-fisheries/animals-and-animal-products/animal-products/milk-and-dairy-products_hr).

Figure 4. Price index of fresh whole milk



Source: Author's calculation from the Eurostat, 2021 database

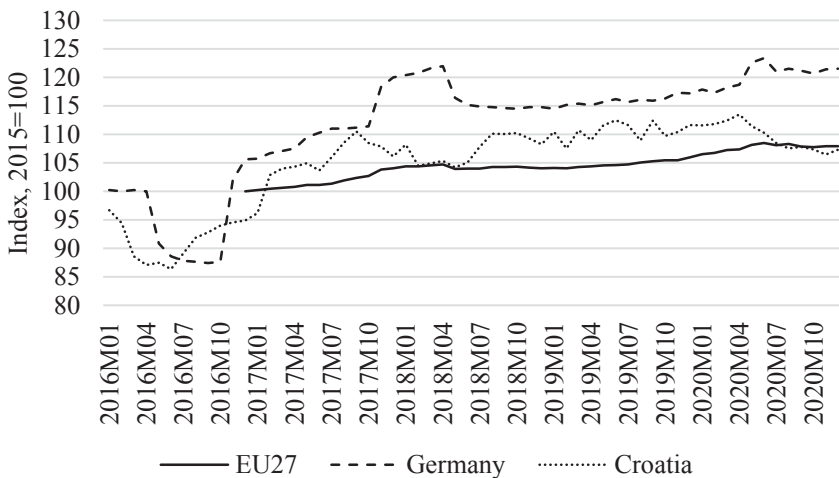
According to previous figure, the index curve oscillates in line with price volatility slightly more for Germany than for the EU-27 and Croatia. Germany recorded the lowest values of the index in June 2016 from 80.7, from where it grew to 107.4 (November / 2016) and slowed down its growth over the next few months, until June 2017. After that, the curve has a rapid rise and reaches its highest value in October 2017 (136.0), after which it falls until April 2018 (112.2). The curve continues to grow further until November 2018 (121.9) and after that it decreases and relatively stabilizes until 2020, when it records an increase and then a decrease again. The lowest value of the curve for the EU-27 is in June 2016 (87.0) from where it is growing and the peak is in October 2017 (120.0). The curve is similar to the German curve, but less unstable than it is. While in Croatia, the curve records the least oscillations in values and is more stable than the other two. The lowest value was recorded in July 2016 (85.8), and the highest in December 2019 (103.8). Values in 2016 were extreme due to the abolition of milk quotas in 2015, and it took time for the market and prices to adjust. After that period, the curves stabilize relatively and follow the 2% annual change.

The Harmonized Index of Consumer Prices (HICP) is a measure of inflation and an economic indicator that measures changes in the prices of consumer goods and services in the household (Eurostat, 2021). The HICP aims to measure changes in consumer prices and they should not affect changes in quality. However, product quality changes over

time, so the statistician adjusts prices to changes in quality, so as not to underestimate inflation. HICP is an indicator of price stability and the annual rate of change should be around 2%. According to Hoehl and Hess (2021) which discuss that European dairy farmers have to manage the raw milk price risk. Price hedging for raw milk and an increasing number of individual fixed-price contracts with processors are now available. However, the choice of hedging a certain share of milk output still leaves individual farmers facing a complex decision. The cash flow model in this study explains the probability of a typical northern European dairy farm surviving illiquidity over an 18-month period under common milk price volatility. The probability of farm survival was dependent in relation to available liquidity buffers and different levels of farm - specific production costs.

The next Figure shows the harmonized index of consumer prices of fresh whole milk for all countries of the European Union, as well as Germany and Croatia.

Figure 5. Harmonized index of consumer prices of fresh whole milk



Source: Author's calculation from the Eurostat, 2021 database

The EU-27 has only been recording data since 2017 and the curve is relatively stable as index have remained in the range of 100 to 110 (Eurostat, 2021). For Germany, the curve starts with an index of 100, and in June 2016 falls to 88.6, where it records the minimum value of the curve. In the next five months, the index is in the approximate values of about 87, and in November 2017 the index jumped to 102. In 2018, the index starts with a value of 120, and in April the maximum value of the index for 2018 is 122, after that it falls and in 2020 in April it starts to rise again and in June 2020 it records the

highest value of the index for the entire reference period in the value of 123.4. For Croatia, the index reaches a minimum in June 2016 with a value of 86.32, and peaks in April 2020 with an index of 113.46. Using data and previous Figure, the instability of consumer prices for Germany and Croatia was observed, especially for the period in 2016-2017 resulting in the abolition of milk quotas. According to Van Winsen et al., (2011) increasing volatility could have a significant impact on the risk profile of dairy farms. Indeed, results show that the risk profile is changing depending on the volatility and average price for milk. However, this change is not very substantial compared to some other subsectors. Also, they show in that case study of selected farms if the milk price volatility doubles an average milk price increase of about 12% compensates for the increased volatility on return on assets. Finally, this paper demonstrated the importance of regarding risk and return together when making normative statements on the consequences of fresh whole milk price volatility.

3.2. Milk production price volatility

To determine profitability of milk production, its first necessary to calculate the production price of milk with 4% milk fat and 3.4% protein which is shown.

Table 1. Milk production price calculation (EU-27)

MILK PRODUCTION PRICE	€/kg
Revenue from milk sold	0,0535
CAP payments	0,0346
TOTAL INCOME	0,0881
Purchased fodder	0,1271
Animal feed production	0,0260
Veterinary costs	0,0344
Maintenance of production buildings and machines	0,0341
Electricity	0,0283
Workers and other contracted works	0,0265+0,0255
Overheads and rents	0,0251+0,0186
Amortization	0,0601
Interest and taxes	0,0150
Own work	0,1239
TOTAL COSTS	0,5438
PRODUCTION PRICE, €/kg	0,4557

Source: Author's calculation from the European Milk Board, EMB, 2021 data

In connection with the previous table the production price of milk in 2019 in the European Union was 0.4557 € / kg, on the other hand the average purchase price of milk was 0.3452 € / kg, which for most producers means a negative financial result (-24%). Milk income and CAP payments are not enough for profitable production.

Production costs were calculated based on the Farm Accountancy Data Network (FADN) for 27 members. The following table shows the average production price and is deducted from the average purchase price.

Table 2. Difference between production price and purchase price for EU-27, € / 100 kg

YEAR	2015.	2016.	2017.	2018.	2019.	AVERAGE
Production price	41.18	40.79	41.55	43.78	45.35	42.53
Purchase price	30.60	28.43	34.86	34.11	34.52	32.50
Difference, € / 100 kg	-10.58	-12.36	-6.69	-9.67	-10.83	-10.03
Difference, %	-26	-30	-16	-22	-24	-24

Source: Author's calculation from the European Milk Board, EMB, 2021 data

In each analyzed year, the purchase price was lower than the cost of production and production was unprofitable for producers. The average cost of production (2015-2019) is 0.4253 € / kg. This situation can be attributed to the abolition of quotas. In 2015, producers lost 10.58 € / 100 kg of milk produced, and the following year the financial difference was higher by 1.78 € / 100 kg. In 2017, the financial loss was slightly lower, while in 2018 and 2019 the loss is growing. On average, producers had an annual financial loss of 10.03 € / 100 kg of milk, and each year production was unprofitable. Many producers are switching to organic production, so the following table compares conventional and organic fodder production for organic milk with 4% milk fat and 3.4% milk protein.

3.3. Milk purchase price volatility

The Government of the Republic of Croatia, according to the Agriculture Act (Official Gazette 66/2001 and 83/2002), has determined the calculation of prices of fresh raw milk. The price of milk for the market in the Republic of Croatia, delivered at the place of purchase, is HRK 1,798 per liter, with standard quality and 3.7% milk fat and 3.2% protein, and there are up to 400,000 somatic cells and 100,000 microorganisms per milliliter. Depending on the number of somatic cells and the number of microorganisms, milk is classified into classes E, I, II, III, and a correction factor of 0.9 to 1.15 is used. The calculation of the basic price of milk is formed based on the percentage of milk fat and protein, with a unit monetary value according to the formula:

$$OCM = (M \times v1) + (B \times v2)$$

OCM is the basic price of milk, *M* is the percentage of fat in milk, and *B* is the percentage of protein in milk. The monetary value of a fat unit is *v1*, ie HRK 0.2596 (0.236), and *v2* is the monetary value of a protein unit, ie HRK 0.3179 (0.289). Also, HRK 0.1798 per liter is deducted from the calculated price of milk if it contains lower values of milk fat of 3.4% or lower values of protein of 3.1%. Furthermore, state financial support for milk, calculated according to the formula:

$$OPM = (MM \times V1) + (MB \times V2)$$

OPM denotes the amount of support for milk, *MM* denotes milk fat as a percentage, *MB* is protein as a percentage, *V1* is milk fat for lowland areas (0.0853) and *V2* is protein for lowland areas (0.1045).

The table shows the purchase prices of milk for producers at the level of EU-27, Germany and Croatia.

Table 3. Purchase prices of milk, € / 100 kg

YEARS	EU-27	GERMANY	CROATIA
2016	28.60	27.38	29.58
2017	35.19	36.41	31.38
2018	34.31	34.71	32.84
2019	34.78	34.35	33.33
2020	34.14	33.74	33.33

Source: Eurostat, <https://ec.europa.eu/eurostat/web/hicp/data/database>

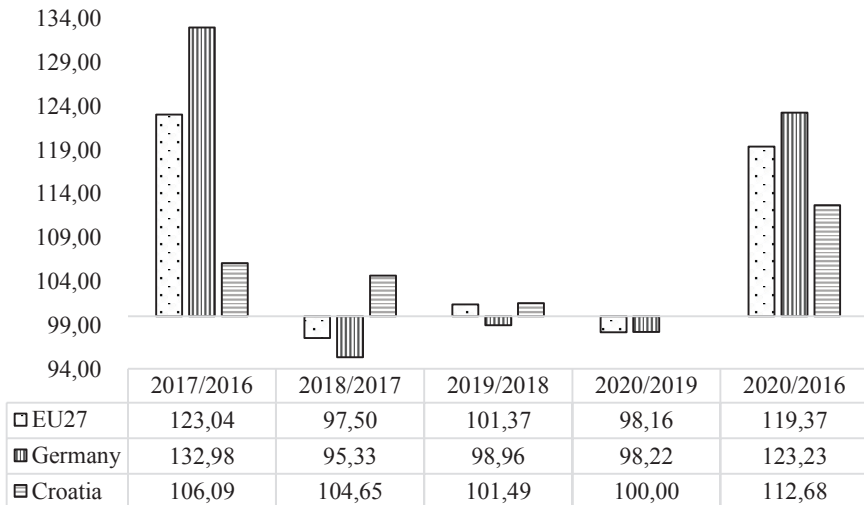
For the data in Table 3. the rate of change from the base year (2016) for the EU-27 is 19.37%. The lowest purchase price of milk in the EU-27 for the reference period was in June 2016 with a value of € 25.83 / 100 kg of milk, and the highest was in November 2017 with € 38.13 / 100 kg of milk. In 2016, purchase prices vary from € 25-33, which could be attributed to the abolition of quotas and the adjustment of countries. In 2017, purchase prices vary from 33-38 € / 100 kg, in 2018 they vary from 32-36 € / 100 kg. In 2019, the range of purchase prices ranges from 33-35 €, and in 2020 they oscillate 32-35 € / 100 kg of milk.

In 2016, the consequence of the abolition of quotas and excessive supply on the market was noticed, and the lowest purchase price of milk in Germany (23.18 € / 100kg) was recorded in June and the highest was in December (33.67 € / 100kg). The average for that year is 27.38 € / 100kg of milk. In 2017, Germany had an average of 36.41 € / 100kg, and the lowest purchase price producers had in April with 33.49 € / 100kg, and the highest in November with as much as 40.52 € / 100kg of milk, price increase of 18% greatly affects the profitability of production. The average for 2018 is € 34.71 / 100 kg of

milk, and in June they received € 32.56 and the highest in November with 37.16. In 2019, the minimum value of the price of milk was in July with € 34.35, and the highest at the beginning and end of the year with € 35, and the annual average is € 34.78 / 100kg of milk. In 2020, the annual average was € 33.74 / 100kg, with a minimum price in June (31.72) and the highest in December (€ 35.11 / 100kg).

For Croatia in 2016, the average purchase price was 29.58 € / 100kg, and the lowest price was in July (27.89), and the highest at the beginning and end of the year (31.00). In 2017, the average price is 31.38 € / 100kg, and the lowest value is achieved in August (29.95), and the highest in December (33.12), which is 10% higher price in compared to three months earlier. In 2018, producers achieve the lowest purchase price in June with 31.6 € / 100kg, and the highest in December with 34.34 € / 100kg, the overall average for the year is 34.71 € / 100kg of milk. For Croatia in 2016, the average purchase price was 29.58 € / 100kg, and the lowest price was in July (27.89 €), and the highest at the beginning and end of the year (31.00). In 2017, the average price is 31.38 € / 100kg, and the lowest value is achieved in August (29.95), and the highest in December (33.12), which is 10% higher price in compared to three months earlier. In 2018, producers achieve the lowest purchase price in June (31.60), and the highest in December (34.34), the overall average for the year is 34.71 € / 100kg of milk. Furthermore, a change in the purchase price of milk was observed, in the period from 2016 to 2020, for the average of the Member States in the EU27, Germany and Croatia.

Figure 6. Milk purchase price index in the EU-27, Germany and Croatia



Source: Author's calculation from the European Commission (2021) data

Milk purchase prices show significant volatility at EU-27 level. The calculated chain indices for the periods 2017/2016 recorded an increase, 2018/2017 recorded a decrease in the purchase price, 2019/2018 increased and 2020/2019 decreased again. The base index records an increase in the purchase price in the observed period for 19,37%. In Germany, the chain index for 2017/2016 is higher than 100, but every following year it records a decline in the purchase price. The rate of change compared to the base year for Germany is 23.23%. In Croatia, the rate of change compared to the base year is 19.37%.

The situation in Croatia is different because the purchase price increased every year and the entire analyzed period is marked by an increase in the purchase price of whole milk. Although the purchase price was not much higher than in previous years, in addition to higher purchase prices, producers were also helped by state financial support for milk (www.apprrr.hr).

Table 4. Difference between purchase price and production price in Croatia, € / 100 kg

YEAR	2015	2016	2017	2018	2019	AVERAGE
Purchase price	32.88	30.37	31.29	32.35	32.75	31.93
Production price	32.13	29.11	34.50	31.59	33.18	32.10
Difference, € / 100 kg	0.75	1.25	-3.21	0.77	-0.43	-0.17
Difference, %	2.35	4.31	-9.29	2.43	-1.29	-0.30

Source: Author's calculation for the purchase price: <http://www.tisup.mps.hr/> and production price: <https://www.fao.org/faostat/en/#data/PP>

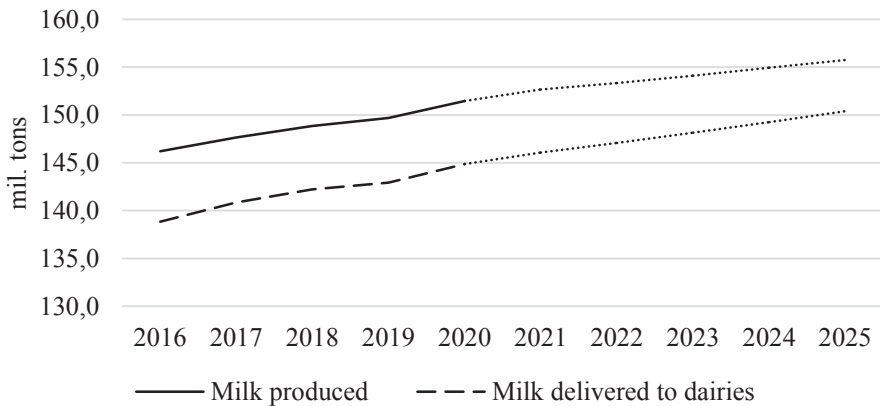
The average production price in Croatia is higher than the purchase price by 0.17 € / 100 kg or 0.53%. The previous Table 2 analyzes the production price and the purchase price for the EU-27 and highlights the differences compared to Croatia in the average purchase price (32.50; 31.93 € / 100 kg) and the average production price (42.53; 32.10 € / 100 kg). In the EU-27, average purchase prices increased by 1.78% compared to Croatia, and production prices increased by 32.49%.

4. PROJECTION OF FUTURE TRENDS IN MILK PRODUCTION AND PRODUCER PRICES

In the previous five-year period, the European Union has been adapting: the abolition of quotas, the impact of the pandemic and natural disasters, all of which have

reduced production. The simulation of the projection for the future five-year period is shown in the following Figure.

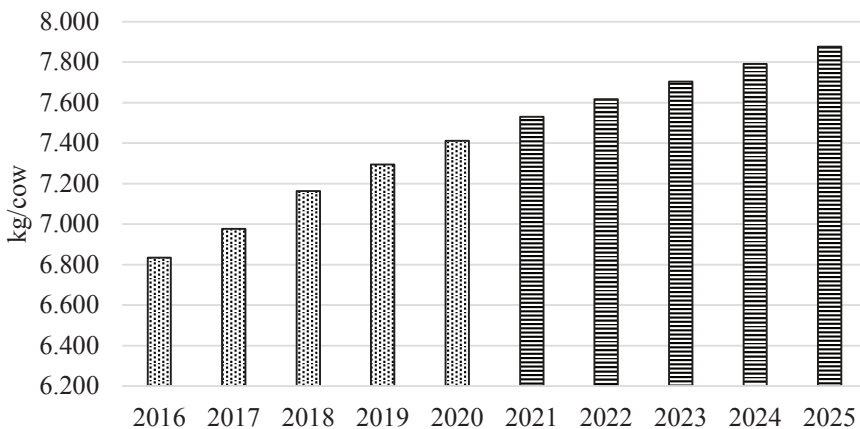
Figure 7. Milk production and delivery to dairies for the EU-27 (2020-2025)



Source: Author's calculation from the European Commission (2021) data

Production is expected to increase in 2021 and decline in 2022, followed by a slight increase and slowdown in production, with milk delivered to dairies (95-96%). Milk production should reach the highest production so far with 155.75 million tons, and delivery of 150.39 million tons. By the end of 2025, not all countries will improve their self-sufficiency, but by 2030 they could. But expected population growth, rising incomes and expanding urbanization will require import growth. Climate change is increasing the number of droughts, floods and diseases, which directly affects price volatility and milk production per cow. Antimicrobial drugs are used to prevent diseases such as mastitis, which affect cow's milk production and milk quality. In recent years, there have been growing consumer concerns about antimicrobial drug residues in milk and resistance, which may affect reduced milk consumption. Drinking milk is used daily and minor fluctuations in consumption are possible but not significant. Due to plant-based alternatives, reduced demand for milk or dairy products is possible (Hanisch et. al., 2018).

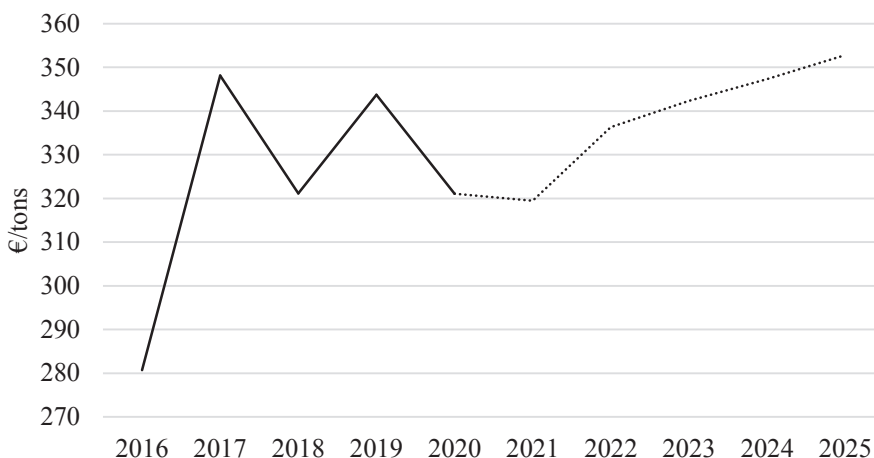
In the previous five years, milk production per cow has grown and such a trend is expected in the next five years.

Figure 8. Average milk production per cow in the EU-27 (2020-2025)

Source: Author's calculation from the European Commission (2021) data

The average milk production per cow is increasing and in 2021 it is 7,530 kg / cow, in 2022 it is 7,610 kg / cow, in 2023 it is projected at 7,700 kg / cow, in 2024 it is 7,790 kg / cow and in 2025 it is 7,870 kg / cow. In the next five years, greater digitalisation is expected due to increased productivity, improved working conditions and higher environmental standards. Improving measures to prevent disease and injury, and improving animal welfare, results in longer life expectancy and increased productivity per cow. By 2025, the average milk production per cow in the EU will be 7,870 kg, and improvement is expected in less developed member states as well (European Commission, 2021).

Milk producer prices varied significantly in the previous five-year period, and less variability is expected in the next five-year period.

Figure 9. Average producer price of milk in the EU-27 (2020-2025)

Source: Author's calculation from the European Commission (2021) data

Although the average producer price for 2021 is lower than in 2020, it is increasing in all subsequent years. By 2025, an increase in the average producer price (353 €/ t) is forecast. The average producer price of milk in 2021 is projected at 319 €/ t, then increases in 2022 to 336 €/ t, in 2023 it is 342 €/ t, in 2024 it is 347 €/ t and in 2025 it is 353 €/ t. By 2025, there is expected to be a global increase in demand for dairy and value-added products, which will cause an increase in raw milk prices in the EU. Despite rising energy and food prices, Europe could remain competitive in the world market.

Highly developed European countries have an increase in organic production. Organic farms have a lower production volume than conventional production and high production costs, so an increase in European milk prices is to be expected.

5. DISCUSSION

Milk production in 2020 is 23,028,248 tons and most of the produced milk is delivered to dairies. The most important EU countries in the production of drinking milk are Germany (4,565,858 t), Spain (3,583,360 t) and France (3,067,980 t), while, Croatia is at the 19th place with a production of 230,600 t, or 1% of total European production. The European Union exports more milk and dairy products (2,148,000 t) than it imports (752,000 t). With the abolition of milk quotas, the number of milk-producing farms is

also decreasing, but in the same time the volume of milk production per cow is increasing. Farms surviving are connected with precision technologies for measuring physiological, behavioral and production indicators to improve farming management and to increase production results. The total milk production per cow per year in EU-27 level in 2015 was 6,859 kg. According to The EU dairy sector yields per dairy cow are 43% higher in the EU-15 than in the EU-13. Stark contrasts exist between EU countries and regions. At national level, the highest annual yields can be found in Denmark, Sweden, Estonia, Finland, and Portugal (between 8,278 and 9,361 kg per head) and the lowest in Romania, Bulgaria and Croatia (from 3,343 to 4,566 kg per head). (European Commission, 2021). Newer technologies maximize genetic potential, affect early detection of diseases, minimize the use of drugs and preventive health measures and it resulted in better cost management and financial results. Furthermore, efficiency has been increased, product quality has improved, costs have been reduced, as well as the negative impact on the environment and animal health and welfare is limited.

An analysis of the relationship between milk production technology and price volatility was conducted by Bórawski (2006) who researched milk price volatility in Poland from 1993-2004. The scientific analysis enabled to measure seasonality and to forecast milk prices. All the simulations presented in the previous section proved to be sensitive to the variable costs of production that were also obtained from the survey of specialised dairy farms. This highlights the important relationship between technical efficiency and a dairy farm's vulnerability to external market price shocks. For policymakers, it demonstrates that periods of low milk prices affect farms in a very heterogeneous way. Rather than supporting milk prices through costly market interventions, individual support to improve farm management and the optimal planning of liquidity may prove substantially more effective if "farm survival" is a policy objective.

In Croatia, milk production per cow in 1990 was 2.369 kg and in 2019 it was 4.608 kg (European Commission, 2021). The rate of change compared to the period (1990) is 51,41%.

In connection with milk production prices volatility, price management is important because of the large difference in the coverage of variable costs what affect the unit price. In order to survive in the market with a positive financial result, producers should have more control over costs, production volume and milk purchase. It is the gap between the purchase price and production prices that encourages German farmers to produce more milk in organic way, but also because of higher purchase prices. Whether it is conventional or organic production, producers need to monitor the entire technological process, costs and unit prices, in order to improve individual segments for better results. The high rate of replacement of the breeding herd and calving of heifers in old age, leads many farms to a higher number of heifers than needed due to the

maintenance of the size of the dairy herd, which results in costs increasing. Later calving of heifers increases the costs of breeding and calving, with an average lower milk production per cow. Buying additional heifers to achieve the desired milk production increases costs and may be the result of unprofitability. Autors Malte et al., (2018) used panel data from EU-27 over the period 2001–2015 to investigate how the market share of cooperatives in a country affects milk price volatility. The key finding is that a higher market share of cooperatives reduces price volatility at the national level. Volatility is influenced by a number of other variables, such as fluctuation in raw milk production, oil price volatility spillover and the number of dairy processors. Policy makers should consider that the promotion of cooperatives might positively affect price stability in the dairy sector. Regarding milk purchase prices volatility authors Schulte et al., (2018) conclude that after the abolition of the milk quota in the European Union, milk price volatility is expected to increase because of the liberalized market conditions. In our research for 2016, the consequences of the abolition of quotas are noticed, which explains the lowest purchase price of milk in Germany in June (23 € / 100kg) and the highest in December (33 € / 100kg). Price volatility is noticeable in the entire market, but every following year the purchase price stagnates in the range of 34 to 36 € / 100 kg of milk. In Croatia, the purchase price in 2016 (29 € / 100kg) was higher than in Germany, but every following year (31-33 € / 100kg) is lower than the EU-27 average.

In the period 2021 to 2025, a slight growth and slowdown in milk production of 2.83% compared to 2020 is noticed. According to projected results, the average producer price of milk in 2025 will be increased by 9.6% compared to 2020. Due to the COVID-19 pandemic and changing consumer habits, lower milk consumption is expected, but also milk production per cow will rise. Under the influence of the pandemic, the cost of animal feed is higher (production prices), while the purchase price of milk is falling down. Therefore, the EU provides support under COVID-19 aid measures to mitigate market disturbances. The latest data and projections will indicate decline of a larger number of milk producers, especially smaller ones. Lowering the purchase price directly contributes to unprofitability and is crucial for producers who have planned their business with higher purchase prices. In Croatia, it is planned to introduce the euro (€) as the national currency in 2023, and market prices will be the same as in all other European Union countries. Then it will be easier to compare prices, the transaction costs will be lower, no currency risk, the price competitiveness of producers will increase and it is assumed that trade of goods will increase at the European level.

It is important to emphasize that in the milk market chain in the Republic of Croatia, in addition to producers and consumers, there are also purchasers, processors, retail chains and the Ministry of Agriculture and other ministries. Considering market situation in the country and the EU affected by Russian-Ukrainian crisis and Brexit on

the EU market there are milk surplus from developed EU countries that are sold in countries that are in milk deficit. Croatia is one of them where traders and retail chain sell milk at dumped prices below actual producer prices. As a result, the number of milk producers is declining as well as domestic milk production, while the import is rising. More specifically, the number of milk producers has decreased by 40.07% in the last 4 years (January 2018-November 2021), and production has fallen by over 16.07% in the same period (Ministry of Agriculture, 2022). Additional effect of these trends are presented in self-sufficiency and it amount 47,70% in 2021 (CLAL,2021).

6. CONCLUSION

Price management in milk production is important for business survival, increasing profitability and farm competitiveness. From the agrobiotechnical process of milk production, in order to maintain current market position, the farms should manage quality and prices. This is a complex task because it often requires a reduction in production costs which can affect the quality and quantity of milk so it is important to manage production resources, use knowledge and carry out controls. Activities to increase competitiveness are: productivity growth per unit of capacity, lower purchase prices of raw materials, lower sales costs (transport, storage) and lower general costs (administrative, overhead). The application of innovative technologies and modern solutions in the production process achieves price competitiveness as well as the organization of activities such as the restructuring of production and business.

Regarding the aim of the research which was to identify price relations in milk production, it was determined that the total production of drinking milk in the EU-27 is 23,028,248 tons, while Croatia produces 230,600 tons (1%) of drinking milk. Milk consumption per capita averages 65 kilograms, and there are very small fluctuations in consumption per year, mostly depending on consumer preferences (lactose-free alternatives), market conditions, purchasing power or some other situations for the member states. In 2016, significant purchase price volatility was recognized due to the consequences of the abolition of quotas and excessive supply on the market, which is confirmed by the lowest price of milk (29 € / 100 kg) and every following year the purchase price grew and was in the range of 31-33 € / 100 kg milk.

Climate changes is affecting price volatility, milk production per cow, which will lead to an increase in the average producer price in the next five years. The COVID-19 pandemic will reduce milk production and consumption, reduce imports and exports, and increase the price of raw materials and animal feed. In the next five years, a slight

increase and slowdown in milk production, extended life expectancy of cows and increased productivity per cow is expected.

Finally, to improve competitiveness and market position, guidelines for more efficient price management are recommended: strengthening *non-price competition* in milk production through the differentiation of dairy products, innovation, quality growth, design and rebranding. In these processes, scientific research, development actions and expert work are of great importance.

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UPRAVLJANJE CIJENAMA U PROIZVODNJI MLIJEKA

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Sažetak

Upravljanje cijenama je dio menadžerskog upravljanja sa svrhom povećanja profitabilnost i konkurentnost. U proizvodnji mlijeka za upravljanje cijenama osnovne su proizvodna i prodajna cijena, čija razlika određuje financijski rezultat poslovanja. Cilj istraživanja je identificirati cjenovne odnose u proizvodnji mlijeka na hrvatskoj i EU razini, prepoznati trendove za razdoblje od 2016. do 2020. i simulirati promjene za naredno razdoblje od 2021. do 2025. godine. Analizirani podatci su preuzeti sa stranica Eurostata te obrađeni pomoću vremenskih i harmoniziranih indeksa.

Proizvodnja mlijeka u EU-27 za 2020. godinu je prosječno 23 mil. tona mlijeka a konzumacija mlijeka po stanovniku u prosjeku iznosi 65 kilograma. Najniža prosječna proizvodna cijena mlijeka, u analiziranom razdoblju na EU-27 razini, je bila u 2016. godini (28 €/100 kg mlijeka) te sljedećih godina iznosi i do 35 €/100 kg. Situacija na tržištu reflektira posljedice ukidanja kvota u mljekarskoj industriji (2015.) te utjecaj pandemije COVID-19 na proizvodnju mlijeka. Za razdoblje od 2021. do 2025. predviđa se blagi rast i usporavanje proizvodnje mlijeka od 2,83% u odnosu na 2020. te povećanje prosječne proizvođačke cijene mlijeka u 2025. za 9,6% u odnosu na 2020. godinu. Ovo istraživanje doprinosi identificiranju izvora poteškoća pri upravljanju cijenama u proizvodnji mlijeka. Razvijene su smjernice za učinkovitije upravljanje cijenama u cilju poboljšanja konkurentnosti i tržišnog pozicioniranja.

Ključne riječi: *upravljanje cijenama; proizvodne i prodajne cijene; volatilnost; proizvodnja mlijeka.*