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MILK PRICES IN THE EUROPEAN UNION BY 2025 AND PROJECTION OF THE PROFITABILITY OF MILK PRODUCTION IN POLAND IN 2020

Aldona SKARŻYNSKA*, Konrad JABŁOŃSKI

Institute of Agricultural and Food Economics, National Research Institute, Warsaw, Poland
*Corresponding author: aldona.skarzynska@ierigz.waw.pl

ABSTRACT

In Europe, more than 70% of milk production falls on the European Union countries. Among the largest milk producers in the EU, Poland ranks fourth. The abolition of quotas for milk production and increase in supply to the market contributed to the decline in milk prices. The aim of the study is to determine the impact of the rate of change in prices of agricultural inputs and changes in milk yield of cows and milk prices on the profitability of milk production in Poland projected for 2020. The sample consisted of 169 farms which in 2014-2015 kept an average of 27 cows. In 2015, the index of the profitability of milk production amounted to 130.7%, and in comparison to 2014 it decreased by 18.4 percentage point. The results projection for 2020 show an improvement in milk yield of cows (by 12.4%) and milk prices (by 15.4%). Stronger growth in the revenues (by 29.1%) than the cost of keeping cows (by 15.5%) will stimulate the improvement of economic results. The index of the profitability of milk production will increase by 15.4 percentage points, and income per cow by 73.3%. This means that it will be at a level similar to 2014. Research shows that fluctuations in selling prices of milk are possible (+/-8.7%). Despite this, the milk production will continue to be profitable. Results of this study are consistent with the projection of the European Commission, which provides for an increase in milk prices and milk production in the EU.

Keywords: *milk production, prices of milk, profitability of milk in 2020, Poland*.

INTRODUCTION

In Poland, the largest share in the commodity structure of agricultural production is held by cow's milk, in 2014 it amounted to 18.8%, while the share of milk in livestock commodity production amounted to 31.7% (Central Statistical Office, 2015). For many agriculturalholdings, it is the most important source of income. Regular income from milk sales is of great importance in order to maintain financial liquidity of the holding. In Poland, for many years, we have been observing the processes of concentration and intensification of milk production. The number of cow rearing holdings and of cowsthemselves is decreasing and increase in milk production is related to an increase in the milk productivity of cows. However, if dairy holdingsare to continue to develop, actions must be

conducted taking into account the specificity of milk production, i.e. high capital- and labour-intensity of production. Resources (e.g. long-term low interest loans) should be allocated for the construction or modernisation of livestock buildings, helping increase the scale of production and make work less difficult. The method of calculating direct payments per hectare of agricultural land, almost regardless of the type of production conducted, maylead to a situation where farmers abandontime-consuming milk production (Parzonko, 2010). According to Ziętara (2002), the profitability of milk production is one of the more complex issues in the economics of agricultural holdings. The reason is the close links between dairy cattle breeding and plant production. To conduct it, the specific size of the holding is required, so are appropriate equipment, extensive knowledge and commitment of the farmer. The functioning of the milk market until 30 March 2015 was subject to regulation of the EU common agricultural policy instruments. Milk quotas were a factor shaping the supply,demand and prices of milk. The abolition of the milk production limits and, consequently, an increase in its supply, contributed to a decline in prices of milk. In the European Union (EU), in December 2015, the average price of milk was EUR 30.47/100 kg and when compared to December 2014 it was lower by 7.9%, and to December 2013 – by 24.2%. On the other hand,the price of milk in Poland in December 2015 was EUR 27.39/100 kg, and when compared to December 2014 it decreased by 8.6%, and to December 2013 – by 26.3% (European Commission, 2016a).

The objective of the studies is to determine how the profitability of milk production in Poland is affected by the rate of change in prices of means of agricultural production, as forecast in the perspective of 2020, and changes in milk yield of cows and prices of milk. The results were presented against a background of changes forecast by 2025 by the European Commission.

MATERIALS AND METHODS

The studies made use of the actual data characterising the activity of livestock production – dairy cows. Those data have been collected and processed according to the rules of the AGROKOSZTY system;the Polish FADN (Farm Accountancy Data Network)database has also been used. The study sample was made of 169 holdings which in 2014 kept dairy cows. Those holdings have been selected by means of purposive sampling from the Polish FADN sample. The empirical data from 2014 were revalued to 2015 in accordance with the change in milk yield and the change in prices of the individual components of the production value and direct and indirect costs. The change indicators applied in revaluations have been calculated using the public statistics data. The results of milk production in 2015 have been adopted as a starting point for drawing up a projection of the profitability of milk production in 2020. The year 2015 has been selected due to a significant decline in the prices of milk (mainly due to the abolition of milk quotas). The structure of the projection is based on extrapolating the selected time series into the future (Skarżyńska, 2014).To each variable describing revenues and costs of milk production the corresponding times series, along with the public

statistics data, have been assigned. Those data covered the period from 1995 to 2015. In order to model the created series and to project their value, the classic trend models have been applied. The trendhas been extracted using the analytical method, i.e. by finding a trend function f(t) (t means time), which best describes the change in the phenomenon over time (Wasilewska, 2011). This approach assumes that the level of the analysed phenomenon is a function of time, and the effect of various factors affecting its coursehas been included in the changes observed over time. The selection of the analytical form of the trend function has been made using a heuristic method. It consists in finding several forms of this function and then selecting one of them according to the criterion applied (Stańko, 1999). Seven functions have been analysed: linear, second degree polynomial (quadratic), exponential, power, logarithmic, hyperbolic and linear-hyperbolic. The trend models created had the following form:

$Y_t = \beta_0 + \beta_1 t + \varepsilon_t$ – linear trend model,

$Y_t = \beta_0 + \beta_1 t + \beta_2 t^2 + \varepsilon_t$ – quadratic (second degree polynomial) trend model,

$Y_t = \beta_0 e^{\beta_1 t} \cdot \varepsilon_t$ – exponential trend model,

$Y_t = \beta_0 (t+2)^{\beta_1} \cdot \varepsilon_t$ – power trend model,

$Y_t = \beta_0 + \beta_1 \ln(t+2) + \varepsilon_t$ – logarithmic trend model,

$Y_t = \beta_0 + \beta_1 \frac{1}{t+2} + \varepsilon_t$ – hyperbolic trend model,

$Y_t = \beta_0 + \beta_1 t + \beta_2 \frac{1}{t+2} + \varepsilon_t$ – linear-hyperbolic trend model,

where:

Y_t – value of the endogenous variable in time*t*,

t – exogenous variable (time), takes integer values from *1*to *n*,

β_0 – absolute term,

β_1, β_2 – slope coefficients of the function,

ε_t – random component.

The parameters of all models have been estimated using the classic method of least squares. For each analysed time series, one trend function has been selected. The selection was made based on the amount of the R^2coefficient of determination and knowledge about the development of the analysed phenomenon over time. The models, in which the parameters were statistically insignificant, have been rejected[1]. On the basis of the selected models, the individual variables have been extrapolated to 2020. In this way, the projection of the economic results of milk production under the average production and price conditions, i.e. arising from the trend, has been obtained. Among the factors determining the profitability of milk production, the milk yield of cows and milk production costs are subject to relatively small changes. The much greater variability is characteristic of the selling price of milk. The variability of the price of milk has beendetermined on the basis of the

[1] The significance of the parameters has been tested using the t-student test, at the significance level of 0.05.

Central Statistical Officedata from the years 1998-2015 using the created trend models. The calculations have been made using the following formula:

$$V = \frac{\sqrt{n^{-1}\sum(Y-\hat{Y})^2}}{\bar{Y}}$$

where:

V – variability of the studied variable,

Y – empirical values of the variable,

$\hat{Y}$ – theoretical values of the variable, resulting from the model,

$\bar{Y}$ – arithmetic mean of the value of the variable,

n – number of observations.

Given the variability of the price of milk, two variants of the projection of the economic results for milk production in 2020 have been drawn up, i.e. with favourableprice conditions of milk (variant A) and with unfavourable conditions (variant B).

RESULTS AND DISCUSSION

Production and prices of cow's milk in the EU – projection by 2025

In Europe, more than 70% of milk production are attributable to the countries of the EU, which when treated as the single market becomes a world leader in milk production (Olszewska, 2015). In 2014, cow's milk production in the EU amounted to 159.6 million tonnes, of which milk produced in the EU-15 countries[2] accounted for 82% of, and in the EU-N13 countries[3]–18%. The largest producers of milk in the EU include Germany, France, Great Britain, Poland, the Netherlands and Italy. Poland is ranked fourth in the EU production of cow's milk, with the share of more than 8% (for comparison, Germany's share is around 20%). The volume of milk production in the EU is very diversified, there are many countries in which it does not exceed 1 million tonnes and others such as e.g. France or Germany, where annual production is about 31 and 25 million tonnes, respectively. In the EU, therefore, only a few countries with a high production potential have a decisive impact on the market situation(European Commission, 2016).

From the data contained in Table 1 it results that by 2025 the EU analysts foresee a systematic increase in milk production, when compared to 2015, on average in the EU by 7.8% (in the EU-15 by 9.0%, while in the EU-N13 by 3.1%). Milk production is a function of two variables – the number of cows and milk yield of cows. The European Commission data indicate that the number of cows in the EU has been decreasing for several years and in 2025 – when compared to 2015 – it will be lower by about 8%, i.e. by 1.8 million head (European Commission, 2016b).Thus, an increase in milk production will take place only due to the milk yield of cows higher

[2] EU 15 – the countries forming the EU before the accession of the new members in 2004, they are: Austria, Belgium, Denmark, Finland, France, Greece, Spain, the Netherlands, Ireland, Luxembourg, Germany, Portugal, Sweden, Great Britain, Italy.

[3] EU-N13 – the countries which joined the EU after 2004, they are: Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Lithuania, Latvia, Malta, Poland, Romania, Slovakia, Slovenia, Hungary.

by 17.6% (in the EU-15 by 14.5%, while in the EU-N13 by 28.5%). On average in the EU, in 2015, when compared to 2014, the price of milk decreased by 18.3% (table 1). It is anticipated, however, that in the next few years, the price of milk will slowly rise. In 2025, it may only insignificantly exceed the level from 2014 (by 0.5%), but when compared to 2015 it may be higher by about 23%. The prices of milk vary among the EU countries. In 2014, the highest monthly prices of milk wererecorded in Cyprus, Malta, Finland, Greece, Sweden, Great Britain, Austria, the Netherlands, Denmark, Ireland, Italy and Germany. On the other hand, the relatively low prices were in Lithuania, Latvia, Romania, Estonia and Poland (European Commission, 2016a).

Table 1. Supply and prices of cows' milk in the EU in 2014-2015 and projection to 2025

Specification	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Total cows' milk production, million t	**159.6**	**161.3**	**162.7**	**163.9**	**165.1**	**166.3**	**167.5**	**168.8**	**170.0**	**171.3**	**172.6**	**173.9**
of which EU-15	130.8	132.2	133.5	134.7	135.8	136.9	138.1	139.3	140.5	141.6	142.8	144.1
of which EU-N13	28.8	29.0	29.2	29.2	29.3	29.3	29.4	29.5	29.6	29.7	29.8	29.9
Milk yield, kg/cow	**6732**	**6806**	**6919**	**7033**	**7149**	**7265**	**7383**	**7504**	**7626**	**7749**	**7874**	**8001**
of which EU-15	7278	7330	7441	7542	7644	7747	7851	7957	8065	8174	8284	8396
of which EU-N13	4914	5028	5130	5263	5401	5541	5685	5832	5984	6140	6299	6463
EU milk producer price, EUR/t	**372**	**304**	**313**	**329**	**323**	**324**	**327**	**336**	**346**	**358**	**367**	**374**

**Source: Own elaboration based onEuropean Commission (2016).*

Profitability of cow's milk production in Poland – projection for 2020

The study sample was 169 farms, which, on average, in the years 2014-2015 kept 27 dairy cows. Their milk yield in 2015 was 6,191 litres and when compared to 2014 it increased by 2.9%. On the other hand, a decrease was recorded in case of: price of milk – 17.0%, income per 1 cow – by38.5%, and per 1 litre of milk by 39.8%. The milk production profitability index (the relationof the production value to direct and indirect costs in total) in 2014 was 149.1% and in 2015 130.7%. The results of milk production in those holdings in 2015 were a starting point for carrying out the projection of changes for 2020.

The projection method used – by extrapolation of the trend observed in the past – allowed determining the expected direction of change both in revenues and in production costs. It is estimated that at the rate of change inthe milk yield foreseen in the perspective of 2020(2.4%) and in the price of milk (2.8-3.2%), we may expect revenues higher by 29.1% (at an annual rate of their increase by 5.1-5.4%). The expected annual increases in revenues in total are estimated at 2.8-3.1%, as a result, in

the year 2020, when compared to 2015 – the costs may be higher by 15.5%[4]. This means that the growth of the production value will be stronger by 13.6 percentage pointsthan the cost increase. In this situation, incomefrom activity per 1 cow will increase by 73.3%, and per 1 litre of milk by 54.2%. It is envisaged that in 2020 the cost of generating the unit of income per 1 cow will decrease by 33.3% (will account for 66.7% of the level from 2015). In contrast, the total costs (direct and indirect in total) of producing 1 litre of milk will increase by 2.8% (Table2).

Among the forecast categories, an important place is occupied by the price. The processes of integration and globalisation are a reason for which the evolution of the prices of agricultural products results not only from the demand and supply relations at home but also from the situation in the global markets and linking with global prices, the impact of the Common Agricultural Policy instruments and even from other conditions. These circumstances suggest that there may be deviations from the level of the price foreseen for 2020 and resulting from the trend. The variant aspect of the projection results in the perspective of 2020 shows the impact of the change in the price of milk resulting from variability over time on the level of income (+/-8.7%). The scope of the presented changes is also affected by the data, which were a starting point for the studies conducted. This means that the presented changes in income and profitability expressed as a relation refer exclusively to the study sample of holdings. Nevertheless, the results obtained give a picture of the situation and its consequences. The objective of the authors was to draw attention to the economic risk whose basis is the price variability.

Table 2. Indicators of changes in the results of milk production in 2015 in relation to 2014 (2014 = 100) and according to the projection in 2020 in relation to 2015 (2015 = 100)

Specification		2015 / 2014	Projection for 2020 of the trend	Variants of the projection for 2020	
				A –favorable	B –unfavorable
Milk yield of cows	l/cow	102.9	112.4	112.4	112.4
Selling price of milk	PLN/liter	83.0	115.4	125.6	106.0
Production value	PLN/cow	86.3	129.1	139.2	119.0
Total cost (direct + indirect)	PLN/cow	98.5	115.5	115.5	115.5
	PLN/liter	95.2	102.8	102.8	102.8
Income from activity	PLN/cow	61.5	173.3	216.4	130.2
	PLN/liter	60.2	154.2	192.5	115.9
Cost production of 1 unit income	PLN/cow	159.7	66.7	53.4	88.7

PLN: Polish Zloty.

**Source: Elaborated based on own studies.*

[4] In the projection model, the invariability of the structure and amount of inputs incurred for keeping dairy cows. This means that the predicted increase in costs results only from the expected change in prices of means of production – based on extrapolation of the trend observed in the past into the future.

The calculations made on the basis of the CSO data showed that over 18 years (1998-2015), the variability of the price of milk in Poland amounted to 8.7%. Taking into account this level of the price variability, deviations from the level of the value of production and income, as foreseen for 2020, have been determined. From the studies it results that the value of production per 1 cow may be subject to fluctuations of +/-10.1%. This means that the increase in relation to 2015 may be 39.2% (favourable variant) or 19.0% (unfavourable variant). On the other hand, income per 1 cow and projected for 2020 may be subject to fluctuations (with the unchanged level of other factors) of +/-43.1%. In the favourable variant, it will be higher than in 2015 by 116.4%, while in the unfavourable variant by only 30.2%(Table2). Fluctuations will also affect the profitability of milk production as a relation of the value of production to the costs incurred for its production. In the analysed holdings, due to an increase or a decrease in the price of milk (by 8.7%), the profitability index in relation to its size resulting from the trend (146.1%) shall decrease or increase by 11.4 percentage points. It will amount to 157.5% or 134.7%. Taking into account the unfavourable variant, it will be lower than in 2014 by 14.4 percentage points, but higher by 4 percentage points when compared to 2015 (Figure 1).

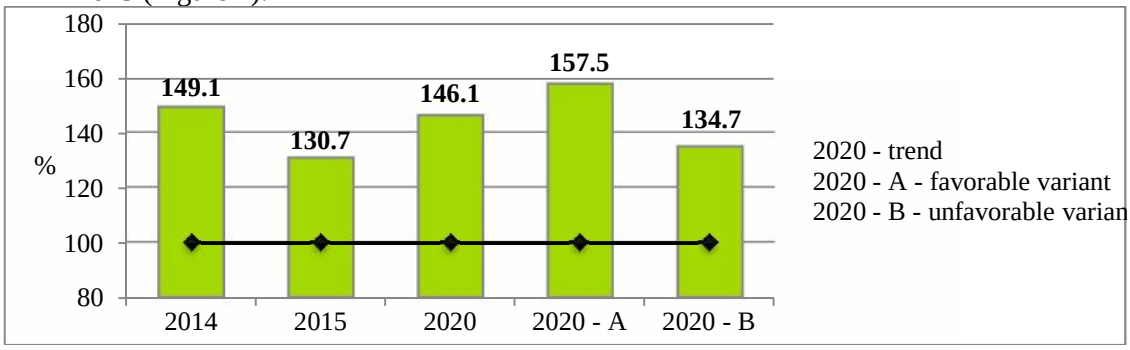

Figure1. Milk production profitability index in the years 2014-2015 and projection for 2020

**Source: Elaborated based on own studies.*

CONCLUSION

By forecasting future events, we are seeking to minimise the risk accompanying the decisions being made. The results of the projection prepared for 2020 in average conditions, i.e. those resulting from the long-term trend indicate an improvement in the milk yield of cows (by 12.4%) and prices of milk (by 15.4%). The stronger growth of revenues (by 29.1%) rather than ofcow maintenance costs (by 15.5%) will stimulate an improvement in economic performance.As a result, the economic efficiency of production will increase by 15.4 percentage points, and income per 1 cow by 73.3%. This means that they will be at a level close to that of 2014. The results of the studies show that within the years there may be fluctuations in the selling price of milk (+/-8.7%), whose consequence will be

fluctuations in income and profitability understood as the relation of the value of production to the costs. Despite these fluctuations, it is estimated that milk production will be profitable, however, in the unfavourable variant the results will be worse than in 2014. The projection of results for 2020 and its variants show the benefits but also potential risks. However, being aware of them is very useful, reduces uncertainty and may contribute to an increase in the accuracy of decisions to be made, and thus to elimination of losses, which could take place in different conditions. The projection of results for milk production in the sample of holdings in Poland is, to some extent, convergent with the EC forecast, which provides for an increase in the price and production of milk in the EU. As a consequence, we should expect also ahigher profitability of milk production.

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