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ENVIRONMENT PROTECTION COSTS IN POLISH DAIRY COOPERATIVES¹

Key words: environmental protection costs, dairy cooperatives in Poland,
scale of purchase and processing, number of dairy products

ABSTRACT. The paper presents problems related to the costs incurred for environmental protection in Polish dairy cooperatives. It was found, *inter alia*, that the costs of environmental protection in this industry sector are high and are rising rapidly. The costs of sewage disposal and treatment are of key importance as they represent the largest share in the total costs of environmental protection, i.e. nearly 95%. In 2018, they amounted to approximately PLN 1.5 million per cooperative, which was almost three times more than in 2004. Other environmental protection costs account for approximately 5% of total environmental protection costs. So, the key to environmental success in dairy cooperatives is rational wastewater management. Therefore, it is advisable for managers to consider building their own wastewater treatment plants with sizes and parameters appropriate to the scale of milk processing and the number of finished product ranges produced. The study also found that the costs of training employees and farmers on environmental protection are low, which may suggest the desirability of increasing them according to real needs, so as to ensure an appropriate level of understanding and persuasion of farmers -shareholders for further investments related to environmental protection. It was also found that the scale of milk processing and the number of manufactured assortments strongly affect the total costs of environmental protection of dairy cooperatives in Poland. Legal requirements regarding environmental protection are so restrictive and economically effective that their omission may lead to increasing financial, management, technological and legal difficulties. Therefore, the compliance of dairy cooperatives with legal environmental requirements is a must, which should generally be assessed positively.

INTRODUCTION

The ability to combine economic goals with growing concern for the state of the natural environment, not only in our surroundings but also in Poland, on continents and in general our planet, including its space coating, is becoming a new paradigm of modern economy. It is high time to understand, respect, take care and put in the effort to look after what is priceless and conditions the duration of our civilization. The essence maybe lies not only in the understanding and declarative verbalization of obvious goals but in real action, here and now, in creative influence on what we have an influence over in each scope. The

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critical point on a mega, macro and micro scale is generally the time and amount of costs incurred, and thus the transition from words to real action and spending money on this purpose. However, actions in this area may result from legal and financial constraints, which generally do not lead to full success. Far better results are achieved when these actions result from understanding and self-acting, especially if the right decisions are taken ahead of time [Juszczuk 2008].

For obvious reasons, socio-economic development cannot do without clearly strengthening the food industry. Poland treats this industry with much the pride, though it continues to be an economic, qualitative, organizational and, most importantly, environmental challenge. The cereal, bakery, meat, dairy as well as fruit and vegetable processing industries have a key position in this industry. However, the durability of raw materials and products is the shortest in the dairy industry. Perhaps because of this, milk processing can severely harm the environment, but it can also be an excellent example – of how to protect it effectively. Until now, economic studies related to environmental protection in the dairy sector have generally been fragmentary. Therefore, the research undertaken is a modest attempt to partially fill this gap [Juszczuk 2004]. The authors, therefore, express the hope that the presented thoughts and conclusions will be useful from a theoretical and application perspective. The authors also thank all representatives of dairy cooperatives in Poland, who, in the course of the research, agreed to share their experience and professional insight on this important global economic problem.

RESEARCH MATERIAL AND METHODS

The aim of the research was to identify the economic and management conditions regarding the costs of environmental protection in dairy cooperatives, related to the changing scale of processing and the number of dairy assortments. The realization of the research goal required conducting literature studies and empirical studies. The research period concerned the years 2004, 2011 and 2018, i.e. from the first year of Poland's membership in the European Union. The research applies to all dairy cooperatives operating in Poland since January 1, 2004, i.e. 214 cooperatives, by selecting a representative sample. In 2004, however, 50 cooperatives were in the process of merging or other significant organizational changes, which is why they were omitted. The remaining 164 cooperatives, i.e. 76.64% of the general population, were ranked in ascending order by the value of total assets and every fourth cooperative was drawn, starting with the cooperative ranked second. In this way, 40 dairy cooperatives were drawn for research. However, complete and reliable data was collected from 32 randomly selected cooperatives. Therefore, the research covered 32 dairy cooperatives continuously operating during the research period, constituting 24.4% of the general population at the end of 2018, as 131 dairy cooperatives operated in Poland in the last year of the research. Source material was primary and secondary data, secondary were:

- financial statements from Monitor Spółdzielczy B,
- mass statistics data on the European Union and Poland,
- statistical data of individual dairy cooperatives,
- materials of the Institute of Agricultural and Food Economics,
- data of the National Audit Association of Dairy Cooperatives.

Primary data included descriptions of the cooperatives surveyed as part of a questionnaire developed by the authors, which was also the basis for an interview with representatives of the management of the cooperatives surveyed. Descriptions and interviews concerned the state and development prospects of dairy cooperatives in Poland, with particular emphasis on economic and management issues related to environmental protection.

The research estimates regression models for the scale of the purchase and processing of milk in a cooperative measured by the value of revenues from the sale of dairy products. The construction of the multiple regression model explaining revenue from the sale of dairy products was as follows [Welfe 2003, Gruszczyński et al. 2003]:

1. Preparation of the model specification:
 - determining the purpose of the study and scope of the dependent variable,
 - determining potential independent variables,
 - initially reducing potential independent variables,
 - selecting the analytical form of the model.
2. Estimation of structural parameters of the model.
3. Statistical verification of constructed models, i.e. the assessment of:
 - the degree of suitability of the model to empirical data using the coefficient of determination,
 - normality of residual component distribution using the Jarque-Bera test,
 - homogeneity of variance of the residual component (heteroscedasticity assessment) using the White test,
 - collinearity of explanatory variables, using the variance inflation factor (VIF).

In accordance with the above procedure, at the first stage, based on a review of the literature and collected data, economic and management indicators, which were potential explanatory variables, were selected [Borkowski et al. 2003]. The selection of explanatory variables resulted from their prevalence in the literature [Zeliaś 1991] and the subjective opinion of the authors. The value of sales of dairy products in the examined cooperatives in PLN thousand was assumed as the explained variable [Juszczak 2014]. Considering the above criteria, the following potential explanatory variables were selected (Table 1).

Total costs of environmental protection were the sum of the following categories:

- cooperative fees for air emissions,
- cooperative fees for exceeding permissible atmospheric pollution standards,
- cooperative fees for exceeding permissible noise standards,
- expenditure on investments related to environmental protection,
- solid waste management costs,
- sewage disposal costs (without the cost of providing water),
- staff training costs in environmental protection,
- farmer training costs in environmental protection (milk suppliers).

From among the designated potential explanatory variables, those that were strongly correlated with the explained variable and weakly correlated with each other were selected [Zeliaś 1991, Borkowski 2003, Wędzki 2005, Mączyńska, Zawadzki 2006, Balina, Pochopień 2012]. The constructed regression models were evaluated using the Student's t-test. In addition, the Fischer-Snedecor test was used to verify the hypothesis regarding the significance and non-randomness of model parameters.

Table 1. Potential explanatory variables for multiple regression models

X1	Total employment [number]
X2	Employment in production [number]
X3	Employment in administration [number]
X4	Employment related to environmental protection [number]
X5	Total sales of dairy products [tonnes]
X6	Purchase of milk [million liters]
X7	Average purchase price of 1 liter of milk from a cooperative member with all derivatives [PLN/liter]
X8	The average amount of milk processed by the cooperative during the day [thousand l]
X9	Cooperative fees for the emission of pollutants into the atmosphere and exceeding the permissible standards of these pollutants and noise [thousand PLN]
X10	Expenditure on investments related to environmental protection [thousand PLN/year]
X11	Solid waste management costs (other than liquid) [thousand PLN/year]
X12	The cost of purchasing cleaning agents and detergents [thousand PLN/year]
X13	Water consumption costs [thousand PLN/year]
X14	Electricity consumption costs
X15	Wastewater disposal costs [thousand PLN/year]
X16	Costs of heat energy from coal, gas and oil [thousand PLN/year]
X17	Staff training costs in environmental protection [thousand PLN/year]
X18	Costs for training farmers in environmental protection [thousand PLN/year]
X19	Financial outlays for innovative activities [thousand PLN/year]
X20	Expenditure on R&D activities [thousand PLN/year]
X21	Number of dairy products
X22	The number of products dynamics (2004 = 100%)
X23	Total environmental costs [thousand PLN/year]
X24	Balance sheet total
X25	Own funds
X26	Total costs

Source: own study

Table 2. Average costs of environmental protection in the examined dairy cooperatives [PLN thousand]

Years	Environmental protection costs						Total
	cooperative fees for the emission of pollutants into the atmosphere and exceeding the permissible standards of these pollutants and noise	solid waste management costs	wastewater disposal costs	staff training costs in environmental protection	farmer training costs in environmental protection (milk suppliers)	other expenses related to environmental protection	
2004	56.65	21.94	476.51	0.07	0.00	2.67	557.84
2011	58.41	24.84	1,433.51	0.29	0.00	0.32	1,517.37
2018	88.21	33.48	2,003.64	0.68	19.24	3.44	2,148.69

Source: own research

FINDINGS

On average, dairy cooperatives in Poland are incurring higher and higher costs of environmental protection and, therefore, the significance of these costs is clearly growing. In 2004, this level was close to PLN 558 thousand and in 2018 it was almost PLN 1,518 thousand. Generally speaking, the costs of environmental protection in this industry sector are high and are also rising rapidly. In addition, wastewater disposal costs are of key importance for two reasons. Firstly, because they represent the largest share in the total costs of environmental protection, e.g. in 2018 they accounted for 94.47% of these costs. Secondly, because their level and importance are growing. In 2004, they amounted to an average of PLN 476.51 thousand and in 2018 already PLN 1,433.51 thousand, so the dynamics were close to 301%. Other environmental protection costs accounted for approximately 5% of total environmental protection costs. Their size is generally increasing, yet moderately.

Therefore, the key to success in the field of environmental protection in dairy cooperatives is rational wastewater management. It seems advisable to consider building own sewage treatment plants with sizes and parameters appropriate to the scale of milk processing and the number of dairy products.

It is worth noting that the costs of training employees and farmers in the field of environmental protection are low and practically insignificant in a managerial sense, which may suggest the desirability of increasing them according to real needs, so as to ensure an appropriate level of understanding and persuading shareholders to further cooperative activities concerning environmental protection. An important and

Table 3. Multiple regression models for the sales value of dairy products [PLN thousand]

Variables	Regression coefficient for a given variable in individual years of the research period		
	2004	2011	2018
constant	-35,517.2	-89,613.90	-20,037.4
X1		789.263	
X6	1,180.20		1,842.83
X7			
X10		-52.158	
X14			0.00461140
X15	0.0160158	-0.0284004	0.00717792
X16			0.00987078
X21	1516.90	114.612	
R ²	0.970694	0.9644	0.993094
JB	66.1519	8.79719	17.4618
χ^2 for JB test	5.99146	5.99146	5.99146
Hypothesis on the normality of residue distribution	confirmed	confirmed	confirmed
T.White	9.48773	12.5916	12.5916
X ² for White test	31.9577	26.5564	31.9502
Hypothesis on the homoscedasticity of model residues	confirmed	confirmed	confirmed
VIF	X6 = 2.288 X ₁₅ = 2.527 X21 = 4.039	X1 = 5.717 X10 = 1.035 X15 = 3.152 X21 = 9.354	X6 = 1.363 X14 = 1.285 X15 = 1.682 X16 = 1.009
Hypothesis about the lack of collinearity of explanatory variables	confirmed	confirmed	confirmed

X1 – total employment [number], X6 – purchase of milk [million liters], X7 – average purchase price of one liter of milk from a cooperative member with all derivatives [PLN/liter], X10 – expenditure on investments related to environmental protection [thousand PLN], X14 – costs of electricity consumption [thousand PLN], X15 – sewage disposal costs [thousand PLN], X16 – costs of thermal energy from coal, gas and oil [thousand PLN], X21 – number of dairy assortments

Source: own research

interesting area of the issue is to recognize the structure of costs incurred for environmental protection in dairy cooperatives. The research shows that the largest share of total costs incurred for environmental protection were the sewage disposal costs, which constituted over 85% in 2004 to over 94% in 2011, while in 2018 this share slightly decreased to 93.25%, which should be assessed positively. It can be assumed that the key to reducing these costs and lowering the unit cost of dairy products in Poland in the face of increasing costs of discharging dairy production wastewater to public treatment plants may be the construction of own sewage treatment plants focused on the biodegradation of water pollution arising in the milk processing process.

The research also drew attention to the factors influencing the increase in the scale of production measured by the value of sales of dairy products achieved by all surveyed dairy cooperatives in 2004, 2011 and 2018. The research, so far, shows that the overriding goal of the enterprise as well as cooperative, can be:

- profit optimization i.e. maximizing it but with an assumed and impassable level of risk,
- a real, stable, and sustainable increase in profit in the long run,
- an increase in the cooperative's market share,
- an increase in the value of cooperatives,
- maximization of benefits for cooperative members, mainly due to the high purchase price of milk.

However, to achieve one or more goals, it is necessary to increase the value of sales. It was, therefore, a matter of determining whether this value was significantly influenced by environmental protection costs and the number of dairy assortments. Therefore, multiple regression models of the value of dairy products sold were constructed in the dairy cooperatives in 2004, 2011 and 2018.

It is worth noting that all constructed models met the conditions imposed by the least squares' method. Namely, they were characterized by a normality of residue distribution, a lack of heteroskedasticity and a lack of collinearity between explanatory variables.

INTERPRETATION OF RESULTS

The value of production and sales in 2004 was influenced by the variability of three factors i.e. milk purchase, sewage disposal costs and the number of dairy assortments. The increase in the purchase of milk at that time by 1 million liters was associated with an increase in the sales value by almost PLN 1,180 million. In addition, an increase in wastewater disposal costs by PLN 1 thousand was associated with an increase in the sales value of only PLN 16, which disproportionately indicates high increases in wastewater disposal costs relative to the increase in economic effects achieved. In addition, at that time, the introduction of one additional assortment of manufactured products resulted in an average increase in the sales value by almost PLN 1,517 million, which is not a big increase.

In 2011, four factors decisively influenced the value of production and sale of dairy products:

- total employment in each cooperative,
- expenditure on investments related to environmental protection,
- sewage disposal costs,
- the number of dairy assortments.

The value of the regression coefficient for the number of assortments proves that increasing this number by one new assortment was associated with an increase in the value of production and sales by just under PLN 115,000. This may mean that practically, in 2011, the Polish market reacted very poorly to a further increase in dairy assortments, and thus new products. This may prove that it has been difficult to achieve a further increase of economic efficiency in Poland since then by increasing the sales value and financial result due to product innovation. Therefore, process and organizational innovations aimed at reducing unit costs may become important. The other two variables at this time are destimulants. And so, an increase in expenditure on investments, related to environmental protection in the cooperative by PLN one thousand, was associated, in 2011, with a decrease in sales by more than PLN 52 thousand. In turn, an increase by the same amount of sewage disposal costs was associated with a decrease in sales by more PLN than 28. Due to the obligatory and restrictive nature of environmental protection requirements, it can be concluded that these restrictions were severe for dairy cooperatives. Probably, also pro-environmental investments of cooperatives were undertaken too late while the costs of wastewater disposal were disproportionately high in relation to the prices of dairy products, and thus the value of sales.

In 2018, the total number of factors decisively influencing the scale of production measured by the sales value remained unchanged, however, the composition of key factors, compared to 2011, changed significantly. In 2018, these variables were:

- purchase volume of milk,
- costs of electricity consumption,
- sewage disposal costs,
- costs of thermal energy from coal, gas and oil.

And so, an increase in the purchase of milk by a dairy cooperative by one million liters was associated, in 2018, with an increase in the sales value of nearly PLN 1,843 million. Importantly, this increase was the highest throughout the entire research period, and may indicate that the added value per 1 liter of raw milk in dairy assortments sold has been growing which should be assessed positively. The econometric model for 2018 also indicates that the increase in electricity costs by PLN one thousand was associated with an increase in the value of sales of PLN only 4.61. In the case of the same increase in costs of sewage disposal and heat energy from coal, gas and oil, the increase in the value of sales of dairy products was PLN 7.18 and PLN 9.87, respectively. Therefore, increasing these costs was economically and managerially unjustified. It can even be considered that these costs were too high at that time and, therefore, there is an urgent need to reduce them clearly. Financial aspects enforce the need for the friendly operation of dairy cooperatives towards the environment.

What is worth emphasizing is that environmental protection requirements are so restrictive and economically effective that bypassing them can lead the dairy cooperative to increasing financial, technological and legal difficulties. Therefore, pro-environmental activities and compliance with legal provisions in this area as well as reducing the costs of electricity and heat as well as those related to the use of the environment seem necessary for many reasons, including legal, economic, management and technological ones.

CONCLUSIONS

The research concerned economic and organizational conditions of environmental protection in dairy cooperatives in Poland. Particular attention was paid to referring these issues to the changing scale of purchase and the number of dairy assortments. Research confirms that this is a complex issue, especially due to the large cost differences associated with various environmental protection activities in the dairy industry. The study included a representative group of dairy cooperatives in Poland. Based on the research, the following conclusions were made.

Economic and organizational activities in the field of environmental protection in dairy cooperatives mainly concern water and sewage management. It is also important to optimize solid waste management, reduce exhaust emissions, odor, dust and noise, as well as protect soil in the cooperative and its impact area. In the total costs incurred for environmental protection, the largest share was noted in the costs of sewage disposal, which constituted over 85% in 2004 to almost 94.5% in 2011, in 2018 this share decreased yet increased in terms of quantity, which should generally be assessed positively. The key to reducing these costs may be the construction of own sewage treatment plants focused on the biodegradation of water pollutants arising in the milk processing process.

In the entire population of studied dairy cooperatives, the number of assortments increased every year. In 2004, it was, on average, over nearly 31 articles. At the end of the period, i.e. in 2018, this number increased to almost 44 but the growth rate of the number of dairy products clearly decreased, suggesting that supply is approaching market saturation in terms of the number of dairy assortments. However, it does not necessarily mean that the product range will not change. Research shows that the introduction of a new product with greater added value will increasingly be associated with the withdrawal of another, less popular and less profitable one. However, increasing the number of attractive and new assortments with increasing added value can be the key to the financial success of a dairy cooperative.

During research, 3 econometric models were constructed explaining the value of sales of dairy products achieved by an average cooperative, separately for each year. All constructed models were characterized by a normality of residue distribution, a lack of heteroskedasticity and a lack of collinearity between explanatory variables. It was found that the value of production and sales in 2004 was connected with three factors, i.e. milk purchase, sewage disposal costs and the number of dairy products. In 2011, four factors decisively influenced the value of production and sales of dairy products. These were: total

employment in each cooperative, expenditure on investments related to environmental protection, costs of sewage disposal and the number of dairy products. In 2018, the factors that had a decisive impact on the scale of production measured by the value of production and sales were: the volume of purchase of milk, the cost of electricity consumption, the cost of sewage disposal and the cost of heat energy from coal, gas and oil.

It has been established that, at present, environmental protection requirements are so restrictive and economically effective that bypassing them may lead the dairy cooperative to increasing financial, management, technological and legal difficulties. Therefore, pro-environmental activities and compliance with legal provisions in this respect as well as increasing expenditure on pro-environmental investments and reducing costs related to the use of the environment is an urgent necessity for dairy cooperatives.

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KOSZTY OCHRONY ŚRODOWISKA W POLSKICH SPÓŁDZIELNIACH MLECZARSKICH

Słowa kluczowe: koszty ochrony środowiska, spółdzielnie mleczarskie w Polsce, skala skupu, liczba asortymentów

ABSTRAKT

W artykule zaprezentowano problem dotyczący kosztów ponoszonych na ochronę środowiska w polskich spółdzielniach mleczarskich. Ustalono m.in., że koszty ochrony środowiska w tym sektorze przemysłu są wysokie, a ponadto szybko rosną. Kluczowe znaczenie mają koszty odprowadzania i oczyszczania ścieków, gdyż stanowią one największy udział w kosztach ogółem ochrony środowiska, tj. około 95%. W 2018 roku wynosiły one średnio na jedną spółdzielnię około 1,5 mln zł i było to prawie trzykrotnie więcej niż w 2004 roku. Pozostałe koszty ochrony środowiska to około 5% kosztów ochrony środowiska ogółem. A zatem kluczem do sukcesu w zakresie ochrony środowiska w spółdzielniach mleczarskich jest racjonalna gospodarka ściekami. W związku z tym, celowe jest rozważenie przez zarządzających budowy własnych oczyszczalni ścieków o rozmiarach i parametrach odpowiednich do skali przetwórstwa mleka i liczby produkowanych asortymentów wyrobów gotowych. W toku badań ustalono również, że koszty szkolenia pracowników i rolników w zakresie ochrony środowiska są niskie, co może sugerować celowość ich zwiększania, stosownie do rzeczywistych potrzeb, tak aby zapewnić właściwy poziom zrozumienia i przekonania rolników spółdzielców do dalszych działań zarządów spółdzielni w zakresie inwestycji związanych z ochroną środowiska. Stwierdzono również, że skala przetwórstwa mleka i liczba wytwarzanych asortymentów silnie oddziałują na koszty ogółem ochrony środowiska spółdzielni mleczarskich w Polsce. Wymogi prawne dotyczące ochrony środowiska są tak restrykcyjne i ekonomicznie skuteczne, że ich pomijanie może doprowadzić spółdzielnię mleczarską do coraz większych trudności finansowych, zarządczych, technologicznych i prawnych. Dlatego przestrzeganie wymogów dotyczących ochrony środowiska jest koniecznością, co ogólnie należy ocenić pozytywnie.

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