

## **The Effectiveness of Family Farms Producing Milk depending on the Scale of Production**

**Anna Borecka, Elżbieta Sowula-Skrzyńska, Anna Szumiec**

*National Research Institute, Animal Production Institute, Faculty of Production Systems and Environment, 32-083 Balice by Krakow*

The main goal of every milk producer is to achieve the greatest possible difference between the production costs and income from the sale of products made on their own farm. It is the difference that determines the profitability of animal production. According to Juchniewicz (1998), Ziętara (2008) and Ziółkowska (2008), the expenditure is the primary factor of the farm profitability. The expenditure analysis is therefore an important element of the farm's operational and financial analysis. It allows determining the optimal decision-making processes. The specialisation of farms in accordance with the potential of their production resources and the right size of production is the development path for the improvement of the farms' competitiveness.

The evaluation of the economic efficiency is usually carried out with the use of an effectiveness measure which, comparing the expenditures of a given object with its results, allows the assessment of the ability of the farm to transform the incurred expenditures into the actual results. However, this formula has only practical significance when a farm achieves one result using only one expenditure type (Czyżewski and Smędzik, 2010).

The application of the DEA (Data Envelopment Analysis) method to determine the technical efficiency of milk production farms is aimed at selecting effective farms and calculating the degree of ineffectiveness of the remaining ones. The technical efficiency is understood as achieving the best effect and, therefore, the most beneficial transformation of the expenditures into effects (Farrell, 1957, Galanopoulos et al., 2006, Kisiełowska, 2005, Prędko, 2003). In addition, this method does not require the determination of the functional relationship between variables and assigning ranks to them (Bezat, 2011, Cwiąkała-Małys and Nowak, 2009, Dybał, 2004). The difference in efficiency is a comparative measure in this method. It is a non-parametric method, and the calculated function can take into account various production technologies, labour intensity, environmental variables, etc. (Rusielik, 1999; Szymańska, 2009).

### **Materials and methods**

The purpose of the research was to determine the economic, production and technical efficiency of farms specialised and focused on milk production. Pursuant to the research, the farms were selected in a targeted manner, focusing on the farms in which revenues from the sale of milk amounted to over 75% in total revenues. The research covered 155 family farms from the Podlasie and Podkarpackie regions in years 2014 -2016. The input material included numerical and descriptive data that originated from the documentation of agricultural farms. The calculation assumes the division of costs into direct and indirect costs. The work focuses primarily on the analysis of direct costs of livestock production which, in fact, reflects the production efficiency of the conducted business operations. Indirect costs are charged to the entire farm as a result of its functioning and, therefore, they are not an indicator of the production efficiency of the livestock.

In order to indicate the differences in the level of expenditures and the obtained production and economic effects, the farms were grouped according to the scale of production. The scale criterion used for milk production was the number of cows held on the farm (group I - up to 25 cows - 55 farms, group II from 26 to 50 cows -49 farms, group III over 51 cows in the herd – 29 farms).

The research results were presented as averages for a given group.

For all the farms, economic efficiency (income from operations and agricultural income) and technical efficiency focused on expenditures, whose aim was to minimise them while maintaining the same results. The DEA (Data Envelopment Analysis) model was used for the calculation of technical efficiency where the following variables were adopted: effects - revenues (PLN) and expenditures - direct costs of animal production (PLN). The application of the DEA method allowed distinguishing effective farms within each group and calculating the degree of ineffectiveness for the remaining ones which, at the same time, gave the scale of the improving efficiency opportunities. The model for farms was constructed based on the following variables:

- 1) the assumed effect: revenues from the sale of milk and animals on the farm,
- 2) the expenditures included the costs of feedstuffs, the costs of feed from purchase, the costs of purchase of animals, the costs of veterinary services, the medicines and inseminations, the costs of energy media directly related to milk production and other costs of milk production.

In the case of expenditure focus, information is obtained as to how much less the effective entity would spend to achieve the same level of performance as the studied entity. In other words, in the model of expenditure focus, ineffective entities can increase their efficiency as a result of the reduction of expenditures.

In the description and comparisons, measures used in economic analyses were applied as well as technical and economic measures and economic categories.

### The results and their discussion

The characteristics of dairy farms are grouped depending on the number of cows in the basic herd. The average area of agricultural land in the analysed farms was 52.84 ha and it was higher than the area of agricultural land per 1 farm in Poland by 42.54 ha (Central Statistical Office (GUS), 2017). Within the farms, the number of cows increased with the increase in the area of agricultural land. The average milk yield per 1 cow was the highest in the group of farms maintaining 26 to 50 cows - it amounted to 7100.74 l and it exceeded by 1537,74 l the average level of milk productivity in individual farms in Poland in 2016 (GUS, 2017). The lowest average yield per 1 piece (5587.61 l) was recorded on farms maintaining up to 25 cows (Tab. 1).

Table 1. General characteristics of farms

Item	Averag	to 25 cows	26–50 cows	over 51 cows
Number of cows (no.)	32,87	18,44	36,86	60,50
Agricultural land area (ha)	52,84	32,02	60,99	82,21
Milk yield (liter)	6383,75	5587,61	7100,74	6930,50
Protein content (%)	3,38	3,41	3,36	3,35
Fat content (%)	4,06	3,94	4,15	4,17
Length of productive life (years)	6,67	7,56	5,79	6,83

Source: own study.

In this group of farms, farmers also achieved the lowest price, i.e. PLN 1.32 per 1 litre of milk. Within the farms producing on a larger scale, the average price of milk was higher by PLN 0.15 per litre (Tab. 2). The animal feed was the dominant item in the structure of direct costs and decided mainly on the profitability of production. In the analysed farms, mainly own feedstuffs was used in feeding. Among the own feedstuffs, the majority of green fodder and hay, hay silage and maize silage

were used. The animal feed from the purchase mainly consisted of post-extraction meal, mineral and fodder additives and dry pulp. The average cost of feed per 1 cow was PLN 3851.53. In the analysed population, the cost of feed was similar and ranged from PLN 3764.45 to PLN 3997.14 per animal (Tab. 2).

The measures of economic efficiency presented in Table 2 indicate that milk production in the studied group of farms was profitable. The highest value of the direct surplus per 1 cow and per 1 litre was achieved by the farms with the largest production scale (PLN 5884.61 and PLN 0.83, respectively). The level of income per 1 cow and 1 litre of milk informs about the unitary profitability of the conducted activity. In the case of income from activities not taking into account the subsidies, the best results were achieved by farms maintaining over 51 cows in the herd (Tab. 2).

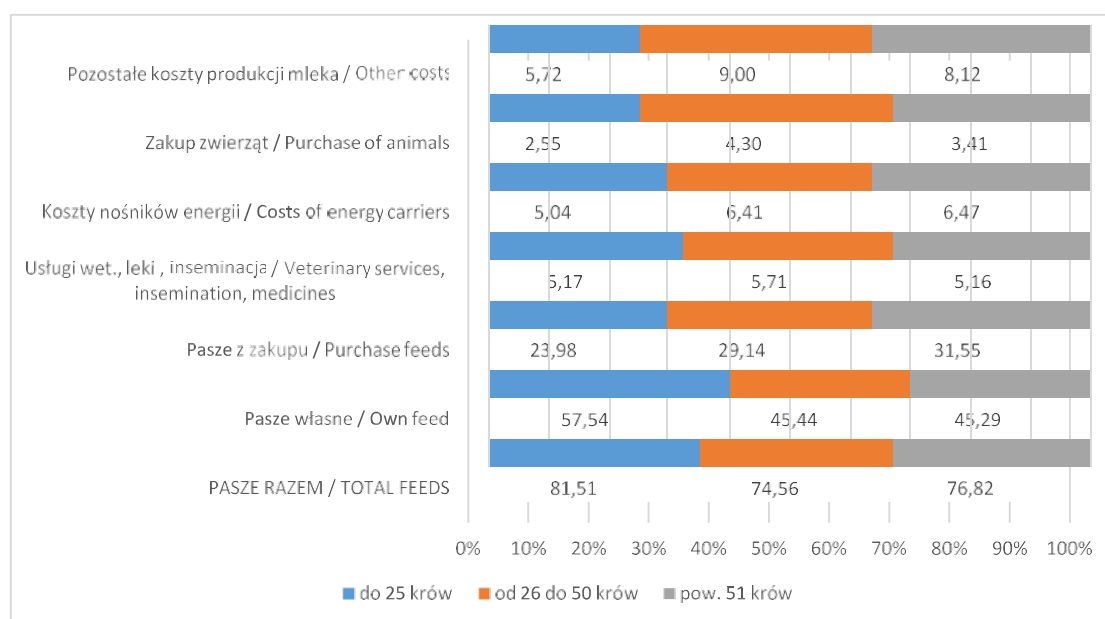
In these facilities, it was recorded at the level of 0.46 PLN/l and was on average higher by 0.15 PLN as compared to farms maintaining up to 25 cows (Tab. 2).

Table 2. Chosen economical indexes of compared dairy farms

<i>Item</i>	<i>Average</i>	<i>to 25 cows</i>	<i>26–50 cows</i>	<i>over 51 cows</i>
<i>Farm area (ha)</i>	52,84	32,02	60,99	80,40
<i>Price of milk (liter)</i>	1,39	1,32	1,43	1,47
<i>Direct costs per cow (cow)</i>	4977,74	4641,24	5370,64	5078,99
<i>Direct costs per liter (liter)</i>	0,76	0,79	0,73	0,76
<i>Feed costs per cow (cow)</i>	3851,53	3764,45	3997,14	3885,72
<i>Feed costs per liter (liter)</i>	0,59	0,64	0,55	0,58
<i>Total costs per liter (liter)</i>	0,94	0,97	0,91	0,94
<i>Gross margin per cow (cow)</i>	5069,31	3892,09	5994,22	5884,61
<i>Gross margin per liter (liter)</i>	0,75	0,66	0,81	0,83
<i>Net income from activity without subsidies (cow)</i>	2792,05	2024,50	3445,16	3347,29
<i>Net income from activity without subsidies (liter)</i>	0,38	0,31	0,44	0,46
<i>Net income from activity with subsidies (cow)</i>	3525,69	2800,32	4120,64	3916,94
<i>Net income from activity with subsidies (liter)</i>	0,51	0,46	0,54	0,55
<i>Net farm income (cow)</i>	3646,90	2953,73	4444,19	3767,28
<i>Net farm income (liter)</i>	0,51	0,45	0,57	0,52
<i>Net farm income (ha)</i>	2742,15	1771,68	3484,33	3535,95

Source: own study

In the structure of direct costs of milk production in all the groups of farms the dominant position was the cost of feed, in particular, own feedstuffs - on average 47.81%. Other significant items of direct costs include, as follows: energy media (6.16%), veterinary services and medicines (5.42%) and other costs of milk production (5.67%) (Figure 1). In the analysis of correlation coefficients (with  $P \leq 0.001$ ), there was a strong correlation between the direct costs of milk production and feed costs ( $r = 0.9819$ ), in particular, those coming from own farms ( $r = 0.9645$ ). The scale of milk production significantly affected direct costs ( $r = 0.8583$ ) while the average number of cows in the herd had a moderate ( $r = 0.4857$ ) impact on the amount of direct costs.



Source: own study.

Fig.1. The structure of direct costs of milk production

Table 3. The result of the DEA analysis for farms producing milk

Production scale	to 25 cows in herd	26–50 cows in herd	above 51 cows in herd
Minimum technical efficiency in the group	0,67	0,86	0,64
Relative efficiency index	63,18%	64,11%	67,78%
Minimum relative efficiency index	43,38%	33,71%	46,62%
Percentage of farms with TE=1	0,2	0,4	0,5
Maximum relative efficiency index	100%	00%	100%

Source: own study. TE, TE\* technical efficiency

The research shows that the total technical efficiency was achieved in 37% of farms. In those that produced milk, the share of effective farms was the lowest in farms that kept up to 25 cows in the basic herd. The percentage of effective holdings was at the level of 0.2 (Tab. 3). This means that in a large part of them the use of expenditure was not optimal. Both the ratio of relative technical efficiency and the percentage of technically effective farms increased with the number of cows kept in the herd.

In the group of the largest objects (over 51 cows), the percentage of technically effective farms was 0.5 while the relative effectiveness rate was 67.78%. The lowest relative effectiveness rate in this group was 46.62% (Tab. 3).

### **Summary and Results**

Determining the economic and technical efficiency of milk producing farms allowed us to specify the following conclusions and statements:

1. An important factor determining the economic efficiency was the scale of production. Its larger size allowed generating higher revenues and at the same time reducing the unit production costs.
2. In the farms focused on milk production, its scale significantly affected direct costs while the average number of cows in the herd had a moderate impact on their level.
3. In the structure of direct costs, the cost of obtaining feed was the dominant item in all the farms covered by the analysis.
4. Owing to the subsidies, the revenues achieved by larger farms increased significantly. In the longer term, however, this may have adverse consequences for the competitive situation of these farms as it may affect the dependence of their income on the mechanisms supporting agricultural income.
5. Farms specialising in milk production and those with a larger production scale revealed a relatively higher degree of technical efficiency, and, therefore, applied manufacturing techniques that ensured them a relatively higher level of production profitability.
6. The applied DEA method allowed determining the amount of the milk production efficiency indicator in the analysed farms. For objects that achieved a low relative efficiency index, there is a more advantageous combination of expenditures and effects that allows taking full advantage of the economies of scale.
7. Based on the research, it can be concluded that not only a larger scale of production affects the higher economic efficiency of farms, but also the technical efficiency is higher in facilities producing on a larger scale. This is probably due to the better management of the farms and a more rational use of expenditures in the production process.

### **Bibliography**

- Bezat A. (2011). Zastosowanie metody DEA w analizie efektywności przedsiębiorstw rolniczych. *Komunikaty, Raporty i Ekspertyza*, Warszawa, nr 545.
- Ćwiąkała-Małys A., Nowak W. (2009). Sposoby klasyfikacji modeli DEA. *Badania operacyjne i decyzje*, 3: 5–18.
- Czyżewski A., Smędzik K. (2010). Efektywność techniczna i środowiskowa gospodarstw rolnych w Polsce według ich typów i klas wielkości w latach 2006–2008. *Rocz. Nauk Roln., Seria G 97 (3)*: 61–71.
- Dybał M. (2004). Ocena efektywności przedsięwzięć gospodarczych za pomocą metody DEA. *Ekonomia* nr 12. Wyd. Uniwersytetu Wrocławskiego, L. Olszewski (red.), Wrocław.
- Farrell M.J. (1957). The measurement of productive efficiency. *J. Royal Statist. Soc.*, vol. 120.
- Galanopoulos K., Aggelopoulos S., Kamenidou I., Mattas K. (2006). Assessing the effects of managerial and production practices on the efficiency of commercial pig farming. *Agricult. Systems*, 88 (2–3): 125–141.
- GUS (2017). *Rolnictwo 2016*, Warszawa.
- Juchniewicz M. (1998). Podstawowe kategorie ekonomiczne stosowane w produkcji rolniczej. W: *Ekonomia i organizacja produkcji rolniczej*, R. Kisiel (red.), Wyd. ART, Olsztyn, ss. 15–44.
- Kisielewska M. (2005). Charakterystyka wybranych metod pomiaru efektywności bazujących na krzywych efektywności. *Zesz. Nauk. AE Wrocław*, 4: 4–6.
- Prędko A. (2003). Analiza efektywności za pomocą metody DEA: Podstawy formalne i ilustracja ekonomiczna.
- Rusielik R. (1999). DEA – zastosowanie w badaniach efektywności spółek AWRSP. W: *Strategiczne modele funkcjonowania spółek hodowlanych Agencji Własności Skarbu Państwa*, Mat. konf., AR Szczecin.
- Szymańska E. (2009). Zastosowanie metody DEA do badania efektywności gospodarstw trzodowych. *J. Agr. Rur. Dev.*, 2 (12): 249–255.
- Ziętara W. (2008). Od gospodarstwa rolnego do przedsiębiorstwa. *Rocz. Nauk. SERiA*, t. 10, z. 3.
- Ziółkowska J. (2008). Efektywność techniczna w gospodarstwach wielkotowarowych. *Studia Monog.*, nr 140, IERiGŻ-PIB, Warszawa.

## **THE EFFECTIVENESS OF FAMILY FARMS PRODUCING MILK DEPENDING ON THE SCALE OF PRODUCTION**

### **Summary**

This study attempted to use the Data Envelopment Analysis (DEA) method to measure effectiveness from the perspective of a farm as an economic unit. The DEA method allowed us to choose efficient farms in the studied group of dairy farms and to calculate the degree of inefficiency of the other farms, which at the same time provided a scale for possible improvement of the efficiency. A total of 155 farms, which derived at least 75% of their income from milk production, were chosen in a targeted way for the study. The economic efficiency and the technical efficiency oriented towards outlays were determined for each farm. The following variables were used to calculate the model: effects – revenue (złoty) and outlays – direct costs of animal production (złoty). The present study, conducted in the group of milk producing farms, showed differences in technical efficiency and in efficiency of scale. A greater scale of production contributes to higher economic efficiency of farms, but also the technical efficiency is higher in larger scale farms. This is probably due to better farm management and more efficient use of the outlays in the production process.

**Key words:** milk production, family farms, production efficiency