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RESEARCH ON PROFIT VARIATION DEPENDING ON MARKETED MILK AND PRODUCTION COST IN DAIRY FARMING

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Abstract

The paper aimed to analyze the effect of marketed milk production and milk production cost on profit in dairy farming in Romania. In this purpose, the data from 10 dairy farms situated in the Southern Romania were collected in the period 2011-2013. The average marketed milk per cow accounted for 5,507 kg with a variation coefficient of 10.90 %. The average milk production cost registered Lei 1.07/kg milk, while the average milk price was Lei 1.23/kg. The average profit coming from marketed milk accounted for Lei 984.89 per cow and yaer with a variation between Lei 2,375/cow/year, the highest level and Lei 314.4/cow/year, the lowest level. The variation coefficient, 69.90 % reflected a large variation from a farm to another. Based on the equation of the regression plan, Z = 1.187 x +11.46 y - 4,262 which assured the minimum residual variance, three variants of simulation were set up. A constant milk production cost, Y= Lei 1.07/kg, and a 100 kg growth of marketed milk could determine Lei 18.7 additonal profit per cow and year. For a constant marketed milk of 5,507 kg, and an increased milk production cost by Lei 0.02/kg has no influence on profit level. When marketed milk increases by 100 kg and milk production cost by Lei 0.02 per kg, farmers' profit could increase by Lei 118.9/cow and year. Marketed milk and milk price have a positive impact on profit, while production cost has a negative impact.

***Key words*:** *income from marketed milk, labor cost, material cost, milk cost, profitability, return*

INTRODUCTION

Economic efficiency in dairy farming is in close relationship with farm size. Small sized farms are not so efficient because they are not able to replace their capital, while larger farms are able to reduce production cost and assure a higher profit [6].

Profit is directly influenced by marketed milk and milk price and, indirectly by milk production cost, according to the formula: $Pr=Q_m(p-c)$, where, Pr= profit, Q_m=marketed milk, p = milk price and c= milk production cost [9].

Marketed milk depends on milk yield per cow and year, the number of dairy cows, total milk production, calves consumption [10].

Milk yield per cow depends on: (a) genetic factors: breed, individuality, cow age, body shape and development, constitution, udder size and shape, temperament, milk production potential, breeding program, the use of frozen semen from high breeding value bulls, and (b) environmental factors such as: feeding, watering, movement, milking, daily program, lactation length, calving interval, age at the 1st calving, cow health, comfort factors: temperature, air humidity, wind currents, weather status, hygiene etc [7].

Milk production cost varies according to the geographical position of the dairy farm, feeding conditions, heifer for replacing the culled cow, artificial insemination service, frozen semen from high value bulls, veterinary services, medicines, depreciation of fixed assets (sheds, equipment etc), electricity, water, fuel and lubricants, land rental, repairs of equipment [14,15]

The three highest cost in a dairy farm are feed costs, replacement costs and labor cost. All these cost items should be kept under control in order to get a higher profit in dairy farming [13]

A study regarding production cost estimates in Romania mentioned that in a farm of 200 dairy cows, for instance, only the annual milking, milk filtering and cooling cost accounted for Euro 210.57/cow/year for 9,150 kg average yield per cow [1].

Another study in a smaller farm of 50 dairy cows producing 500 kg milk/day and spending Lei 190.5 per day for feeding, electricity, water etc and selling milk at Lei 0.95/kg, mentioned that the farmer could get Lei 475 income/day and a profit of Lei 284.5 per farm. This means that the milk yield was 10 kg/cow, milk production cost was Lei 0.381/kg and cost per cow and day accounted for Lei 1.45 per head. This means Lei 5.69 profit/cow/day and Lei 0.56 profit per kg milk [16]

In Romania milk production cost are lower than in other EU countries such as Hungary, Poland and Slovakia [11].

In Romania, an increase by 1,000 kg milk per cow and year from 5,000 to 6,000 kg average milk production could bring an additional variable cost of Lei 767. Therefore, the higher the milk yield, the higher variable cost [8].

Milk price is directly linked to milk quality which has to fulfill the market standards regarding acidity, density, fat percentage, protein percentage, number of somatic cells, number of pathogenic germs. Milk quality depends on cow feeding and season. [17].

Milk price has also a direct influence on profit, because it is important to be higher than milk cost in order to assure a positive financial result. In Romania, milk which meets the quality standards from a microbiological point of view, with 3.2 % fat and 3.7 % protein content was sold at Euro 0.30-0.33 per kg in average in the year 2011 compared to milk price in other EU countries where farmers received Euro 0.33-0.34 per kg milk. Therefore, Romanian farmers received a quite similar milk price at farm gate [12].

Therefore, profit is directly proportional with marketed milk and milk price and inversely proportional with milk production cost.

To increase profit, farmers should grow the amount of milk delivered in the market, improve milk quality and keep under control milk production cost.

In this context, the purpose of this paper was to analyze the relationships between marketed milk, milk production cost and financial result in term of profit using the simple and multiple correlations and regression function, as well as the effect of each factor on profit in dairy farming in Romania.

MATERIALS AND METHODS

In order to carry out this research work, the data were collected from 10 dairy farms situated in the Southern Romania. The data regarding the economic indicators: marketed milk, milk production cost and milk price were picked up for the period 2011-2013 from each farm book-keeping.

The average and variation coefficient were calculated for each indicator accoridng to the formulas:

Average, $A = \frac{X_1 + X_2 + ...X_n}{n}$, (1)

where n = number of years and X= economic indicator (marketed milk, milk production cost, milk price)

Standard Deviation, S, $S = \left(\sqrt{\frac{\sum_{i=1}^{n} (X_i - \overline{X})^2}{n-1}} \right)$ (2)

Variation Coefficient, $V\%_{V_{\%}} = \frac{S}{\overline{X}}$ x 100 (3)

The coefficients of simple linear correlation were estimated using the formula:

$r_{xy} = S_{xy} / S_x \cdot S_y$, calculating the Student variables in order to test the significance of differences as follows:

$t_{xy} = (r_{xy} / \sqrt{1 - r_{xy}^2}) \cdot \sqrt{n-2}$ and the estimated values were compared with the corresponding quantiles for $t_{2.5\ \%}$, $t_{0.5\%}$ and $t_{0.05\%}$ with n-2 degrees of liberty.

The coefficient of the total multiple liner correlation was determined using the formula:

$r_{z.xy} = (\sqrt{r_{xy}^2 + r_{yz}^2 - 2 r_{xy} . r_{xz} . r_{yz}}) / (1 - r_{xy}^2)$

and the partial coefficients of multiple linear correlation were calculated using the formula:

$r_{zx.y} = (r_{xz} - r_{yz} \cdot r_{xy}) / \sqrt{(1 - r_{yz}^2)(1 - r_{xy}^2)}$

The test of significance was carried out by calculating the Fisher variables which were

compared with the quantiles for $F_{5\%}$, $F_{1\%}$, and $F_{0.1\%}$, according to the formula:

$F_x = [r^2_{z.xy}/(1- r^2_{z.xy})]x (n-3)$.

Because the linear regression function between a factor Z and other two factors X and Y is the regression plan having the formula: $Z= ax + by +c$, the parameters a, b, and c were calculated so that the residual variance to have a minimum value (the least square method), according to the formula:

$S^2_{s.xy}=(Z_1 - ax_1 - by_1 - c)+...+(Z_n - ax_n - by_n - c)^2/(n-1)$= minimum.

It results that the partial derivates of $S^2_{s.xy}$ in relation to the parameters a, b, and c should be zero. Therefore, it is created the system of normal equations given below:

$a \Sigma x^2_i + b \Sigma x_i y_i + c \Sigma x_i = \Sigma x_i z_i$

$a \Sigma x_i y_i + b \Sigma y^2_i + c \Sigma y_i = \Sigma y_i z_i$

$a \Sigma x_i + b \Sigma y_i + nc = \Sigma n_i$

This system of normal equations whose unknowns are a, b and c has the following solutions:

$a= r_{zx.y} . S_{z.y}/ S_{x.y}$; $b= r_{z.xy} . S_{z.x}/ S_{y.x}$ and

$c=\overline{z} - a\overline{x} - b\overline{y}$

The formula presented below was used for the confidence strip of the regression plan:

$$S_{\alpha/2} = \sqrt{(n-1)(1-r^2_{z.xy})/n(n-3)}.S_z .t_{\alpha/2}$$

The contribution of the factors x, y to the variation of z were calculated using the formulas:

$A_{(X,Y)}= r^2_{zx.y}$; $A_{(X.Y)}= r^2_{zx.y}(1-r^2_{zy})$

$A_{(y.x)}= r^2_{zy.x}$; $A_{(XY)}= r^2_{zx} + r^2_{zy} - r^2_{z.xy}$

and the contribution of the error:

$A_{(E)}= 1-A_{(X,Y)}$

Based on Z function of profit, three simulations were made considered, one by one, (a)marketed milk as a variable factor and milk production cost as a constant factor, (b) marketed milk as constant factor and milk production cost as a variable factor and (c) both marketed milk and milk production as variable factors. In this way, there were presented the impact of the variation of these two factors on profit coming from marketed milk.

RESULTS AND DISCUSSIONS

The average and the variation coefficients for the studied economic indicators are presented in Table 1.

The average marketed milk per cow in the studied farms accounted for 5,507 kg with a variation coefficient of 10.90 %. Marketed milk varied between 6.250 kg per cow and year, the maximum level and 4,285 kg/cow/year, the minimum level.

The average milk production cost registered Lei 1.07/kg milk, but its value varied between Lei 1.19/kg milk, the highest milk cost and Lei 0.98/kg, the lowest level. The variation coefficient for this indicator was 7.85 %. The cost items with the highest share in the milk production cost were: feeding cost, energy cost, fuel cost, medicines and veterinary services. Feeding cost was on the top position taking into account as a cow consumed about 40 kg forage per day and forage price is enough expensive (hay price=Lei 0.7/kg, maize price = Lei 0.7/kg etc).

The average milk price registered Lei 1.23/kg and varied between Lei 1.4/kg, the highest level and Lei 1.1/kg, the lowest level. Its variation coefficinet accounted for 7.64 %.

The average profit coming from marketed milk/cow/year recorded Lei 984.89 with a variation between Lei 2,375/cow/year, the highest level and Lei 314.4/cow/year, the lowest level. The variation coefficient was 69.90 % reflecting a large variation from a farm to another. The main factor determining this variation was the amount of marketed milk, but also, production cost and milk price at farm gate.

Table 1. Averages and the variation coefficients for the economic indicators

Indicator	MU	$\overline{X}$	S	V%
Marketed milk	Kg/cow/year	5,507	600.59	10.90
Milk production cost	Lei/kg	1.07	0.084	7.85
Milk price	Lei/kg	1.23	0.094	7.64
Profit	Lei/cow/year	984.89	688.504	69.90

Source: Own calculations

Coefficients of simple linear correlation are presented in Table 2. Between the amount of marketed milk and milk production cost it was found a negative and low correlation, r = -0.023. Therefore, these two indicators are not correlated between them, and the estimated

Student value was -0.064 < 2.31, the quantile for $t_{2.5\%}$.

Also between milk production cost and profit from marketd milk, the correlation coefficient was a negative one (r = - 0.376), reflecting that between these two economic indicators there is not a linear correlation. The Student estimated value was -1.145 < 2.31, the quantile for $t_{2.5\%}$.

Between marketed milk and profit from milk sold to processors it was found a strong and position correlation, r = 0.918, highly significant. Therefore, these two economic indicators are strongly correlated, as atested by the estimated Student value 6.537 >0.505, the quantile for $t_{0.05\%}$.

Table 2. Coefficients of simple linear correlation between the economic indicators

Indicator	Milk production cost	Profit from marketed milk
Marketed milk	-0.023	0.918***
Milk production cost	-	-0.376

Source: Own calculations

Coefficients of multiple linear correlation are presented in Table 3.

Table 3. Coefficients of multiple linear correlation between the economic indicators

Correlation type	Coefficient of correlation
Total coefficient of multiple linear correlation between profit from marketed milk/cow/year and the pair of indicators: marketed milk/cow/year x milk production cost	0.984 ***
Partial coefficient of multiple linear correlation between the pair of indicators: profit from marketed milk/cow/year x milk prodfuction cost, considered constant	0.981***
Partial coefficient of multiple linear correlation between the pair of indicators: profit from marketed milk/cow/year x milk prodfuction cost, when marketed milk was considered constant	-0.895

Source: Own calculations

It was found a strong and substantially significant correlation, F =30.50 > 21.69 for $F_{0.1\%}$, between profit coming from marketed milk/cow/year and the pair of economic indicators: marketed milk and milk production cost, as well as between profit from marketed milk and marketed milk/cow/year, when milk production cost was considered constant.

When marketed milk was constant, the partial multiple correlation between profit from marketed milk/cow/year and milk production cost was very low, not significant and of a negative value.

The equation of the regression plan which assured the minimum residual variance was:

Z = 1.187 x +11.46 y - 4,262 having the confidence interval $d_{\alpha/2}$ = 309.40.

The contributions of the variation of the factors marketed milk and milk production cost to the variation of profit from marketed milk/cow/year are given in Table 4. The main factor with a deep influence on profit from marketed milk is the amount of milk sold to processors, because its contribution to the variation of this indicator of economic efficiency was A_X = 82.6 %, under a constant milk production cost.

Table 4. The contributions of the variation of marketed milk and milk production cost to the profit variation

Contribution factor	Contribution %
The total contribution of the pair of economic indicators: marketed milk/cow/year and milk production cost	96.8
The partial contribution of the variation of marketed milk, when milk production cost was considered constant	82.6
The partial contribution of the variation of milk production cost, while marketed milk was considered constant	12.6
The partial contribution ofthe variation of the interraction between marketed milk/cow/year and milk production cost	1.6
The contribution of the error variation	3.2

Source: Own calculations

When marketed milk was considered a fixed factor, milk production cost had a negative influence, but a weak one on profit from marketed milk per cow.

Simulation of the variation of the profit from marketed milk

Taking into account these aspects, it was established by simulation the profit variation depending on marketed milk and milk

production cost, considered one by one, firstly, as variable indicators and then, secondly, as fixed indicators (Table 5).

(a)Considering marketed milk production, X, a variable factor and milk production cost, Y, a constant factor and equal to Lei 1.07/kg milk, the average milk production cost registered by the 10 dairy farms involved in this study, one can notice that a growth of marketed milk by 100 kg could determine an increased profit from milk by Lei 18.7 per cow and year in average from a marketed milk production level to another.

Table 5.Profit variation (Z) depending on marketed milk (X), considered a variable indicator and milk production cost (Y), considered a constant factor

X-Marketed milk, a variable indicator Y-Milk production cost, a constant factor = Lei 1.07/kg	Z=Profit from marketed milk	X-Marketed milk, a variable indicator Y-Milk production cost, a constant factor= Lei 1.07/kg	Z=Profit from marketed milk
4,000	498.26	5,600	2,397.46
4,100	616.96	5,700	2,516.16
4,200	736.66	5,800	2,634.86
4,300	854.36	5,900	2,753.56
4,400	973.06	6,000	2,872.26
4,500	1,091.76	6,100	2,990.96
4,600	1,210.46	6,200	3,109.66
4,700	1,329.16	6,300	3,228.36
4,800	1,447.86	6,400	3,347.06
4,900	1,566.56	6,500	3,465.76
5,000	1,685.26	6,600	3,584.46
5,100	1,803.96	6,700	3,703.16
5,200	1,922.66	6,800	3,821.86
5,300	2,041.36	6,900	3,940.56
5,400	2,160.06	7,000	4,059.26
5,500	2,278.76		

Source: Own calculations

The difference between a farm where a cow gives 7,000 kg marketed milk and a farm where a cow produces 4,000 kg marketed milk, in terms of profit from marketed milk is Lei +3,561 per cow and year. The difference in terms of profit, between the farm where a cow produces 7,000 kg marketed milk and a farm where a cow achieves 5,000 kg marketed milk is Lei +2,374/cow/year. And the additonal profit coming from milk sold to processors got by a farm where a cow produced 7,000 kg marketed milk compared to a farm where a cow produced 6,000 kg marketed milk is Lei +1,187 per cow and year.

Therefore, for an additional amount of 1,000 kg milk marketed to processors, a farmer could get Lei 1,187 additional profit per cow and year.

(b)Considering marketed milk, X, a constant factor and equal to 5,507 kg, the average marketed milk registered by the 10 dairy farms considered in this study and milk production cost, Y, a variable factor, one can notice that a growth by Lei 0.02/ kg production cost can not affect profit level, than in a very low measure, Lei 0.229/cow and year, practically by 0.01 %, which means nothing ((Table 6).

Table 6.Profit variation (Z) depending on marketed milk (X), considered a constant factor and milk production cost (Y), considered a variable factor

X-Marketed milk, a variable indicator Y-Milk production cost, a constant factor =5,507 kg/cow/year	Z=Profit from marketed milk	X-Marketed milk, a variable indicator Y-Milk prodcution cost, a constant factor=5,507 kg/cow/year	Z=Profit from marketed milk
1	2,286.266	1.22	2,288.790
1.02	2,286.498	1.24	2,289.019
1.04	2,286.727	1.26	2,289.248
1.06	2,286.956	1.28	2,289.477
1.08	2,287.185	1.30	2,289.707
1.10	2,287.415	1.32	2,289.936
1.12	2,287.644	1.34	2,290.165
1.14	2,287.873	1.36	2,290.394
1.16	2,288.102	1.38	2,290.623
1.18	2,288.331	1.40	2,290.852
1.20	2,288.561		

Source: Own calculations

(c)Considering marketed milk, X, a variable factor and milk production cost also a variable factor, one can notice that profit could grow by Lei 118.9/cow and year for each 100 kg increase of marketed milk and every additional Lei 0.02 for milk production cost (Table 7).

Table 7.Profit variation (Z) depending on marketed milk (X), considered a variable factor and milk production cost (Y), considered also a variable factor

X-Marketed milk, a variable factor	Y-Milk production cost, a variable factor	Z-Profit from marketed milk	X-Marketed milk, a variable factor	Y-Milk production cost, a variable factor	Z-Profit from marketed milk
4,000	1	497.46	5,600	1.32	2,400.327
4,100	1.02	616.38	5,700	1.34	2,519.256
4,200	1.04	735.31	5,800	1.36	2,522.181
4,300	1.06	854.24	5,900	1.38	2,757.114
4,400	1.08	973.17	6,000	1.40	2,876.044
4,500	1.10	1,092.106	6,100	1.42	2,994.973
4,600	1.12	1,211.035	6,200	1.44	3,113.901
4,700	1.14	1,3289.96	6,300	1.46	3,199.456
4,800	1.16	1,448.89	6,400	1.48	3,351.760
4,900	1.18	1,567.82	6,500	1.50	3,470.69
5,000	1.20	1,686.752	6,600	1.52	3,589.61
5,100	1.22	1,805.681	6,700	1.54	3,708.54
5,200	1.24	1,924.620	6,800	1.56	3,827.47
5,300	1.26	2,043.539	6,900	1.58	3,946.406
5,400	1.28	2,162.468	7,000	1.60	4,065.336
5,500	1.30	2,281.398			

Source: Own calculations

CONCLUSIONS

Marketed milk represents one of the key factors for increasing profit in dairy farms.

At a constant level of milk production cost, Y= Lei 1.07/kg, an 100 kg growth of marketed milk could determine an additonal profit from milk accounting for Lei 18.7 per cow and year in average,

When marketed milk is constant and equal to 5,507 kg,and milk production cost would grow by Lei 0.02/kg, its influence on profit coming from sold milk could be neglected because is very small.

When both marleted milk and milk production cost were variable factors, profit increased by Lei 118.9/cow and year for each 100 kg increase of marketed milk and every additional Lei 0.02 production cost.

The large variety of dairy farms regarding farms size and production potential, feeding and raising conditions it isnot possible to set up a model available for any farm. Howeverm what is impportant for practice is the fact that farmers should peridically analyze production records, production costs and profit in order to identify the favorable factors of influence which could increase their profit. In this respect, it is important to identify and decide which pair of marketed milk and prodcution cost shoudl adopt in order to get a higher and higher profit.

Froma technical point of view, farmers should keep in thier mind that the harminization of all the factors determining marketed milk per cowmis very important for producing a kilogram of milk with lower production costs.

An increased milk yield requires an optimal feeding and selection pressure by high breeding value bulls, besides the selection of the primiparous cows. An increased marketed milk requires an increased average milk and also a reduced milk consumption by calves, but also a higher milk quality.

Farmer should keep under control milk production costs looking for solutions to reduce them as mush as they can in order to balance the relationship between milk cost and milk price in the benefit of a higher profit from marketed milk.

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