

## CALCULATIONS IN MILK PRODUCTION ON FAMILY FARMS

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### Abstract

Milk production in Serbia is mostly practiced by family farms characterised by small herds of cattle, low milk yield per cow, high feed costs, and variable milk quality. Both small and specialised farms housing up to 10 lactating cows are often unable to maintain their cost-effectiveness. A study was conducted on two family farms i.e. farm A and farm B during 2013-2015 to record production data. Total production value, variable costs and contribution margin were calculated. For easy comparison between the farms, results were expressed per lactating cow. The sensitivity analysis of milk yield and farmgate milk prices showed that, at low values, contribution margins were more sensitive to changes in farmgate milk price. Through subsidies and premium payments, family farms maintain the cost-effectiveness of their production. However, small-scale producers are facing the largest threat, given low milk yields per cow and poor milk quality.

**Keywords:** contribution margin, price of milk, sensitivity analysis.

### Introduction

In the Republic of Serbia, almost every fourth agricultural holding is engaged in cattle husbandry, and 156 thousand holdings are involved in cow milk production. Statistical data show that milk production in Serbia is mostly practiced by family farms with an average production capacity of 2.8 lactating cows. Demographic conditions are unfavourable as 56% of livestock units are owned by farmers aged between 55 and 64 years (Popović, 2014). According to data for 2000-2013, the average annual milk production in Serbia was 1.5 billion litres, 60% of which were sold and processed, and the rest consumed and processed on the farm for household purposes. Serbia's surplus in foreign trade was 35.2 million dollars, with Serbia as a net exporter of milk and milk products to neighbouring countries (Veljković et al., 2015). This production was accompanied by a decline in the number of lactating cows, as well as by a gradual reduction in the total milk produced. Milk yield per cow increased to 3,172 litres in 2013, whereas the average yield per cow in 2000-2013 was 2,620 litres (Živković, 2015). Improvement in lactating cow breeds has led to better milk performance, and will expectedly result in a further decline in cow numbers. Milk production on family farms is an important factor in rural development, and is their continuous source of income throughout the year. This production is facing a range of problems, such as unfavourable parity pricing, increases in feed and input prices, low farmgate prices of milk and beef cattle, low production capacity and outdated facilities and equipment (Radivojević et al., 2009). In order to become competitive and achieve production cost-effectiveness, farmers strive to reduce costs, provide high-quality feed, improve feed conversion efficiency (Veljković et al., 2013a), and increase milk quality through appropriate hygiene practices (Veljković et al., 2013b). Farmgate milk prices are dependent on quality standards, and the milk sold should preferably be graded as Extra Grade or First Grade. The volume of milk produced is extremely sensitive to the price paid for raw milk and the premium payments received (Vaško et al., 2012). Milk premium payments as economic incentives of the agrarian policy can substantially encourage or discourage this production.

### Material and methods

The economic analysis of milk production on family farms in the present study involved the use of the calculation method. Gross margin and contribution margin were calculated. Calculations were based on variable costs, and data were analysed by MS Office Excel 2010. The analysis of the contribution margin is used to evaluate farm performance, estimate the current and future economic situation of the farm, and assess its cost-effectiveness and profitability (Grgić and Franić, 2002; Haluška and Rimac, 2005.) In similar studies, the average contribution margins were EUR 681 (Subić et al., 2010), and EUR 515 (Vaško et al., 2012). In the present research, the contribution margins were lower as the analysis covered less successful family farms facing multiple difficulties in milk production. During 2013-2015, milk production was monitored on a number of farms in Kraljevo and Čačak. Data were collected by completing the questionnaires (survey forms) delivered to farm holders. This paper provides economic analyses for two farms, farm A and farm B, covering revenues and variable costs per lactating cow per year. These family farms are traditionally experienced in milk production; they own stables, related equipment and feed production machinery; and engage mostly their family members in farm work.

### Results and discussion

Calculations were used in milk production to determine economic parameters i.e. total revenues and total variable costs, and their difference as the contribution margin. Apart from calculating total revenues and costs for farms A and B, their annual economic performance per lactating cow for the period 2013-2015 was also determined. The subsidy received per lactating cow on each farm was RSD 20,000 in 2013 and 2014, and increased to 25,000 in 2015. In all three years, each farm received a premium payment of RSD 7 per litre of milk, which was a significant economic contribution to the production as these incentives accounted for 20-24% of total farm revenue. Noteworthy when making calculations, as the value of the euro changed relative to the dinar value, the calculation was made using the average exchange rate published by the National Bank of Serbia. Over the three-year period, milk production on farm A was as follows: in 2013, there were 8 lactating cows, with an average milk yield of 3,455 litres per cow per year; in 2014, there were 8 lactating cows, and the average annual milk yield slightly increased to 3,955 litres; in 2015, the number of lactating cows increased to 9, but milk yield was somewhat lower – 3,842 litres per cow per year. Being dependent on the amount of milk sold to dairies, income in 2013 was EUR 889.15 per lactating cow (Tab.1). Milk sales accounted for 49% of total revenue. In 2013, farm A achieved the highest farmgate milk price for the three-year period i.e. 0.3 eurocents (without premium). In total, 23,657 litres of milk were purchased from the farm, and 3,980 litres of milk were used for household purposes and calf diet, thus making up 8% of total revenue. In 2014, the average farmgate milk price decreased by 0.28 eurocents; farm revenue earned from milk sales was EUR 1,018.13 per cow, which accounted for 52% of total revenue. In the same year, farm A achieved the highest revenue and the highest contribution margin for the period surveyed - EUR 401.58 per lactating cow per year (Tab.1), with 29,300 litres of milk sold to a dairy plant, which was a 24% increase compared to the previous year, and 2,660 litres of milk i.e. 5% consumed for farm purposes. Farmgate milk price was the lowest in 2015 i.e. 0.23 eurocents; milk sales were the highest (32,130 litres), but due to the low farmgate price, the revenue earned from milk accounted for 48% of total revenues, whereas incentives made up 24%. The increase in feed costs and the reduction in total revenues led to the lowest contribution margin in this year – EUR 114.93 per lactating cow per year (Tab. 1). The analysis of variable costs during the survey period showed that feed costs accounted for up to 87-88% of total costs for the period. On farm A, to increase milk yield per cow, the amount of concentrate feed used per cow per year was increased. Both concentrate feed and roughage were produced on the farm to make judicious savings. Economic performance in terms of feed costs per cow was better in 2014, whereas the maximum was achieved in 2015 i.e. EUR 1,451 per lactating cow per year (Tab.2).

Table 1. Calculation of contribution margins of milk production on farm A

| Revenue across years and per lactating cow in Euros* | Amount per cow 2013 | %          | Amount per cow 2014 | %          | Amount per cow 2015 | %          |
|--|---------------------|------------|---------------------|------------|---------------------|------------|
| Milk sold to dairies                                 | 889.15              | 49         | 1018.13             | 52         | 832.79              | 48         |
| Milk for household purposes                          | 54.87               | 3          | 50.73               | 3          | 28.38               | 2          |
| Milk for calf diet                                   | 94.71               | 5          | 41.70               | 2          | 34.99               | 2          |
| Calves (aged 10 days)                                | 244.03              | 13         | 244.29              | 12         | 241.61              | 13         |
| Manure   | 179.75              | 10         | 205.33              | 11         | 191.62              | 11         |
| Milk premium   | 180.41              | 10         | 215.97              | 11         | 208.20              | 12         |
| Incentive for high-quality breeding cows             | 174.31              | 10         | 168.48              | 9          | 208.28              | 12         |
| <b>TOTAL REVENUE</b>                                 | <b>1817.23</b>      | <b>100</b> | <b>1944.63</b>      | <b>100</b> | <b>1745.87</b>      | <b>100</b> |
| <b>TOTAL VARIABLE COSTS</b>                          | <b>1471.15</b>      | <b>100</b> | <b>1543.05</b>      | <b>100</b> | <b>1630.94</b>      | <b>100</b> |
| Concentrate feed                                     | 624.85              | 43         | 619.16              | 40         | 743.56              | 45         |
| Roughage   | 667.60              | 45         | 721.08              | 47         | 707.32              | 43         |
| Litter   | 85.89               | 6          | 97.29               | 6          | 74.52               | 5          |
| Veterinary services and drugs                        | 10.89               | 1          | 10.53               | 1          | 12.50               | 1          |
| Insemination   | 21.79               | 1          | 28.43               | 2          | 24.99               | 2          |
| Consumables  | 13.06               | 1          | 12.64               | 1          | 12.50               | 1          |
| Selection costs                                      | 26.15               | 2          | 33.70               | 2          | 33.33               | 2          |
| Electricity  | 20.92               | 1          | 20.22               | 1          | 22.22               | 1          |
| <b>CONTRIBUTION MARGIN</b>                           | <b>346.08</b>       |            | <b>401.58</b>       |            | <b>114.93</b>       |            |

(\*in Euros, official average exchange rate, NBS)

Table 2. Costs expended on concentrate feed and roughage on farm A

| Feed costs per lactating cow in Euros | Amount per cow 2013 | Amount per cow 2014 | Amount per cow 2015 |
|---------------------------------------|---------------------|---------------------|---------------------|
| Concentrate feed                      | 433.15              | 619.16              | 743.56              |
| Meal                                  | 108.90              | 0.00                | 0.00                |
| Maize                                 | 82.80               | 0.00                | 0.00                |
| Total concentrate feeds               | 624.85              | 619.16              | 743.56              |
| Maize silage                          | 188.26              | 291.47              | 279.09              |
| Lucerne                               | 87.15               | 75.82               | 254.94              |
| Hay                                   | 392.19              | 353.79              | 173.29              |
| Total roughage                        | 667.60              | 721.08              | 707.32              |

Based on these calculations, positive gross contribution margins were generated, with 2014 as the economically most favourable year for farm A. Rather than having a positive effect, the economic performance of farms, as presented in Tables 1 and 2, led to the stagnation of milk production. In contrast to farm A, farm B achieved a somewhat higher average milk yield per cow. In 2013, farm B had 7 lactating cows, with 4,955 litres of milk produced per cow per year. In 2014, the number of lactating cows increased to 8, and the average milk yield decreased to 3,703 litres. In 2015, the number of lactating cows remained the same, but the average annual milk yield increased to 4,470 litres. Farmgate milk prices on farm B were somewhat lower for the same period. Milk sales to dairies were highest in 2013 i.e. 31,295 litres at 0.28 eurocents per litre; the lowest amount of milk sold to dairies was in 2014 i.e. 25,000 litres at an average price of 0.25 eurocents; in 2015, the amount of milk sold was 29,500 litres at a farmgate price of as low as 0.22 eurocents, being the lowest farmgate milk price on both farms. As the farmgate milk price decreased over the years, the farm retained substantial amounts of milk for its own purposes, e.g. up to 6,260 litres or 10% of total revenues in 2015. At sufficiently high farmgate milk prices, milk producers are more motivated to sell their milk than to consume and process it on their farms, as was the case with farm B.

Table 3. Calculation of gross margins of milk production on farm B

| Revenue across years and per lactating cow in Euros* | Amount per cow 2013 | %          | Amount per cow 2014 | %          | Amount per cow 2015 | %          |
|--|---------------------|------------|---------------------|------------|---------------------|------------|
| Milk sold to dairies                                 | 1246.84             | 57         | 789.74              | 47         | 798.76              | 45         |
| Milk for household purposes                          | 29.08               | 1          | 57.65               | 3          | 39.53               | 4          |
| Milk for calf feeding                                | 105.98              | 5          | 88.45               | 6          | 129.97              | 6          |
| Calves (aged 10 days)                                | 244.03              | 11         | 235.87              | 14         | 233.28              | 13         |
| Manure   | 123.26              | 6          | 150.05              | 9          | 148.40              | 8          |
| Milk premium   | 272.75              | 12         | 184.27              | 11         | 215.05              | 12         |
| Incentive for high-quality breeding cows             | 174.31              | 8          | 168.48              | 10         | 208.28              | 12         |
| <b>TOTAL REVENUE</b>                                 | <b>2196.25</b>      | <b>100</b> | <b>1674.51</b>      | <b>100</b> | <b>1773.27</b>      | <b>100</b> |
| <b>TOTAL VARIABLE COSTS</b>                          | <b>1521.56</b>      | <b>100</b> | <b>1427.96</b>      | <b>100</b> | <b>1418.90</b>      | <b>100</b> |
| Concentrate feed                                     | 578.96              | 38         | 664.11              | 47         | 364.28              | 26         |
| Roughage   | 764.36              | 50         | 565.77              | 40         | 854.87              | 60         |
| Litter   | 65.44               | 4          | 90.30               | 6          | 74.36               | 5          |
| Veterinary services and drugs                        | 26.15               | 2          | 17.53               | 2          | 41.66               | 3          |
| Insemination   | 21.79               | 2          | 22.43               | 1          | 16.66               | 1          |
| Consumables  | 11.95               | 1          | 12.64               | 1          | 12.50               | 1          |
| Selection cost                                       | 30.50               | 2          | 33.70               | 2          | 33.33               | 2          |
| Electricity  | 22.41               | 1          | 21.48               | 1          | 21.24               | 2          |
| <b>CONTRIBUTION MARGIN</b>                           | <b>674.69</b>       |            | <b>246.5</b>        |            | <b>354.37</b>       |            |

(\*in Euros, official average exchange rate, NBS)

Table 4. Costs expended on concentrate feed and roughage on farm B

| Feed costs per lactating cow in Euros | Amount per cow 2013 | Amount per cow 2014 | Amount per cow 2015 |
|---------------------------------------|---------------------|---------------------|---------------------|
| Concentrate feed                      | 286.30              | 326.69              | 364.28              |
| Maize                                 | 292.66              | 337.4               | 0.00                |
| Total concentrate feeds               | 578.96              | 664.11              | 364.28              |
| Maize silage                          | 278.35              | 439.31              | 657.75              |
| Lucerne                               | 322.47              | 0.00                | 77.98               |
| Hay                                   | 163.54              | 120.46              | 119.14              |
| Total roughage                        | 764.36              | 559.77              | 854.87              |

The highest contribution of milk sales to total revenues was in 2013 (57%), followed by 2014 (47%), and lowest in 2015 (45%). In 2015, subsidies accounted for 24% of total revenues (Tab. 3). The lowest revenues and the lowest contribution margin of EUR 246.5 per lactating cow per year (Tab. 3) were achieved by farm B in 2014. Due to unfavourable economic conditions for milk production, farm B significantly reduced cow feed costs to make savings in concentrate feed and roughage production and ration balancing. Costs of feed for lactating cows were lowest in 2015 i.e. EUR 1,219 per cow per year, with a greater proportion of roughage in the diet (Tab. 4). For easy comparison between farm A and farm B, all values were calculated per lactating cow across years. The farms were similar in production capacity, and had 8 lactating cows on average. In 2013, the farms achieved higher farmgate milk prices than in 2015. The highest contribution margin generated by farm A was in 2014, and that by farm B in 2013. Parity pricing was unfavourable for both farms in 2015. On farm A, the ratio of the farmgate price of a litre of milk to one kilogram of concentrate feed was 0.23 to 0.29 eurocents, whereas the ratio on farm B in 2014 was 0.25 to 0.26 eurocents. In these years, the contribution margins achieved by the farms were the lowest. Based on the calculations of milk production on farms A and B, contribution margins were analysed and a sensitivity analysis was used to indicate determinant factors, primarily farmgate milk price, average milk yield per cow and production costs. The sensitivity of the contribution margin was analysed relative to the change in

farmgate milk price and milk yield per cow. The lowest values of the contribution margins were used: the contribution margin generated in 2015 for farm A, and that achieved in 2014 for farm B.

Table 5. Sensitivity of gross margin to changes in farmgate price and milk yield per cow for farm A in 2015

|                         | Price in Euros per litre of milk |         |         |          |        |        |
|-------------------------|----------------------------------|---------|---------|----------|--------|--------|
|                         |                                  | -20%    | -10%    | Achieved | 10%    | 20%    |
| Milk yield per cow in l |                                  | 0.18    | 0.21    | 0.23     | 0.25   | 0.28   |
| -20%                    | 3073.6                           | -203.19 | -132.49 | -61.80   | 8.89   | 79.58  |
| -10%                    | 3457.8                           | -132.49 | -52.97  | 26.56    | 106.09 | 185.62 |
| Achieved                | 3842.0                           | -61.80  | 26.56   | 114.93   | 203.30 | 291.66 |
| 10%                     | 4226.2                           | 8.89    | 106.09  | 203.30   | 300.50 | 397.70 |
| 20%                     | 4610.4                           | 79.58   | 185.62  | 291.66   | 397.70 | 503.74 |

The sensitivity analysis showed that the low values of the contribution margin were more sensitive to changes in farmgate milk price, as confirmed by farm A. The contribution margin has negative values if farmgate milk price and milk yield per cow decrease by 10 and 20%, respectively (Any decrease in these factors at a low contribution margin leads to its negative value, Tab. 5). As shown by the sensitivity analysis, in the worst case scenario, farm A would suffer a loss of EUR 203 per cow per year or, in a better case, the contribution margin would increase to EUR 504 per cow per year. For farm B, the contribution margin would have negative values if only a single factor decreased by 20%; the contribution margin thus ranging from a loss of EUR 87 to an increase to EUR 654 per cow per year (Tabs. 5 and 6).

Table 6. Sensitivity of gross margin to changes in farmgate price and milk yield per cow for farm B in 2014

|                         | Price in Euros per litre |        |        |          |        |        |
|-------------------------|--------------------------|--------|--------|----------|--------|--------|
|                         |                          | -20%   | -10%   | Achieved | 10%    | 20%    |
| Milk yield per cow in l |                          | 0.20   | 0.23   | 0.25     | 0.28   | 0.30   |
| -20%                    | 2962.4                   | -86.71 | -12.65 | 61.41    | 135.47 | 209.53 |
| -10%                    | 3332.7                   | -12.65 | 70.67  | 153.99   | 237.30 | 320.62 |
| Achieved                | 3703.0                   | 61.41  | 153.99 | 246.56   | 339.14 | 431.71 |
| 10%                     | 4073.3                   | 135.47 | 237.30 | 339.14   | 440.97 | 542.80 |
| 20%                     | 4443.6                   | 209.53 | 320.62 | 431.71   | 542.80 | 653.89 |

While having no effect on the farmgate price, farms should preferably plan their contribution margins through milk yield increases, as any increase in the contribution margin improves farms' resistance to fluctuations in farmgate prices. A combination of factors positively affecting and increasing the contribution margin should be used.

### Conclusions

The analysis of the economic performance of milk production on family farms and low contribution margins show difficulty in maintaining its cost-effectiveness. The decrease in farmgate milk price and the increase in feed costs during the survey period had a negative effect on contribution margins. The annual contribution margins per lactating cow were mostly low, except in favourable years for farm A in 2014 and farm B in 2013. Milk yields achieved per cow are not sufficient to ensure production stability and cover negative economic effects. Milk production on these family farms is largely dependent on subsidies received, notably premium payments per litre of milk and incentives per lactating cow. Without economic support and improvement in milk production, small-scale farms will gradually disappear, and this will adversely affect rural development, leading to rural devastation.

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