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# DETERMINING THE NUMBER OF OCCUPIED PERSONS, NEEDED BY DAIRY CATTLE FARMS IN BULGARIA

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***Abstract***

*The aim of the study is to determine the number of occupied persons, needed by dairy cattle farms in Bulgaria. The information was collected through interview and the number of cows in the main herd, decares of arable land (own and rented) and the number of occupied persons, directly involved in the production process, were analyzed. A regression model was constructed with a confidence level of 95% using the Ordinary Least Squares Method. The regression model is as follows: $L = C_1.A + C_2.D + C + a$, where: L is natural logarithm of the the number of occupied persons, needed by dairy cattle farms; A is natural logarithm of the decares of arable land; D is natural logarithm of the number of dairy cows; $C_1$ and $C_2$ are the coefficients of the independent variables; C is a constant; a is an error of the regression. By replacing the constant and the coefficients with their theoretical values, it is obtained the following model: L = 0.067.A + 0.596.D - 1.386. The number of occupied persons could vary depending on the type of crops, the technology and the intensification of the production process. With the increase in the number of cows in the main herd and the amount of arable land, the number of occupied persons needed also increase. The constant in the regression model is a negative number (-1.386), which could be explained by better utilization of the working time: a major part of the occupied persons can perform activities related to dairy farming, and can also be included in forage production. It could be concluded that for a farm with 20 cows and 20 decares of arable land, the theoretical number of occupied persons is 1.8. A farm with 100 cows and 100 decares of arable land needs an average of 5.3 workers, but the number can vary between 3.8 and 6.8 workers. In a farm with 150 dairy cows and 3,000 decares of arable land needs an average of 8.5 workers. The combination of forage production and dairy cattle production leads to optimization of the number of occupied persons needed.*

***Key words*****:** *dairy cattle breeding, forage production, occupied persons, regression analysis*

## INTRODUCTION

In 2015 Bulgaria produced 1,028,036 tons of cow milk, which accounted for 89.2% of total milk production. The concentration of dairy herds in the country is still low. There were 276.2 thousand dairy cows on 01.11.2015, which was 6.5% less than in 2014. In the last decade there was a steady trend for reduction of the number of dairy cattle farms in which were bred up to 9 animals. At the same time, the number of farms with 20 or more dairy cows steadily rises [5]. The average milk yield of dairy cattle herds in Bulgaria is still unsatisfactory: 3,668 kg in 2013, while the EU-28 average yield of cow's milk was 6,553 kg in 2013 [2].

In recent years major land tenants show interest in investing and establishing animal farms, including dairy cattle farms. The human factor is crucial to the effective functioning of each business unit. This creates the need to analyze the current state of cattle farms in the area of human resources. Taking into account the number of people who are actually engaged in dairy farming and/or in plant production, it could be possible to plan the necessary number of occupied persons when a dairy farm is established or when the number of animals or arable land have been changed. This could be achieved by the methods of the regression analysis. Regression analysis could be applied in dairy farming in order to explore the relations between milk production and number of dairy animals [6], as well as to explore various economic indicators, such as profit and costs [3].

## MATERIALS AND METHODS

*The aim of the study is to determine the number of occupied persons, needed by dairy cattle farms in Bulgaria.* To

achieve the aim, a linear regression model was developed, based on 10 dairy cattle farms in Bulgaria. The information was collected through interview and the number of cows in the main herd, decares of arable land (own and rented) and the number of occupied persons, directly involved in the production process (employees, involved in the cattle farm; employees, involved in crop production, and owners, involved in the working process) were analyzed. The number of occupied persons (expressed as a full-time equivalent), directly involved in the production process represents the number of occupied persons, needed by dairy cattle farms.

In the analyzed farms were bred between 25 and 146 cows in the main herd and the arable land was used for the production of feed: lucerne for the production of lucerne hay; forage corn - one part of which is given to animals in the form of concentrated feed, another part is used for the production of silage and the rest is sold; wheat - part of the production is used to feed the animals (grain and straw) and another part is sold.

Some of the farms grow grain crops such as oats. The ratio between the cultivated crops in the farms varies: some of the farms do not grow alfalfa, others do not grow grain crops. In some farms the own production of forages occupies minimum rate, while in other farms the animals are fed entirely with forages, produced in the farm. Also some farms sell part of its plant production, while others realize revenue only from the sale of animal production. The number of occupied persons employed on farms varies depending on the size of the farm (number of cows and amount of arable land) and production technologies.

A regression model was constructed with a confidence level of 95% using the Ordinary Least Squares Method. The regression model is as follows:

$$L = C_1.A + C_2.D + C + a$$

where:

L – natural logarithm of the the number of occupied persons, needed by dairy cattle farms;

A – natural logarithm of the decares of arable land;

D – natural logarithm of the number of dairy cows;

$C_1$ and $C_2$ – coefficients of the independent variables;

C – constant;

a - error of the regression;

The null hypothesis was tested during the estimation of the parameters. According to the null hypothesis, the regression coefficients corresponding to the variables are equal to zero. The standard error of the regression, the coefficient of determination (R-squared), and Jarque – Bera Test of Normality were calculated.

## RESULTS AND DISCUSSIONS

The probability of acceptance of the null hypothesis (Prob.) in Table 1, is less than 0.05 and each of the estimated coefficients is statistically significantly different from zero [4]. This means that the null hypothesis is rejected. The coefficient of determination (R-squared) is high in value (0.92).

Table 1. Estimation of the parameters of the regression model /Dependent variable – natural logarithm of the the number of occupied persons, needed by dairy cattle farms /L/; N= 10

| Variable | Coefficient | Standard error | t-Statistic (Probability) |
|---|---|---|---|
| A | 0.067 | 0.02 | 3.17 (0.016) |
| D | 0.596 | 0.07 | 8.82 (0.000) |
| C | -1.386 | 0.31 | -4.47 (0.003) |
| R-squared of regression | 0.92 | | |
| Standard error of regression | 0.13 | | |
| Jarque – Bera Test of Normality (Probability) | 0.49 (0.78) | | |
| F-statistic of regression (Probability) | 40.98 (0.0001) | | |

Source: Own calculation.

The probability of Jarque – Bera Test of Normality was higher than 0.05, so we accept the hypothesis that the regression residuals were normally distributed.

Fig. 1 represents the actual and fitted values of number of occupied persons, needed by

dairy cattle farms.

By replacing the constant and the coefficients with their theoretical values, it is obtained the following model (Table 1):

$$L = 0.067.A + 0.596.D - 1.386$$

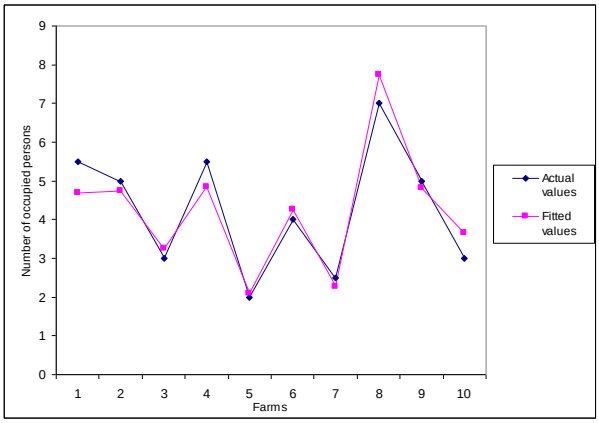


Fig. 1. Actual and fitted values of number of occupied persons, needed by dairy cattle farms

For better presentation of the results of the regression model, in Fig. 2 are shown the theoretical values of the number of occupied persons needed in case of different combinations between the number of cows and decares of arable land (Table 2).

Table 2. Number of cows and decares of arable land

| Case | Number of cows | Arable land /decares/ |
|---|---|---|
| 1 | 13 | 80 |
| 2 | 20 | 20 |
| 3 | 25 | 70 |
| 4 | 30 | 50 |
| 5 | 40 | 100 |
| 6 | 45 | 150 |
| 7 | 50 | 200 |
| 8 | 60 | 500 |
| 9 | 70 | 400 |
| 10 | 70 | 800 |
| 11 | 80 | 100 |
| 12 | 90 | 120 |
| 13 | 100 | 100 |
| 14 | 130 | 150 |
| 15 | 130 | 300 |
| 16 | 150 | 500 |
| 17 | 150 | 1,000 |
| 18 | 150 | 3,000 |

The number of occupied persons could vary depending on the type of crops, the technology and the intensification of the production process.

From Figure 2 could be concluded that for a farm with 20 cows and 20 decares of arable land, the theoretical number of occupied persons is 1.8 with a lower bound of variation of 1.2 and an upper bound of 2.4 occupied persons number; for the farm with 50 cows and 200 decares of arable land, the theoretical number of occupied persons is 3.7 workers with a lower bound of variation of 2.7 workers and an upper bound of 4.7 workers.

Farm with 100 cows and 100 decares of land needs an average of 5.3 workers, but the number can vary between 3.8 and 6.8 workers.

With the increase of farm size, the standard error also increases, leading to a wider range between the minimum and maximum number of occupied persons needed. In a farm with 150 dairy cows and 3,000 decares of arable land needs an average of 8.5 workers, the minimum number of occupied persons is 5.7 and the maximum - 11.3, which is almost 2 times more than the minimum number. The wide range of variation can be explained by the specific technological solutions, type of crops, specific characteristics of the production process and the level of management in the particular farm.

With the increase of farm size, the possible technological solutions, related to milking, cleaning, feeding and reproduction of animals, forage production and storage also increase.

Dairy cattle farms in Bulgaria in 2011, on average had 13 dairy cows and 80 decares forage areas and the average number of occupied persons was 2.18 [1].

When replace that number of cows and decares in the regression, the results are: the average number of occupied persons is 1.5; the minimum number of occupied persons is 1.0 and the maximum - 2.1 (Table 2 and Fig. 2).

The maximum value from the regression is quite similar to the reported data [1] (2.1 vs 2.18).

For comparison according to the same report [1], in 2011 dairy cattle farms in EU-27 on average had 29 dairy cows and 290 decares forage areas and the average number of occupied persons was 1.82.

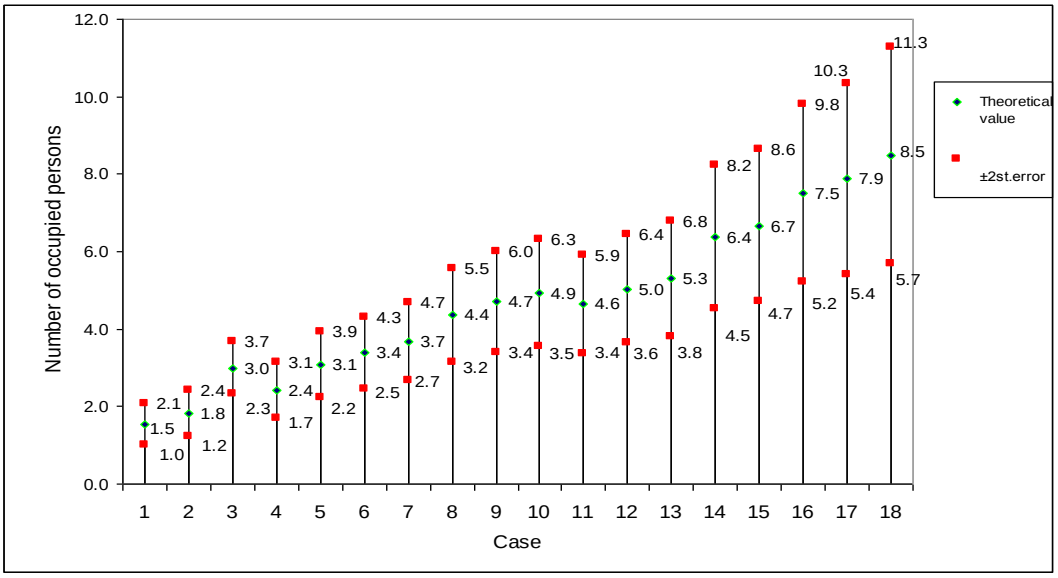


Fig. 2. Theoretical values of the number of occupied persons needed

For Denmark these indicators were: 142 dairy cows, 1,020 decares and 2.38 persons; for Poland: 16 dairy cows, 130 decares and 1.91 persons; for Slovakia: 217 dairy cows, 7,880 decares and 29.57 persons; for Romania: 4 dairy cows, 20 decares and 1.34 persons.

Profitability depends on labour costs and optimization of occupied persons' number in dairy cattle farms. According to some authors [7], labour costs comprises 14,97% from the total costs in a dairy cattle farm in Bulgaria.

With the increase in the number of cows in the main herd and the amount of arable land, the number of occupied persons needed also increase. The constant in the regression model is a negative number (-1.386), which could be explained by better utilization of the working time: a major part of the occupied persons can perform activities related to dairy farming, and can also be included in forage production.

The combination of forage production and dairy cattle production leads to optimization of the number of occupied persons needed.

## CONCLUSIONS

It could be concluded that for a farm with 20 cows and 20 decares of arable land, the theoretical number of occupied persons is 1.8. A farm with 100 cows and 100 decares of arable land needs an average of 5.3 workers, but the number can vary between 3.8 and 6.8 workers. In a farm with 150 dairy cows and 3,000 decares of arable land needs an average of 8.5 workers.

The combination of forage production and dairy cattle production leads to better utilization of the working time and optimization of the number of occupied persons needed.

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