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TÍTULO: Análisis marginal y gestión de costos en servicios veterinarios para ganado.

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RESUMEN: De acuerdo con los datos masivos de la empresa agrícola modelo que lleva a cabo la cría intensiva de ganado lechero, se establece que entre los costos de llevar a cabo acciones veterinarias y el rendimiento del ganado, existe una conexión cercana determinada por el valor alto (significativo) del coeficiente de correlación. Este valor puede considerarse como un producto previo de medidas veterinarias. Su comparación con el ingreso máximo de la venta de leche permitió establecer el valor óptimo para los costos empresariales de las medidas veterinarias, que es un 40% más alto que la implementación real.

PALABRAS CLAVES: Análisis de márgenes, desarrollo sostenible de la cría de ganado lechero, optimización de costos, costos de atención veterinaria.

TITLE: Marginal analysis and cost management in veterinary services for livestock.

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ABSTRACT: According to mass data of the model agricultural enterprise conducting intensive dairy cattle breeding, it is established that between costs of carrying out veterinary actions and a livestock yield there is a close connection determined by high (significant) value of correlation coefficient. This value can be considered as a pre-product of veterinary measures. Comparison of it with the maximum income from the sale of milk allowed to establish the optimal value for the enterprise costs of veterinary measures, which is 40% higher than the actual implementation.

KEY WORDS: Margin analysis, sustainable development of dairy cattle breeding, cost optimization, veterinary care costs.

INTRODUCTION.

High-intensive dairy breeding development sustainability can be reduced by the fact that high-producing cattle are exposed to the risk of various diseases to the fullest extent This is due to the fact that the animal's body works at the maximum work rate. A heavy-milking cow on intensive feeding is generally used no longer than three lactations.

Among the diseases of high-producing cattle, the most common are ketosis, acidosis, laminitis, etc. This is often due to the fact that, in order to achieve high productivity, the feeding diet consists up to 70% of concentrated fodder. Heavy-milking cattle are particularly at risk of disease in the second phase of the dry period and at the beginning of the lactation, as the need for glucose during these periods is met by increased concentrates content in the feed (Barashkin, 2014).

One of the most common diseases is cow rumen acidosis. According to individual scientists, about 50% of high-producing cattle suffer from a latent form of acidosis (Donnik, 2009). According to the same studies, this disease alone results in the loss of more than 1200 kg of milk per cow yearly.

High concentration of cattle adjusts the way to keep the cattle when they are not grazed, resulting in a lack of insolation, physical inactivity, and related diseases. There is a change in the type of feeding with increased proportion and quantity of concentrates and silage in the diet, at the expense of root crops and haylage.

A number of scientists have noted the decrease in milk-yield among heavy-milking cows two weeks before and 3 weeks after a hoof disease was discovered (Warnick, e al. 1998). A number of researchers have noted a decrease in milk-yield four months before a hoof disease is detected. The daily loss in cow's milk-yield as a result of the hoof disease varies from 0.8 to 2.8 kilograms (Hernandez, e al. 2002, Rajala-Schultz, et al. 1999). This makes up from 300 to 400 kg per cow for lactation. In addition to the apparent loss, cow lameness also influences the increase in the cost of labor and veterinary activities, as well as the decline in the birth rate of cows (Bicalho, et al. 2007).

The cows suffering from limb diseases are 3.5 times more exposed to the risk of ovarian diseases (Garbarino, et al. 2004). The cows suffering from limb diseases tend to rest much more, what leads to malnutrition. This also leads to the long-term exposure of pathogenic microflora to the outer cover of animals provoking mastitis (Sharma and Rajput, 2017).

In the case of high-intensive dairy cattle breeding, a good physiological condition of a cow is not a goal the enterprise is interested in; however, research shows that lameness is common among high-producing cattle (Deluyker, et al. 1991). Cow lameness increases particularly in the autumn-spring period at increased humidity, and especially in the housing type of cattle, the way most of the high-producing cattle are kept.

This research was conducted to support methodological tools for determining the optimum cost of veterinary activities for a dairy herd, thereby increasing the sustainable milk production and increasing competitiveness of an agricultural enterprise. To that end, it was suggested to use a well-known method in the economics called marginal analysis. However, in order to use this method, it is necessary to extract from the amount of milk received the quantity that has been obtained as a result of veterinary activities. In this regard, the authors were asked to use the dependence regression equation coefficients of the milk yield amount on the amount of money to be used to carry out veterinary activities.

DEVELOPMENT.

Methods.

A method of marginal analysis has been applied to determine the optimum cost of veterinary activities. This method involves calculating and comparing the marginal cost of the product (milk) production and value of the marginal product.

Marginal cost (MC) is an additional cost incurred by an enterprise to produce an additional unit of product. In this case, the cost of veterinary activities is considered. According to a multitude of studies, the timely implementation of cattle diseases preventive measures, as well as the direct treatment of already sick cattle, significantly increase animal productivity; that means, that increasing the cattle productivity, i.e. the production of additional amounts of milk, is a marginal (additional) product (MP_f – marginal product) of a particular factor (in this case, this is the cost of veterinary activities), provided that the number of other factors is unchanged (Mitev, et al. 2012; De Velazco, 2018).

The value (price) expression of the production factor marginal product is the marginal revenue from the production factor – MR_f (marginal revenue). In perfect competition, marginal revenue from the sale of a unit of goods equals (MR_{f1})the price of the goods (P):

$$MR_{f1} = P \quad (1)$$

The marginal revenue of the production factor is calculated according to the formula (2):

$$MR_f = P * Q_f \quad (2)$$

where Q_f is the number of products (milk) resulting from the use of f factor (in this case this is veterinary activities)?

After having achieved a certain amount of production with a constant number of other factors, the marginal product of the variable factor of production is reduced. This is a consequence of the well-known economic law of the decreasing effect of the production factor, which implies the following: with the constant number of factors, each subsequent unit of this production factor is characterized by the lesser impact.

To the cost level at which the rate of cost increase overtakes the rate of output increase caused by this cost, the enterprise should continue to increase this cost (cost of veterinary activities), which will lead to increased profits. If the rate of increase in veterinarian interventions cost is higher than the increase in the cattle productivity caused by it, the cost of veterinary activities becomes inefficient. Thus, the best value will be the cost level at which the marginal revenue from the production factor use (MR) is equal to the marginal cost of the production factor (MC_f):

$$MR_f = MC_f \quad (3)$$

To separate from the entire number of products (milk) produced the amount to be obtained through veterinary activities (Q_f)) is methodically difficult. To this end, it is proposed to use the correlation regression equation coefficient between the value of milk yield (Y) and the veterinary activities cost (X). In a linear constraint, this equation looks the following way: Y=a+bX. The coefficient b from the regression equation shows the average increase in cattle productivity, with an increase in the veterinary activities cost per one unit (per RUB th.), with other conditions being equal and with a

certain amount of cost value (b =Q_f). The regression model can have not only a linear form. The basis to choosing a regression model will be the value of approximation.

Results.

Use of the methods presented above helped receive the results, which were tested in the AO Agrofirma Dmitrova Gora located in the Tver region of the Russian Federation. In the farm unit stated above, the morbidity rate of cows is high, as the biological capabilities of the cows' bodies are used at full capacity and the cows are not used for more than three lactations. Digestive diseases are the leading ones (Table 1). This is due to the fact that the diet of high-producing cattle contains a high proportion of concentrates.

Table 1 – The dynamics in the number of cow diseases by the sources in AO Agrofirma Dmitrova Gora.

Cow Organs Diseases	2014	2015	2016
Limbs, spec.	408	132	204
Reproductive bodies, spec.	275	337	192
Digestive organs, spec.	835	1759	1980
Udder (mastitis), spec.	266	311	294
Total	3798	4554	4686

That is why timely delivery of preventive and curative interventions is an important point to improve the dairy cattle efficiency. Since these activities cost at a high price, an important subject of scientific research is to find an optimal cost of veterinary activities. In AO Agrofirma Dmitrova Gora, the cost of veterinary activities is increasing from year to year (Figure 1).

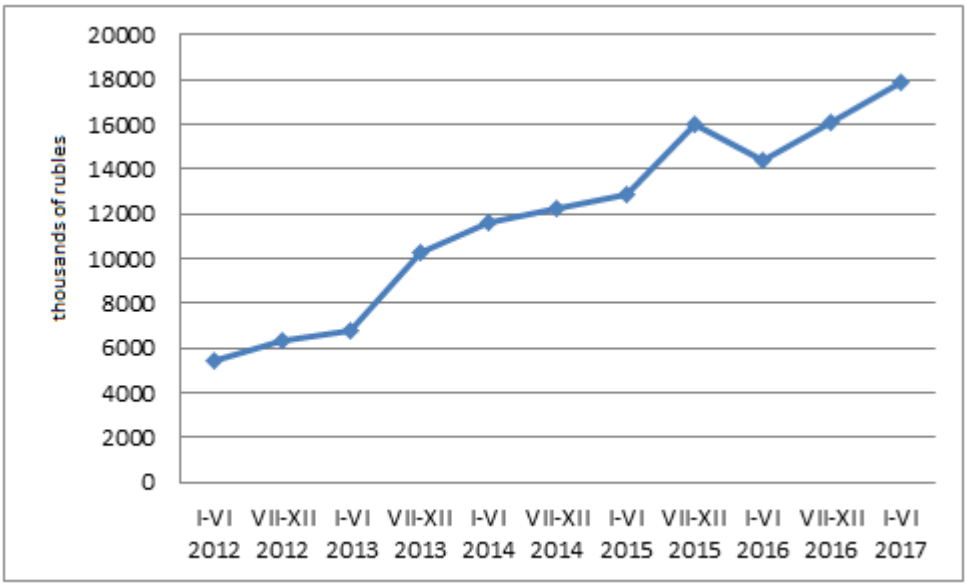

Figure 1 – The cost of veterinary activities behavior in AO Agrofirma Dmitrova Gora

The bulk of the cost of veterinary activities is the veterinary cost (58%) (Figure 2).

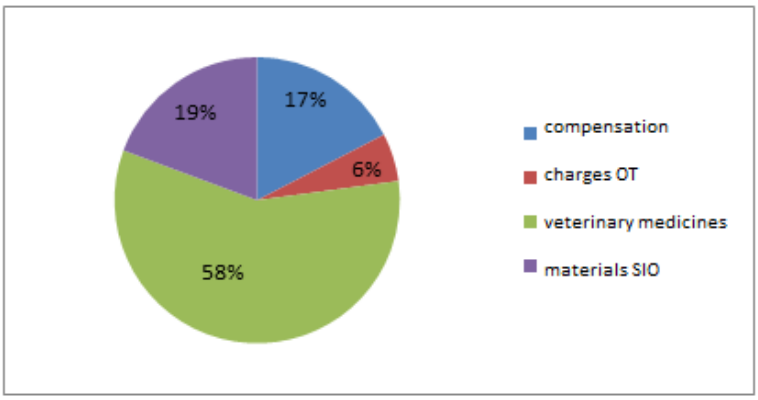

Figure 2 – Cost for veterinary activities structure in AO Agrofirma Dmitrova Gora, 2016.

To determine the value of the cattle milk yield obtained as a result of veterinary activities, the milk yield dependence on the cost of veterinary activities regression equation is calculated according to the data in Table 2. To even inflation effects, the actual prices were adjusted to a common basis – 2017.

Table 2 – The cost of veterinary activities and the milk yield per a forage-fed cow in AO Agrofirma Dmitrova Gora *

Period	Cost of veterinary activities per 1 forage-fed cow, RUB th.	Cost of veterinary activities per 1 forage-fed cow at comparable prices in 2017, RUB th.	Milk yield per forage-fed cow for a period, L.
1st half-year of 2012	1.446	2.214	3,782
2nd half-year of 2012	1.561	2.390	4,072
1st half-year of 2013	1.564	2.246	4,349
2nd half-year of 2013	2.357	3.385	4,351
1st half-year of 2014	2.678	3.611	4,327
2nd half-year of 2014	2.656	3.581	4,592
1st half-year of 2015	2.733	3.307	4,693
2nd half-year of 2015	3.576	4.327	4,476
1st half-year of 2016	3.078	3.299	4,660
2nd half-year of 2016	3.531	3.786	4,550
1st half-year of 2017	3.834	3.834	4,652

Figure 3 shows the regression between the cost of veterinary activities and milk yield of cattle in AO Agrofirma Dmitrova Gora at comparable prices in 2017.

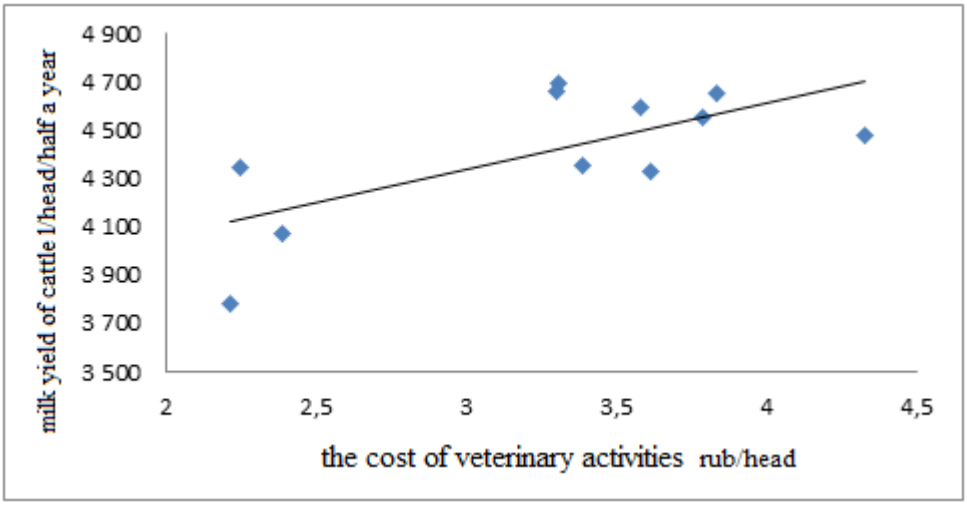

Figure 3 – regression between cost of veterinary activities (comparable prices in 2017) and milk yield of cattle in AO Agrofirma Dmitrova Gora.

In the result, the following regression equation has been obtained:

$Y=3508,6+275,4X$.

According to the mass data, there is a close correlation between the cost of veterinary activities and milk yield of cattle, the correlation coefficient equals to 0.687. This value is significant. The coefficient in the unknown X of this regression equation can be interpreted as follows: as the cost of veterinary activities rises by one unit (per RUB th./spec./half-year), the milk yield per one species rises by 275.4 L/half-year on average (Q_f).

This value can be considered as a marginal product (MP_f) from the "cost of veterinary activities" factor. The marginal revenue (MR_f) from this factor of production is calculated by the following formula: the product produced multiplied by the price of its implementation (22 RUB/L). That is, the marginal revenue from the unit of this factor equals 6058.8 RUB/species/half-year or 12117.6 RUB/species/year. Consequently, the optimum cost of veterinary activities (at other conditions remained unchanged) equals 12117.6 RUB/species/year. This figure exceeds the actual data stated in the Table 2. That means, that the farm unit has a certain potential for increasing the cattle productivity, with increased cost of veterinary activities.

Summary.

It follows from the study that high-producing cattle are exposed to the risk of diseases to the fullest extent that leads to loss of milk yield of cattle. Veterinary activities execution favors the sustainable growth of milk yield of cattle, which will ensure the sustainable development of an agricultural enterprise. In order to develop a strategy to optimize the cost of veterinary activities, a method of marginal analysis can be applied, which implies marginal revenue to be equal to marginal cost. Regression equation factors can be used to determine the value of the marginal revenue from veterinary activities.

CONCLUSIONS.

Fixing the optimum cost of veterinary activities will reduce the milk unit production cost and thus improve the economic efficiency of milk production.

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