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Research Article

Efficiency Improvement of Dairy Husbandry with Application of Milking Robotics

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ABSTRACT.

The relevance of the research topic is determined by the need to determine the effectiveness of the milking robotics application, since this issue has not been sufficiently studied. The article identifies the specific effects that arise when using milking robotics in comparison with traditional milking technology. The analysis of efficiency indicators was carried out in agricultural organizations, which received stable results of simultaneous application of robotics and milking in a long milk pipeline. It is established that the use of robotics in the milk production contributes to the overall increase in milk production at 90.5 centners, or 181.1 thousand rubles per year in value terms, and decrease in the cost of milk, taking into account emerging effects, from 1807 rubles per centner to 1678 rubles per center. The main effects associated with the use of robotics are to save the payroll, increase the quality of milk, increase productivity on 5.2% compared to traditional milking technology. In addition, there is an increase in the marketability of milk on 1-2% due to earlier detection and treatment of mastitis, and decrease in feed costs on 6%. The effect of saving feed is 134950 rubles per robot. At the same time, robotic milking leads to increasing in depreciation charges, although they do not affect direct cash flow, and the cost of third-party services for servicing the robot. Without taking into account the costs of depreciation, milking robotics are much more effective than traditional milking technology.

Keywords: milking robotics, agricultural robotics, efficiency of robotics.

1. INTRODUCTION

The growth of the quality of life and living standards of the population, the arrival of foreign companies on the domestic market exacerbate competition in the food market and cause the region's agricultural organizations to improve technological processes in the direction of reducing the cost of production, improving its quality [1], seeking new development principles, induce to increase the rate of production.At the same time, regional agricultural organizations function in conditions of acute shortage of personnel [2], low labor attractiveness in the industry, negative demography in rural areas [3]. In these circumstances, is important to acquire innovations and innovative technology [4], save labor resources and increase the creative component of labor in agriculture.These conditions put the agricultural organizations before the alternative of choosing the application of various labor-saving technologies [5], among which one can distinguish:

- technical systems not related to robotics, or traditional. In agriculture, they include mechanization, which has been developing since the XIX century. The production of the main grain crops is highly mechanized and equipped with a complex of different machines for tillage, crop cultivation and harvesting. In husbandry, livestock-breeding complexes of industrial type in pigs, poultry and dairy cattle breeding have been identified, which do not require significant employment of labor.

- Agricultural robotics [6]. An example of intelligent robotics can serve robots in animal husbandry, used for milking, manure cleaning, shearing, etc. [7]

The agricultural organizations of the Sverdlovsk region are rapidly introducing robotics, the total number of installed robots for the period 2015-2017 was 22 units with a total investment of more than 200 million rubles.So far, the degree of penetration and effects of robotic innovations have been little studied [8]. Some domestic and foreign studies have shown that, from a purely economic point of view, the use of milking robotics is not advisable because of the high capital intensity [9, 10]. In particular, research in a number of European countries calls into question the feasibility of investing in milking robotics (AMS), if the released labor of farm owners is not used in other profitable activities.

2. CHARACTERISTICS OF THE RESEARCH METHODOLOGY.

In these conditions, it is becoming important to study the effectiveness of using milking robotics in comparison with traditional milking technology by agricultural organizations in the region, determining the main emerging effects and their ranking (sensitivity), and developing practical recommendations for commodity producers.Traditional technology is milking in a milk pipe with a tied animal housing the usual number of livestock on a standard farm of 200 heads. On a farm with robotics, there are 130 heads kept loafing, while the load per one milking robot is 65 heads. In the calculations, the values used were calculated for 65 heads.The study was conducted in 5 business entities, or in 100% of regional agricultural organizations, which received sustainable results with a total of 9 robots used.The efficiency of using milking robotics is the ratio of the obtained effect, characterized by the absolute size of the increase in the production of gross output, the increase in its quality, the reduction in the use of labor resources in comparison with traditional production technology and costs for robotics, which include the purchase, installation, and the cost of third-party servicing.To determine the effectiveness of milking robotics, in comparison with traditional technology, were summarized the results of the work of the organizations KFK Shishkin A.A., PSKKolos, SPK Glinsky, OOO Nikolskoye, OOO RusVelikaya of the Sverdlovsk Region. The remaining organizations do not yet have stable results of milking robotics, since they worked less than the established time.The calculation of the efficiency of using milking robots is based on the determination of all the particular effects that arise when using this equipment in comparison with traditional technology with milking in a long milk pipe.The use of milking robotics in the region is accompanied by an increase in productivity, an increase in the quality of milk, the release of workers, a more rational use of feeds, while increasing costs for depreciation and maintenance compared with traditional production technology.

Taking into account the available results, the effect from the use of milking robotics (Edr) can be calculated using the following formula:

$$Эдр = Э_{вп} + Э_{к} + Э_{от} + Э_{эк} - \Delta А_{пр} - З_{со},$$

$Э_{вп}$ - the effect of the increase in the volume of gross output, rubles;

$Э_{к}$ - effect from improving the quality of milk, rubles;

$Э_{от}$ - the effect of saving labor costs, rubles;

$Э_{эк}$-effect from saving feed, rubles;

ΔАпр - change in the annual amount of depreciation charges, rubles;

Зсо - expenses for the work of third-party organizations related to the operation of robotics, rubles.

The introduction of robotics makes it necessary to evaluate this activity in accordance with the method for comparing the annual economic effect of milk production using traditional technology and robotic technology.

3. EFFICIENCY OF MILKING ROBOTICS' APPLICATION.

The most significant in the introduction of robotics in the agricultural organization is the effect of saving the wage fund with the relative release of personnel.As a result of changes in the nature of the labor resources' using in the milking robots, workers are released to other

areas of employment, including the creation and filling of jobs in the service of robotics.

The number of relatively released workers is calculated by the formula:

$$Эч = \frac{(тс - тн) * 100}{Б * Нв} * Ан \quad (2)$$

$A_н$ – annual output, cwt;

$тс$ – labor intensity before the robotics introduction, person-hour / cwt;

$тн$ – labor intensity after the robotics introduction, person-hour / cwt;

Б – working time balance of 1 worker per year, h;

$Н_в$ – performance standards of output,%.

The effect of reducing labor costs ($Эот$) can be calculated by the following formula:

$$Э_{от} = З_м \times М \times Э_ч, \quad (3)$$

$З_м$ – average monthly salary of an employee with deductions, rubles;

M – number of months in a year;

$Э_ч$ – number of released employees.

Thus, for a group of research organizations, the number of relatively released workers is 17 people.This does not mean that people will be reduced, they can be employed in other sectors of the economy or, after retraining, they will be able to realize labor potential in the same organization. The effect of reducing labor costs is 3712800 rubles for a group of organizations, and for one used robot is 412533 rubles.Domestic researchers point an increase in gross milk production as the main source of growth effectiveness of milking robots.

There are various estimates of the impact of the use of milking robotics on the animals' productivity. Some foreign studies indicate an increase in productivity from 6 to 25% for lactation, which is highly questionable, while the increase in productivity on 5-10% with increasing milking rates from two to three times a day can be called reasonable [11,12].Domestic researchers have shown increasing in milk production after changing to robotics milking on 2-2,4%, which is due to the increase in the milking rate.

Additional products output can be calculated by the formula:

$$Э_{вп} = Ц * ОП_2 – Ц * ОП_1 \quad (2)$$

Эвп— effect from the additional products output;

– $ОП_1$и$ОП_2$– volume of production before and after the introduction of robotics;

– Ц – milk sales price, rub.

The effect of additional output after introduction of robotics is presented below (Table 1).

Таб. 1. Milk production using different milking technologies.

Index	PSK "Kolos"		SPK "Glinsky"		OOO «Nikolsky»		OOO "RusVelikaya"		KFH Shishkin	
	Traditional technology	Milking robotics	Traditional technology	Milking robotics	Traditional technology	Milking robotics	Traditional technology	Milking robotics	Traditional technology	Milking robotics
Number of cattle on the farm, head	65	65	65	65	65	65	65	65	65	65
Productivity per head, kg	5541	5856	6176	6228	5548	6158	4078	4380	5580	5694
Gross output, centners	3601,7	3806,4	4014,4	4048,2	3606,2	4002,7	2650,7	2847	3627	3701,1
The cost of gross output in current prices, thousand rubles.	7203,3	7612,8	8028,8	8096,4	7212,4	8005,4	5301,4	5694	7254	7402,2
Increase in gross output (effect), thousand rubles.	0,0	409,5	0,0	67,6	0,0	793,0	0,0	392,6	0,0	148,2
Growth of gross output per one robot by group of organizations, thousand rubles.										181,1

It can be seen from the table that the productivity of animals in the group of organizations increases from 5385 kg to 5663 kg per head for a year or on 5.2%, the total increase in production is 90.5 centners, or 181.1 thousand rubles per year in value terms.Robotic milking ensures the quality of milk at the level of European standards by separating normal milk from mastitis, old and milk of quarantine animals, thorough cleaning of equipment after each cow, eliminating the human factor associated with the low technological discipline of machine milking operators.The effect of improving the quality of milk when robot milking is formed from an increase in the milk farm-gate price of the highest grade in comparison with the milk price of the first grade.Also, the main advantages of robotics include the growth of milk on 1-2% due to earlier detection and treatment of mastitis, constant monitoring of milk quality and reduction in the number of somatic cells.

The annual effect of using robotics (Эк) on improving the quality of milk is determined by the formula:

$$Эк = \left(\left(\frac{ВП1 * ФЖ1}{БЖ}\right) * Т1 * ЦР1\right) - \left(\left(\frac{ВП2 * ФЖ2}{БЖ}\right) * Т2 * ЦР\right) \quad (3)$$

Эк – effect through the sale of better products (rubles);

$ВП_1$ и $ВП_2$ –the gross volume of milk production in the milking robot and the milk line, cwt;

$Цр_1$ и $ЦР_2$ – the selling price of 1 centner of milk on robotics and milk line, rubles per centner;

$ФЖ_1$ и $ФЖ_2$ – fat content of milk on robotics and milk line,%;

БЖ – basic fat content, %;

$Т_1$ и $Т_2$ – marketability of milk by robotics and milk line,%.

Calculation of the effect from improving the quality of milk per one milking robot is advisable to carry out, taking as a basis the production of milk on the milk line (Table 2).

Table. 2. The effect from improving the quality of milk using milking robotics.

Index	Traditional technology	Milking Robotics
Number of cattle on the farm, head.	65	65
Productivity, kg	5384,6	5663,2
Gross output, centners	3500	3500
Marketability ,%	93,3	94,2
Sold milk, centners	3265	3297
Actual fat content of milk,%	3,54	3,77
Standard weight with a fat content of 3.5%, centner	3302	3551
Farm-gate price, rubles / centner.	2000	2070
Proceeds, thousand rubles.	6606	7351
Effect per robot by group of organizations, thousand rubles.	-	745,6

As can be seen from the table, due to the sale of milk of the highest grade, organizations receive a premium to the price of 70 rubles per centner, the marketability of 0.9 per centner of the standard weight due to fat content.Thus, the effect due to the increase in the milk quality will be 745.6 thousand rubles per robot.The use of robotic milking positively influences on the increase of the milk grade in comparison with the traditional milking technology in the milk pipeline and contributes to providing the population with quality dairy products.The cost of feed in the structure of the prime cost of milk amounted 37.7%, and on a farm with robotics 31.7%. In our opinion, this is due to the organization of feeding, which is more rational on a farm with robots. With a yard housing method (robotics)is used mixed diet, most of the concentrates are fed individually during milking, which makes it possible to use more expensive feeds more rationally. With a tie-up housing method (milk line) feeding is in small-

groups depending on milk yield, lactation, fatness and age, so the use of concentrates is less rational.

The effect of saving feeds can be calculated from the formula:

$$Эек = Ск1 * ВП1 - Ск2 * Вп2$$

$Э_{эк}$ – the effect of saving feed, rubles .;

$Ск_1$ и $Ск_2$ – the cost of feed for the production of 1 centner of milk when milking the milk line and robotics;

$ВП_1$ и $ВП_2$ - the volume of production on robotics and milk line, center.

Thus, the effect of saving feed is 134950 rubles per robot.

The main results (effects) of using robotics in the agricultural organizations of the Sverdlovsk Region are given in view of the rank of significance (Table 3).

Таб. 3. Main results (effects) of using one milking robot.

Main results (effects) of using a milking robot	Annual benefit, thousand rubles.	Rank of significance, No.
Increase in the value of gross output	181,1	3
Saving of the payroll, thousand rubles.	412,5	2
Saving feed, thousand rubles.	135,0	4
Improving the quality of milk	745,6	1
Cost of services of third-party organizations for servicing robotics, thousand rubles.	-215,2	
Amortization expenses, thousand rubles	-1216,1	
The cumulative effect of using milking robotics, thousand rubles.	42,9	

As can be seen from the table, the annual cumulative effect of using robotics was 42.9 thousand rubles. This may seem insignificant against a background of sufficiently high capital costs for the purchase of milking robots.However, without considering amortization expenses, since it does not affect direct cash flow, milking robotics are much more efficient than traditional milking technology.It may also indicate the need to find ways to reduce the cost of robotics through its domestic production.The greatest significance in the use of milking robotics is the improvement in the quality of products (rank of significance 1) than saving labor costs in the release of workers (rank of significance 2).

It is necessary to compare the level of profitability of milk production in different milking technologies (Table 4).

Table 4. Efficiency of different milking technologies by group of organizations.

Index	Traditional technology	Robotics
Average annual livestock, head.	65	65
Milk yield per 1 cow, cwt	5384,6	5663,2
Gross production of milk, cwt	3500,0	3681
Marketability,%	93,3	94,2
Sold milk, cwt	3265	3468
Standard weight of milk, cwt	3303	3735
The selling price, rub / cwt	2000	2070
Proceeds from milk sales, thousand rubles.	6606	7732
The prime cost of 1 cwt of milk, rub.	1624	1807
Total prime cost, thousand rubles.	5303	6266
The prime cost of 1 centner of milk, taking into account the standard weight, rubles.	1606	1678
Profit, thousand rubles.	1302,8	1465,7
Level of profitability,%	24,57	23,39

According to the table it is clear that the prime cost of milk, taking into account the emerging effects, is reduced from 1807 rubles per centner to 1678 rubles per centner. At the same time, the profitability level for milking in the milk pipeline is 24.57%, and robotics provide a profitability of 23.39%. Thus, both technologies provide rather high efficiency values, but there

are no significant advantages of robotics in comparison with traditional technology, primarily because of high amortization expenses and payment for third-party services in robotics. However, without taking into account amortization expenses, since they do not affect direct cash flow, milking robotics are much more efficient than traditional technology with milking in a long milk pipeline.

4. CONSEQUENCES

1. The use of robotics in the production of milk contributes to the overall increase in milk production on 90.5 centners, or 181.1 thousand rubles per year in value terms, a reduction in the prime cost of milk, taking into account emerging effects from 1807 rubles per cent to 1678 rubles per cent.
2. The main effects associated with the use of robotics are to save the wage fund, increase the quality of milk, increase productivity on 5.2% compared to traditional milking technology.
3. Use of robots allows to increase the growth of milk marketability on 1-2% due to earlier detection and treatment of mastitis, reduction of feed costs on 6%. The effect of saving feed is 134950 rubles per robot.
4. At the same time, robotic milking leads to an increase in amortization expenses, although they do not affect direct cash flow, and the cost of third-party services for servicing the robot. Without taking into account the costs of amortization, milking robotics are much more effective than traditional milking technology.

5. CONCLUSION

In general, it can be said that the use of milking robotics is justified in order to increase the quality of milk, as the level of the used equipment can significantly reduce the number of somatic cells, reduce the influence of the human factor and get the product of European standards.In terms of importance, the second place goes to the effect of saving labor costs, which is shown in the release of some workers into other spheres of employment. In conditions of labor shortage in rural areas, the use of robotics can be the only solution. In general, the use of robots is accompanied by significant social effects in the form of increasing the attractiveness of labor in agriculture, its content, reducing injuries and occupational diseases. The use of robotics in general and milking robots in agriculture in particular will make it possible to change the face of future professions in the industry and increase the fixability of young people.However, the high level of capital intensity of milking robotics at this stage does not allow us to speak of significant economic advantages compared to traditional technology, since its use is associated with high amortization expenses (although they do not affect direct cash flow) and payment for services of organizations servicing robots.

6.CONFLICT OF INTERESTS

The authors confirm that the presented data do not contain a conflict of interest.

GRATITUDES

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