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# MEASURES TO MINIMIZE BIOLOGICAL RISKS IN DAIRY FARMING: COST ANALYSIS

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## Abstract

The purpose of the research is to consider issues related to the analysis of the costs of measures to reduce the level of biological risks at enterprises of the agro-industrial complex. The object of the research includes measures to reduce the level of biological risks at enterprises of the agro-industrial complex. The article presents the composition of costs for carrying out organizational, economic, veterinary and sanitary measures, describes in detail additional costs of identifying biological risk factors (causative agents of infectious diseases) that show variability under the influence of environmental conditions. One can also find calculations of the economic damage caused to agricultural enterprises as a result of exposure to factors of microbiological risk by the example of 4 especially dangerous zooanthroponoses (diseases caused by biological risk factors common to humans and animals): mycobacterium of tuberculosis, bacteria of the genera Brucella, Leptospira and Listeria monocytogenes. Mycobacterium tuberculosis (MTB) is a type of mycobacteria that causes tuberculosis (Tuberculosis) in humans (in 90-95% of cases), cattle, goats, pigs, etc. Bacteria of genus Brucella are the causative agents of brucellosis (Brucellosis). Brucella are thermolabile, they die instantly when boiled, low temperatures have little effect on Brucella. Bacteria of genus Leptospira are the causative agents of Leptospirosis. Listeria monocytogenes is a type species of genus Listeria, which is the causative agent of Listeriosis. This mobile non-spore-forming gram-positive bacillus can transform into L-forms and parasitize inside cells, causing the latent development of infection.



*Keywords:* Ativities, analysis, cattle breeding, costs, damage, risks

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## 1. Introduction

The impact of risks on the activities of enterprises in the agro-industrial complex is significantly greater than that in related industries due to the uncertainty of weather conditions and climatic features, a low degree of probability of the predicted results of the vital activity of living beings. Currently, in order to increase the efficiency of decision-making in the field of management, it is necessary to develop tools that allow achieving optimal forms of management, forecasting and planning measures for the management system in conditions of uncertainty and risk. Failure to accept risk factors at agricultural enterprises can provoke serious problems in the development of the agricultural sector as a whole (Belova, 2019; Zavgorodnyaya et al., 2018).

## 2. Problem Statement

To reduce the level of biological risks at agricultural enterprises, it is necessary to carry out a number of control measures (a list of control critical points must be developed). It is necessary to carry out a set of veterinary-sanitary and sanitary-hygienic measures and comply with the rules for quality control of raw materials and stages of production. The implementation of these measures requires high costs (Konkina & Martynushkin, 2020; Krylatykh, 2011).

## 3. Research Questions

The article analyzes the costs of reducing the level of biological risks in milk production. In dairy farming, it is more advisable to use preventive measures than to incur significant and unplanned economic losses from the negative impact of risks that periodically arise in this area (Mikhaylovich et al., 2018).

## 4. Purpose of the Study

The purpose of this work is a comparative analysis of the additional costs of identifying the causative agents of four especially dangerous zooanthroponoses that can cause extremely negative consequences of biological risks. Researchers attribute a significant physical and moral deterioration of laboratory equipment and a lack of qualified personnel in the field of veterinary services to the main factors hindering the development of dairy production in Russia (Bakulina et al., 2020).

## 5. Research Methods

During the research, the following methods were used.

1 – General research methods: analysis, synthesis, analogy, deduction, induction.

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2 – Data collection and processing methods: one-factor methods, vector methods, multifactor methods.

3 – Methods for determining costs and damage as a result of the implementation of a risk situation: determining the level of costs for organizational, economic and veterinary and sanitary measures, determining the level of additional costs for identifying biological risk factors, determining the level of costs for PCR laboratory equipment, determining the level of economic damage caused to agricultural enterprises as a result of risk factors.

## 6. Findings

Table 01 presents the costs of economic, veterinary and sanitary measures.

**Table 1.** Costs of economic and veterinary and sanitary measures

| Risk factor | PPE costs | Costs for clinical examinations, diagnosis and prevention of diseases | Costs for disinfection, pest control and deratization | General costs |
|---|---|---|---|---|
| Mycobacterium tuberculosis (MBT) Mycobacterium bovis Mycobacterium avium | High. Due to the purchase of specialized clothing and shoes, disinfectants, preventive measures to prevent infection. | Very high. Associated with mandatory clinical examinations once a year and planned general tuberculinization of animals. | High. They are connected with putting in order all sanitary facilities, taking cattle to summer camps and sanitary repairs of all premises of the farm. The current disinfection is carried out after each regular survey of the dysfunctional livestock. Final disinfection is mandatory. | Very high |
| Bacteria of genus Brucella (B. melitensis, B. abortus, B. suis) | High. Due to the purchase of specialized clothing and shoes, disinfectants, preventive measures to prevent infection. | High. Associated with systematic livestock surveys and preventive vaccinations (if necessary). | High. They are connected with putting of all sanitary facilities in order (special attention is paid to the maternity ward), disinfection, disinfection of manure and wastewater. | High |
| Bacteria of genus Leptospira | High. Due to the purchase of specialized clothing and shoes, disinfectants, preventive measures to prevent infection. | High. Associated with systematic examinations and preventive vaccination of livestock. | High. They are connected with the widespread deratization, cleaning and disinfection of livestock buildings, water chlorination, bio thermal disinfection of manure. | High |
| Listeriamonocytogenes | High. Due to the purchase of specialized clothing and shoes, disinfectants, preventive measures to prevent infection. | High. Associated with systematic surveys and vaccinations of livestock. | High. They are connected with deratization and insect control, replacement of feed, disinfection, manure disinfection. | High |

A significant part of the costs of veterinary-sanitary and sanitary-hygienic measures is covered by the state (costs of medicines, disinfectants, etc.).

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The list of costs does not include the costs of organizing laboratories in the enterprise. At the same time, specific diagnostics associated with the manifestation of the variability of pathogens under the influence of environmental factors (for example, the incorrect use of antibiotics) requires special equipment, which is sometimes too expensive for an agro-industrial complex enterprise to afford its installation (the equipment of veterinary stations and laboratories is often outdated). Most enterprises do not have their own laboratories at all (Krylatykh & Fedorov, 2013).

Approved in December 2010 “Sanitary norms and rules 3.1.7. 2817-10” recommend using polymerase chain reaction (PCR) as an additional method of laboratory diagnostics.

Currently, PCR diagnostics is available to a limited number of laboratories with the appropriate equipment and trained personnel (the cost of training varies from 11,900 to 76,000 thousand rubles per person). The specifics of the costs of organizing PCR laboratories is due to the fact that their organization requires careful preparatory work (Konkina & Martynushkin, 2020).

Table 02 presents additional costs of identifying the causative agents of four highly dangerous zooanthroponoses.

**Table 2.** Additional costs to identify biological risk factors (causative agents of infectious diseases) that show variability under the influence of environmental conditions

| Risk factor | Additional costs for specific diagnostics | Additional equipment costs | | Additional costs for preparations and analyses | |
|---|---|---|---|---|---|
| | | Type | Price (rub.) | Type | Price (rub.) |
| Mycobacteriumtuberculosis, M. bovis, M. avium | Very high. Associated with the problematic nature of identifying L-forms and the need for additional studies using a phase contrast or fluorescence microscope. | Phase contrast microscopes<br>Motic BA300<br>+ digital camera<br>Levenhuk C1400<br>Levenhuk C800<br>Levenhuk C510<br>Motic DMBA300 with built-in digital camera<br>Fluorescence microscope<br>Science ADL-601F | <br>73,520<br><br>27,900<br>22,900<br>17,900<br>129,900<br><br>174,746 | 1 analysis (1 type of bacteria)<br>1 analysis (complex) | 390<br>1,360 |
| Bacteria of genus Brucella | High. Associated with the lamellar agglutination reaction with rose bengal antigen - rose bengal sample (RBS), immunodiffusion test with OPS antigen (IT) and a ring test to detect antibodies in cow's milk (RT). | – | | A set of components for the diagnosis of brucellosis in animals in a ring reaction (CR) with milk.<br>A set of components for the diagnosis of animal brucellosis in prepaid expenses.<br>A set for diagnostics using IT with OPS antigen | 2,900<br>1,714<br>7,660 |

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| | | | | | |
|---|---|---|---|---|---|
| Bacteria of genus Leptospira | Average. To detect leptospira, the agglutination reaction (AR) and micro agglutination reaction using fluorescent polyglobulin (PMA) and the immune-fluorescent method are used. | Darkfield digital microscope Celestron with LCD-screen Penta View<br>Altami BIO 3 | 16,990<br>34,000 | – | |
| Listeria mono-cytogenes | Very high. Associated with the polymerase chain reaction (PCR) and PCR laboratory equipment. | Equipment for PCR laboratory from 2,000,000 to 76,000,000 | | Listeria IgG Kits "Listeri O-IgG" | 4,012<br>2,184 |

It is necessary to determine in advance what tasks are to be solved in the laboratory. In addition, it is important to understand by what methods the assigned tasks will be achieved. It is necessary to resolve issues on PCR diagnostics, equipment, reagents, consumables, requirements and standards for organizing modern PCR laboratories (Kuhl et al., 2020).

The functioning of the PCR laboratory can be based on three basic methods:

- classical polymerase chain reaction (PCR with electrophoretic detection),
- PCR in “real time” (Real-time PCR),
- “End-point” PCR with fluorescence detection (FLASH).

Other methods can be used in a PCR laboratory with the appropriate equipment. The choice of the method will affect the total cost of the laboratory equipment project (Table 03).

**Table 3.** PCR laboratory equipment costs

| Laboratory type | PCR with electrophoretic detection | Real-time PCR | PCR in FLASH modification | Sanger sequencing | Pyro - sequencing | Multiplex analysis |
|---|---|---|---|---|---|---|
| Clinical and diagnostic | + | + | + | - | - | + |
| Forensic medicine | + | + | - | + | - | - |
| Research | + | + | + | + | + | + |
| Mobile laboratory | - | + | - | - | - | - |
| GMO analysis | + | + | - | - | - | - |
| HLA laboratory | + | - | - | + | - | + |
| Recommended research volume per day | 20-200 | 20-200 | 20-200 | 8-32 | 4-8 | 96-288 |
| Solution cost range (thousand rubles) | 900-4,000 | 1,000-5,000 | 1,000-4,000 | 2,000-13,000 | 5,000-35,000 | 2,000-15,000 |

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In addition to the type of the PCR laboratory, it is equally important to determine the approximate sample throughput of the laboratory, that is, how many analyzes, tests and reactions are planned to be performed per day (week, month) in the laboratory. Based on the expected number, it is necessary to determine in advance the number of employees (operators) who will conduct the tests in the laboratory. To reduce the level of biological risks, costs are necessary for organizational, economic and veterinary and sanitary measures (Zavgorodnyaya et al., 2018).

The highest ones among them are:

- costs of personal protective equipment (Polikarpova & Mizikovskiy, 2018);

- costs of disinfection, disinsection and deratization. They are associated with putting in order all sanitary facilities (sanitary inspection, farm fences, disinfection barriers, maternity ward, quarantine room), taking cattle to summer camps and sanitary repair of farm premises (Ushakov et al., 2018);

- costs for quarantine and veterinary treatment of newly received animals, restrictions on production. For example, it is not allowed to export raw milk obtained from cows in a dysfunctional herd that react to tuberculin. Such milk is subject to on-farm processing (boiling or processing into melted butter) (Beukes et al., 2010);

- the costs of clinical examinations, diagnosis and prevention of diseases are also extremely high (Khaleghipour et al., 2020).

Even taking into account the fact of state funding, the costs of reducing biological risks for agricultural enterprises still remain quite high. But these costs are justified, since in a case of a risky situation, an agro-industrial complex enterprise may suffer both insignificant and very high economic damage. As a result of quarantine and restrictions on the export and import of feed, products, animals, the improvement of livestock, the stoppage of the production process as a result of the detection of contaminated raw materials, enterprises also incur losses.

Economic losses arising from enterprises of the agro-industrial complex due to the negative impact of risk are presented in Table 04 (exemplified by 4 especially dangerous zooanthroponoses).

**Table 4.** Economic losses arising from the negative impact of risks in the field of microbiology

| Risk factor | Damage from the lack of offspring | Damage from decline of milk production | Damage from the forced slaughter of animals and mortality | Damage from disposal of affected organs and carcasses | Damage associated with the cost of improving the livestock | Damage assessment |
|---|---|---|---|---|---|---|
| Mycobacterium tuberculosis (MBT), Mycobacterium bovis, Mycobacteriumavium | High. Associated with the forced slaughter of animals. | High (up to 35%) | Very high. Slaughter is required. | Very high. Disposal is mandatory. | High. Associated with a high retirement rate (up to 100%). | Very high |
| Bacteria of genus Brucella (B. melitensis, B. abortus, B. suis) | High. Associated with the forced slaughter of animals | High (20-39 %) | Very high. Slaughter is required. | Very high. Meat from animals serologically positive for brucellosis is neutralized by | High. Associated with recreational activities. | Very high |

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| | | | | | | |
|---|---|---|---|---|---|---|
| | (up to 90% abortions). | | | boiling. The meat obtained from the slaughter of animals with signs of brucellosis is destroyed. | | |
| Bacteria of genus Leptospira (L. icterohaemorr-hagiae, L. grippothyphosa, L. hebdomadis, L. pomona, L. tarassovi) | High. The death of offspring is up to 90%, 15-20% abortions in cows and up to 100% in sows. | High (22-37%) | High. Animals are treated with subsequent delivery for slaughter. Mortality is high (25-60%). | High. If there are degenerative changes or icteric staining that does not disappear within 2 days, the carcass and all internal organs are sent for technical disposal. If there are no such signs, then the carcass and internal organs are released after boiling. | High. Associated with treatment costs. | High |
| Listeria monocytogenes | High. The death of offspring and abortions up to 90%. | Average (up to 20%) | High. Animals are treated (with subsequent delivery for slaughter). Mortality with nervous forms of the disease is 100% and that with septic diseases is 50%. | Average. Pathologically altered organs, blood and heads from sick animals are sent for technical disposal. Carcasses and internal organs without changes for the manufacture are disinfected for boiled, boiled-smoked sausages or canned food. | High. Associated with treatment costs. | High |

## 7. Conclusion

In connection with the above, it is necessary to take into account the following aspects in the work of the veterinary service of agricultural enterprises: technical and technological provision, the level of pharmacological production and a specially equipped vehicle fleet, the level of qualifications of specialists in the field of veterinary medicine, the degree of reasoning for the personnel motivation system (Polischuk et al., 2018).

To improve the safety of products of agricultural enterprises and reduce the level of biological risks, according to Bolshov it is necessary:

1) to contribute to the growth of material and technical security of both the entire agro-industrial complex and veterinary services that monitor the health of animals and the quality of products (Byshov, Borychev, Kashirin, et al., 2018);

2) to increase the level of pharmacological support for the work of veterinary specialists;

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3) to increase the efficiency of functioning, employees of institutions of veterinary services should be provided with special transport (Byshov, Borychev, Uspensky, et al., 2018);

4) to increase the level of education, knowledge, skills of veterinary specialists and workers of enterprises of the agro-industrial complex.

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