ECOLOGICAL AGRICULTURE AND SUSTAINABLE DEVELOPMENT

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Dear friends,

This year was rich for scientific audience in both our countries (Serbia and Russia). Specially thanks go to editors for their efforts, hard work and dedication. Namely, without ***Prof. Dr Litovchenko Viktor Grigorievich****, rector of South Ural State Agrarian University, Russia and* ***Prof. Dr Mirjana Radovic Markovic*** *and their work this project was not be possible.*

We hope that Conference we did together in South Ural State Agrarian University at the end of November became the kind of open dialog platform for modern tendencies in agricultural economics. It was the place where we together discussed a lot of important questions and points of statistics in agriculture, modern methods of mathematical modelling in economics, part of green ecological types of agricultural business. More than 20 scientists presented results of their research in modern economics. Some of its positions could find place in worldwide base of knowledge dedicated to modern agricultural economics.

Finally, many thanks to ***Prof. Vukovic*** *for his encouragement and support as a curator of this project that presented some interesting unknown for us in South Ural terms of EU and Serbia laws in agriculture regulation mechanism.*

South Ural State Agrarian University, Russia

Research Development Center - FBEE, Belgrade, Serbia

Ecological Agriculture and Sustainable Development

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ORIGINAL RESEARCH PAPERS

MODERN ESTIMATE OF ENVIRONMENTAL ETHICS AND SUSTAINABLE DEVELOPMENT ISSUES

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ABSTRACT

The article covers some aspects of the formation of environmental ethics or environmental consciousness in the contemporary society. Environmental ethics is one of the basic conditions of modern sustainable social and economic development on local and global levels. Environmental ethics is the moral relationship between society and the environment. Environmental ethics bases on the development of philosophy, closely connects with public views, and is implemented in practice in management and in the sphere of consumption. Global sustainable development has different sides. Increased consumption leads to environmental problems. However, the transition to eco-friendly methods requires additional resources. The environmental pollution is associated with poverty. And environmental ethics implies the ability to solve ecological problems. Sociological studies show how environmental ethics forms in Russia. Interest in the environmental movement is growing, but the environmental awareness is still not very evident. Identifying the factors of the formation of environmental consciousness is essential for the formation of the socio-ethical foundations of sustainable development in modern society.

JEL classification: O13, Q01, Q59

Keywords: *ecology, ecological problems, environmental ethics, environmental consciousness, environmental sociology, social ecology, sustainable development*

1. INTRODUCTION

Despite many years of discussions within Russian and foreign social studies on environmental ethics, its development problems and outspread in modern social communication systems, the term of "environmental ethics" itself stays still not clear. Attempts to define it often look like protruding certain opinions on significance of various environment-oriented initiatives. From the perspective of previous studies undertaken by the authors of this article, ecological ethics can be regarded as an integral part of social ethics, a set of collective representations that reflects opinions of various social groups about the nature, permissible forms and boundaries of its social exploitation, and the place of man and society.

Ecological ethnics is constantly reproduced in the modern system of public communications and forms specific cultural environment, i.e. norms, values, rules of conduct and social sanctions for the non-compliance. It defines society’s attitude toward various problems of natural environment protection and solubility considering existing economic, political, socio-cultural restrictions. Often ecological ethics is treated as a general category, and even as general value (or value system). However, the society’s’ stance on nature, capability and above all the need to preserve it unspoiled is not universal at all. The attitude depends on the specific socio-economic and political conditions that form characteristics of sustainable social development and determine approach to the nature as to the most important and still underestimated by the majority factor.

2. THEORY

We can list several works written by global ecologists concerning the need for the ecological ethics' development, which prove its necessity and capability of evolving in the modern society beyond reasonable doubt (Traer, 2009; McShane, 2014; Gardiner, Thompson, 2017). Marion Hourdequin attempted to work out a concept of environmental ethics (Hourdequin, 2015). Callicott has proved that environmental ethics has become integral to the history of moral philosophy in the Western intellectual tradition (Callicott, 1999, p.6). Attfield writes that "environment" generally means "objective encompassing system of nature", so ""environmental ethics" is the study of the ethics of human interactions with the impacts on such systems" (Attfield, 2014). Modern philosophers write about the development from anthropocentrism to biocentrism (Keller, 2010). According to Murray Bookchin, "all our ecological problems arise from the deep-seated social problems" and "present ecological problems cannot be clearly understood without dealing problems within society" (Keller, 2010, p. 268). Therefore, sociology is an important part of environmental researching, and social ecology shows the influence of modern global processes on the development of the global and local environment. Rolston points out that society retains what it values. Natural areas have vital value by preserving various forms of life (Rolston, 2012). The reduction of biodiversity is driven by human influence. Therefore, environmental ethics arise as recognition of the right to life for various natural forms. Lisa Siders raises an interesting topic: how the theory of natural selection is incorporated into environmental ethics (Sideris, 2003).

The debatable question of market economy and environmental rights is relevant to social ecology and corporate development. Scholarships show that environmental ethics can provide company benefits and now "corporate sustainability management is loaded with questions about the value and moral status of humans, non-humans, and ecosystems" (Schuler et al, 2017, p.237). Modern Russian and international researches prove that the environmental ethics influences formation of the "Green economy" - is a new concept of economic development that includes creating new (better) quality of life for population (Vukovic, 2018, p.2). Ecology gives priority to sustainable development, and social innovation must comply with the principle of environmental friendliness and optimal use of resources (Lyovkina, 2017, 126). Novikova also considers questions of combining environmental ethics and consumer society in the concept of happiness (Novikova, 2017).

However, still quite little attention is paid to studying the factors that impede its development and global spread. We have it as it is despite significant increased popularity of discussions about problems and capability for environmental conservation in the second half of the 20 –early 21st centuries. Despite the formation of a specific socio-political discourse, called environmentalism (Smith, 2001) – by this term we mean specific view of the possibility of getting rid of threats caused by increased human interference in nature in the course of progress in science and technology, freedom from the escalation of extensive undue resource-consuming industrial and economic activity, and also cultivation of perception of our planet as an interdependent ecosystem. In face of the adherence to principles of the well-known doctrine of sustainable (balanced, self-sustaining) development declared by the international political and economic organizations (as well as by the certain socio-political movements), environmental ethics has not become the basis for a new vision on the nature which is "the environment is the only one home for all of us". And Russia is not an exception (Baynova at all, 2018).

Being based on factor analysis, employing the structural genetic approach and data taken from empirical sociological researches this article reviews problems and dissentions of ecological ethics developments' evolution in the world and in modern Russia.

3. DATA AND METHODS

There are plenty of factors that hamper the evolution and spread of environmental ethics in the world and in Russia, and with the beginning of the new century we can see more and more of them.

The first factor, which is generally not taken by many researchers as essential, is the socio-historical one. The fact that first conservation laws appeared in ancient Babylon and ancient China only confirms the idea that the whole history of mankind could be fully seen as the totality of the processes of adaptation of different societies in different epochs to the environment through degradation of nature itself. And efficiency of this adaptation is directly proportional to the degree of destructive impact of human's activity on the environment. However, humanity always acts with slim thought for the problem of environmental costs of its economic activity, preferring to solve its short-term problems of providing comfort and obtain "modern" ever-increasing material needs at the expense of future generations. With the times passing by, the historical types and forms of the impact of different societies on the environment were being changed. But the fact that this process finally overcame local boundaries for the first time in history is quite a distinguishing characteristic of the second half of the 20 – early 21st centuries. And the whole system of global environmental threats to mankind was formed based on it. In large extend this happened under the influence of the process (or rather totality of inconsistent processes) which was named in the 21stcentury as "the industrial society's formation," and which, through the efforts of many representatives of the social sciences, primarily adherers of the economic theory, has been turned into the main subject of all scientific researches, and also proclaimed a stepping stone of the socio-historical development of the mankind. With all the intellectual consequences that come with it like significant artificial limitation of the critical perception of consequences of various industries' development, both in academia and people's minds. Industrial and economic upturn, apparently carried out through nature degradation, began to be considered (and promoted) purely as a goal, and socio-economic development sustainability was interpreted mainly as stability of rates of increase in its statistical measures.

Existence of environmental threats is made worse by the fact that mature economies and developing countries react in completely different ways, as a rule, depending on their financial and economic possibilities. So that another one factor hindering the global spread of ecological ethics is the existing and increasing geo-economic disparity. According to the global development researchers, at present inequality, already considerable, is being increased. The USA, Western Europe and Japan are 100 times richer than Ethiopia, Haiti and Nepal. And if the gap between countries in the early 20 centuries was only 1: 9, then at the beginning of the 21st century this gap in income per capita (between 10% of the richest countries inhabitants and 10% of the poorest) exceeds 10 thousand times (Birdsall, 2005). According to the World Bank experts, at the end of the 20 centuries, in the thirteen richest countries in the world income per capita was in excess of $ 20,000 per year, while in the 26 poorest countries it was less than $350 (Global Economy and Economic Disparity, 2005). Cyclical movements in the global economy happened in the first decade of the 21st century, called the "world economic crisis," only strengthened it.

The issue of global disparity growth is exacerbated by the a priori idea of externalizing environmental costs, common for traditional economy (primarily classical and neoclassical approaches). More, global industrial economic growth is usually proposed as the main way of solving all the contradictions between rich and poor countries. Until now it is believed that the industrial human intervention in nature costs nothing to nature itself, which integral part the humanity is. As D. Efremenko rightly notes: "The cost reduction in the Largest Economies due to externalization stimulates a further increase in consumption thereby further increasing global inequality and environmental stress" (Efremenko, 2007, p. 86).

The rise of the global consumer society is another factor hindering the development and spread of environmental ethics. The values of the global consumer society, which direct people to total abidance of nature by making life comfortable, come into direct contradiction with the ethnic culture's values. After all, these cultures for thousand years have guided people to harmonious engagement with the environment. New social values target an increasing number of people around the world to follow in their consumer behavior a universal strategy for creating personal comfort at any cost, including the cost of nature degradation. The doctrine of sustainable growth implies, among other things, some restrictions of global consumerism (however clearly vague) and buildup of prerequisites for moderate consumption.

But such ideas apparently contravene both with the aspiration of modern transnational producers of goods and services to obtain super profit because of the global spread of industry and expansion of consumption, and with the aspirations of most people of different societies to achieve universal standards of the consumer society regardless their welfare. This contradiction is aggravated by the presence of yet another, more substantial, structural contradiction, associated with the global consumer society evolvement. This is a contradiction between the ever-increasing production, the imposition of universal consumption patterns on millions of people, and real possibilities, which are quite modest, of the majority to follow these patterns. In such a situation, environmental ethics itself turns into one of the elements of the universal consumption patterns. It can become an effective background for the discourse of the global consumer society that is being formed, transformed and managed by advertising and specific PR tools. This discourse manifests itself, for example, in the wide-spread trend for "green" (ethical) consumerism.

The global consumer society and global industrialization can't be imagined without transnationalism – the expansion of the transnational companies' influence. Indeed, as many experts rightly believe, it would be impossible to solve global and local environmental problems without their assistance and support with the new technologies of efficient use of resources and power management, investment capitals, without their strategies for implementing corporate environmental standards.

Still when we talk about transnationalism, we also cannot hide several dangers connected with it. Thus, there is a risk of freezing of environmental regulation, especially in poor countries and regions, where rise of income in certain social groups and broaden options for joining the values of the "consumer society" becomes prior over environmental activities. Considering weak and dependent on big business bureaucratic apparatus, it is more convenient for the state to abandon the improvement of environmental regulation, if it is present to some extent, or simply not to conduct any real work to control the maintenance of environmental standards, limiting itself to declarations of intent.

Research data, which has been accumulating year after year, disprove the optimistic view saying that "environmental degradation is only a temporary phenomenon that will easily change," since negative changes tend to accumulate from decade to decade. And with the growing cost of solving environmental problems, the opportunities for making effective conservational and environment restoration policies at the global and local levels are rapidly disappearing. From an economic point of view, it makes this depravation of the ecological situation more and more irretrievable. Also noteworthy is the fact that "a policy in which priority is given to economic growth at the price of the environment is short-sighted, as it will subsequently lead to significant expenditures that could otherwise be avoided" (Globalization, Growth and Poverty, Building a Global World Economy, 2004, page 159). Ecological ethics will receive a new impetus to its global spread only when the majority loose the illusions, driven by the impact of the factors listed above. Factors, which sideline possibility for an independent and responsible evaluation of most of the risks that actually exist and are reproduced in connection with the escalation of the extensive economic activity in the modern societies' system.

The transformation of socio-economic development and globalization particularly affect agriculture. Agriculture is the type of economic activity that is closely connected with the natural environment. Global distribution of new agricultural technologies since the 1960s. has led to soil fertility decline and has also increased pollution due to accumulation of pesticides and herbicides in the soil (Petrov, 2015). The researchers estimate the land area withdrawn from agricultural use. Up to 35% of arable land has been irrevocably withdrawn from agricultural use over the past 40 years (Ustyan, 2008, p. 66). Near 11% of the total vegetation cover of the Earth has been lost since 1945. Shortage of agricultural land is compensated by deforestation. In addition, intensification of irrigated agriculture has aggravated the water problem (Kovalev, 2004, p. 28-29). Data for the last 10 years in Russia shows the following trends. The area of agricultural ground is gradually reduced. Reduction isn't big in percentage terms, but the area shrinks by one million hectares every year. At the same time the area of agricultural ground itself, arable land and pastures don't decrease. Therefore, the reduction goes now at the expense of other lands with auxiliary value for agriculture (Baynova et al, 2017). As a result, the "Green revolution" leads to aggravation of agricultural production by the gap and does not eliminate the famine. The transition from massive technological impact on the environment to environmentally and socially safer "organic" agriculture is a solution to the problems. But organic agriculture is rather elitist due to the increase in the cost of food by 20-30% on average (Kovalev, 2005, p. 22-28).

4. RESULTS

Number of surveys aimed on ecology and ecological ethics is growing but not as fast as it is necessary under current conditions. Their findings reveal that about two thirds of Russian citizens to some extend express concerns about ecological situation in their own town or rural area (Problems of Ecology, 2016). However, despite the significant growth of information in the media in recent years on topics related to the environment, only one quarter of Russian citizens know that 2017 was declared the Year of Ecology. At the same time, over the past seven years the number of citizens who believe that environmental situation will not change significantly for better in the coming years has grown from 40% to 48% (Ecological situation in Russia: monitoring, 2017).

Ecological issues began to bother the inhabitants of Russia in the 2000s in a time when economic growth and a certain improvement in the standard of living took place. By the end of the 2000s two-thirds of Russians (64%) were confident that sustainable development of Russia is impossible without solving environmental problems. That very time a significant number of Russians (84%) began to presume that grassroots should deal with environmental problems. Nevertheless, 56% of respondents were sure that they can't influence the progress in this area, shifting responsibility to the authorities, and only one third of respondents (31%) were convinced that they can influence the solution of environmental problems personally. Moreover, the more prosperous were citizens, the more active was their position on environmental issues (Ecological situation in the mass consciousness of Russians, 2008, pp. 3, 10).

Has the situation changed by the end of the new decade? Even if so, this change is insignificant. Survey data shows that citizens still assign responsibility for environmental protection and solving environmental problems mainly to the authorities, with the only difference that in the second decade of the new century the emphasis in environmental protection expectations shifted to local (25%) and regional (23%) of the authorities (Ecological situation in Russia: monitoring, 2017).

It is remarkable that Russians pay more and more attention to the ecological reputation of organizations (public and private, domestic and transnational). At the same time, the gradual expansion of environmentally responsible consumers in Russia arises. However, this can be just a part of the global fashion trends (pushed by advertising in the media) for a healthy or "green" lifestyle and "green" consuming so far. By the middle of the 2010-s only 30% of Russians in some way dealt with ethical consumption (purchase of the appropriate goods or boycotting purchases, waste recycling).

Still, experts conclude that ethical consumers in Russia are multi-profile. They reveal the highest "sensitivity" to information about the environmental harm caused by manufacturers in the place of residence of respondents - 78% (Shabanova, 2015).

Over the past seven years, the number of respondents who noticed some improvement in the environmental situation has increased from 10% to 24% (Ecological situation in Russia: monitoring, 2017). However, according to recent VTsIOM research, ratio of Russians who believe that human health is deteriorating particularly because of environmental problems (61%) also increases (Environmental issues, 2016).

At the same time the main sources of environmental hazards in Russians' opinion are transport and industrial enterprises, and air and water pollution are their main concern. It should be noted that concerns among Russians about the state of the environment is growing year by year due to the increase of the amount of information about the state of nature and environmental initiatives. Moreover, the vast majority of citizens consider it important to obtain information permanently about the state of the environment (especially about the cleanliness of air and water bodies - more than 80%) and about environmental initiatives (environmental projects).

With that in mind, it is important to pay attention to the fact that the manifestation of civil ecological consciousness for many Russians is associated primarily with "plain to see" problems solution and sometimes literally – for instance, personal participation in dealing with problem of garbage and waste driven by consumption (Abramov, 2013, pp. 4-7, 12-14).

Despite commendable growth in the number of youth environmental movements and organizations in our country, especially in the last ten years the ever more steadfast commitment of young people to the trend of "green" consumption, Russian youth is still poorly involved in their activities (the share of environmental movements in the socio-political activity of youth is 3.5%, although every second young person takes part in two or more social movements) (Sheregi, 2013, pp. 26-27). The problems of low income (71%) and threats of unemployment (54%) caused much more anxiety among Russian youth (as well as the rest of Russians), even in the "steady period", before the crisis (Gudkov, Dubin, Zorina, 2011, page 38). Now the situation has only worsened.

However, as basic values for Russian youth, along with good job, money and family, health and sound environment (as a factor that exerts paramount influence on health) comes first (Sheregi, 2013, pp. 88-89). Studies of students show that the state of the environment and ecology at the place of residence is also significant for most respondents (88%). But not more than two thirds of young people (66%) express satisfaction with the environment (Koval, 2018).

That is why an important aspect of the development of environmental ethics in Russia is also an environmental education system development (which includes a set of measures for the development of environmental education starting from pre-school institutions and schools), since such a mechanism for environmental ethics' extension is sought by the society.

5. CONCLUSIONS

We note finally, that, despite the significant increase in the popularity of environmental initiatives and environmental policy effectiveness' growths in Russia, economic barriers remain significant encumbrance to the environmental ethics outspread. These are especially important in times of the current global economic crisis, as in presence of negative global trends issues of wages and unemployment seem much more topical for many than the environmental problems. And this must be considered when implementing environmental policy measures and developing environmental education.

Thus, it should be noted that the opportunities for the advancement of environmental ethics in the system of modern mass communications are still being reduced under the influence of many negative factors – both exist and coming ones. Overriding these factors' influence in the patterns of modern mass communications should become the top target of environmental policy in different countries in the first half of the 21st century.

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ORIGINAL RESEARCH PAPER

MODERN SOCIO-CULTURAL REALITY AND ECOLOGY

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ABSTRACT

The paper is concerned with the attempts to understand the origins of the environmental crisis that characterizes the current state of civilization. The controversial nature of interactions between society and nature is shown. Referring to the last stage of the human sociality formation, the authors trace changes in the attitude of man to the environment and conclude that the solution of the environmental problem is associated with changes in value priorities. This position is reflected in many modern philosophical and biological studies.

JEL *classification: Q5, Q57*

Keywords: *biosphere, nature, society, man, morality, anthropocentrism, ecocentrism, ethics of responsibility*

1. INTRODUCTION

Biological sciences are in a new stage of their development, which is called bioengineering, with such research directions as genetic engineering, cell engineering, biogeochemists engineering being put in the forefront. Biotechnologies that are based on gene and cell engineering allow overcoming evolutionary barriers, carrying out arbitrary construction and transfer of genes between organisms that do not have natural possibilities for entering genetic contacts. F. Fukuyama, assessing the achievements of the modern biotechnological revolution, considers this revolution not only to violate the measured course of natural processes, but to lead to the fact that the future of humanity is open and depends crucially on our current actions (Fukuyama, 2002). These innovations are based on the experience of the negative effects of the scientific-technological progress that mankind already has, including the depletion of natural resources, environmental pollution, etc., resulting in the destruction of environmental links in the Earth's biosphere. The humanity has come to the point of an urgent need to look back to rethink its interrelation with the surrounding nature. Here, a whole range of problems and questions arise concerning various aspects of the situation (Foerster, 2003).

This paper is focused on analyzing the origins of the current environmental situation if it is inevitable because of the man nature and society, or it is the random result of tasks that were incorrectly set by humanity. Worded in a similar way, the goal of the research involves identifying such characteristics of a person and society, which, on the one hand, reflect the specificity of the studied phenomena, and on the other hand, make it possible to generate complex environmental problems that humanity faces today.

2. LITERATURE REVIEW

Publications reviewed in international issues prove modern environmental studies to be often narrowly local and devoted to problems arising in exploitation of nature. We should mention the works of European researchers devoted to the problems of combining the modern anthropogenic landscape with nature conservation zones (Lanzas, Hermoso, de-Miguel, Bota, & Brotons, 2018), (Carlier & Moran, 2019), as well as to the problems of co-ordination of interests of business and social groups for environmental management, and the role of political structures in their regulation (Martino, Tett, & Kenter, 2019). Chinese environmentalists focusing on the study of factors and special programs to restore natural systems research in a similar way (Qin, Li, Liu, Yan, & Huang, 2019), (Sheng, Zhen, Xiao, & Hu, 2019). The work by Chilean specialists is also of considerable interest. They believe that quantification, mathematization, and the cult of measurement as a criterion of objectivity associated with Eurocentricism, caused to choose the way of relating to nature that led to an environmental crisis at present (Blanco & Aguiar, 2019).

3. METHODOLOGY

The research methodology involves the identification and analysis of factors that ensured the separation of human society from the natural environment. The research is also connected with the analysis of the factors determining the immersion and inseparability of human being from nature. The material of research is to study various life aspects of archaic societies, their beliefs and rituals, observations of animal communities, philosophical studies on the problems of social being, human nature, and the interrelations of society and nature.

4. EMPIRICAL FINDINGS

In human interactions with the environment, two opposite vectors can be distinguished. The first is related to the tool (labor) activity. Its directionality goes from a person to the environment external to him, with the help of a tool the person transforms nature. This is a feature of human adaptation: unlike animals, man does not adapt to the environment, but adjusts the environment to his needs. In relation to nature, this is a destructive vector: a person or society takes what is necessary from nature, uses it, transforms it to satisfy his own needs, returning waste or used tools to nature. It is this very vector of activity that demonstrates an unusually high level of development today. Until recently, the impact of society on the biosphere was not so significant as to affect its condition. The situation changed dramatically when wood fuel was substituted with mineral one. This happened during the industrial revolution in the 17-18th centuries, when within a few decades, enormous masses of matter and energy accumulated in the biosphere during millions of years were thrown into the environment. This immediately affected its state, for example, fresh water reserves decreased dramatically, and the air, soil and bio-resources deteriorated. It became clear that the natural use of the biosphere came to an end and it was necessary to regulate the biosphere usage.

Another vector is associated with the "building" of society. It is a creative vector by its nature, it is associated with openness as one of the fundamental traits of man, separating him from animals. In philosophy, there is a tradition of viewing a person as an open being, and here we mean the social level of openness, i.e. society. Society is not associated with man by nature, it is created and functions due to people (Nagornykh, 2011), (Pogulyaeva, 2018), (Bodriyyar, 2018).

If in the infancy of mankind, the external vector was aimed at interacting with nature, opposing man (man is nature), then the internal vector was aimed at regulating the “man-man” interaction, i.e. at transformations of people’ relationships. At the junction of these two processes, a qualitatively new artificial environment was formed to become the human habitat. This artificial environment is a fragment of the natural environment, transformed by the creativity of people acting as a society. The destructive nature of the external vector in this synthesis is overcome, initiating creative activity to generate culture.

What in the implementation of the internal vector provides this transformation? The destruction of biological mechanisms necessary for community functioning as innate behavioral patterns absent (human openness also manifests itself in them) and the complication of our ancestors’ activities could lead to chaos and destruction of any community. The basis of social being is a special mechanism that generates some specific attitude of a person towards a person, ensuring people’ unification and the maintenance of cooperation order. Morality becomes this mechanism. At the same time, moral norms should have been of a “general” character, i.e. related not to a specific situation, but to people’s general behavior in relation to their relatives. These norms required justification (in the form of myths) and systematic special reinforcement (in the form of rituals), since other norms of human interaction were "perfected" by the centuries-long joint actions of ancestors (for example, hut building or hunting).

Under the conditions of the appropriating farm, the formation of ideas justifying the obligation of ethical norms took place based on the vector of instrumental activities, since the primitive team was immersed in the natural environment and was completely dependent on it. Totemistic beliefs reflected this process. Totemistic notions and the associated clan organization "equated" people to animal communities. By this, people identified themselves in the forming mythological picture of the world. Each person (tribesman) became the same (equal) as hundreds of animals representing the totem. Conceptions of their equality were formed, for their own special rules were created: how to treat them and act. These rules did not apply to others. Thus, the primitive team delimited itself as a special society from other people but used for this the way of identifying itself with animals, because the habitat of these people was the natural environment little physically transformed by them.

At the stage of the producing economy, a reverse movement took place: the person began to transfer the changed social relations to instrumental activities, i.e. on the interaction with nature. The appropriating economy radically changed the environment, making it different to the natural environment. The artificial environment in its synthesis with society, through which the natural environment was perceived, came to the first place in people's perception (Plotnikov, 2001). But society is heterogeneous socially and economically, and the farther its heterogeneity goes, the more it grows. Its unity is supported by traditions, rituals, some certain ideas, the basis of this complex being the moral that defines common, equal to all rules, relationships and principles of interaction. Nature, however, is increasingly acting as a foreign environment, not cultivated, constantly destroying the people's efforts to maintain the proper condition for the developed space, ethical rules serving the human society. Thus, a "wedge" occurs in the tie "man – nature". Once the natural environment has acquired the status of an alien, then ethical norms and rules do not apply to it, one can treat it as an alien. This trend gradually intensified in the historical development of mankind. The current situation showed that this dynamic reached its limit.

The way out is seen as the ways of returning nature the status of being equal to humanity. It is necessary to focus on the understanding of nature organism. Interactions with nature cannot be built only based on immediate benefits. In the article "Ecological culture as the highest form of humanism" E.V. Girusov emphasizes that it is necessary to shift the vector of considering and solving the environmental problems from anthropocentrism to ecocentrism. Thus, he understands the manifestation of a new humanism assuming the intrinsic value of life and freedom not only for humans, but also for all living beings and all-natural objects (Girusov, 2009).

Although the term "ecology" was introduced by Haeckel, even in antiquity the great Aristotle coined the word "oikonomia" to denote the science of proper housekeeping, because he believed that the household should be managed on a scientific basis, rationally and reasonably. Nowadays, the common home for all humans is the planet Earth, and therefore our common "household" also needs to be managed and improved. First, it is necessary to take measures against environmental pollution: this includes the protection of the water and air basins, the protection of the soil, the preservation of flora and fauna, the preservation of the genetic resources. In solving all these problems, the key role belongs to man, since he is not a passive victim of the world development course, but the key figure.

The central concept of social ecology is the "society-nature system", which implies the applying the laws concerning the part-to-whole ratio to society, with the biosphere being the whole in relation to society. We live in an era of transition from the pre-ecological phase of interaction between nature and society to the ecological one. The fate of humanity depends on the success of this transition. Under these conditions, philosophy acquires a new mission of revising the ideological orientations associated with the critical approach to all manifestations of human activity (Picot della Mirandola, 1991). Therefore, it is necessary to develop mutually agreed ethical, legal, economic regulations that would reflect the laws of the co-evolutionary development of the "man-society-nature" system: "this broad ethical, economic and legal approach makes it possible to transform environmental imperatives from some of the most important intentions and trends into visible realities of our time, supported by a new environmental education"(Liseev, Petrov, Fesenkova, & Khen, 2016).

If earlier the nature-transforming function of culture was emphasized, now it is necessary to focus on the nature-preserving function, which means not the opposition of nature and society, but their combination. Therefore, the call "Everything for Nature", including man as a part of nature, sounds more relevant. The former aim concerning the conquest of nature is becoming more and more dangerous. The intention to conquer nature must be replaced with an idea of cooperation with nature, of respectful attitude towards it. Since we remain living in nature, we must obey its laws. It has to be stated that a person still does not possess the main property for any living organism – the property of ecological self-sufficiency. But without this property, man and mankind have no future.

Developing the noosphere theory V.I. Vernadsky showed that with the development of production activities, the role of the main geological factor begins to shift precisely to man (Vernadsky, 2014). Therefore, the most important task that humanity currently faces is to prevent such changes that would harm the natural environment and all forms of life, including humans. It is necessary to make this process rational. However, it must be stated that so far, the impact of society on the biosphere does not contribute to the improvement of its organization, stability and integrity. Therefore, it is extremely important to develop the scientific foundations of human economic activity, which would consider the consequences of all the changes of natural processes that people make, because any society's impact on nature boomerangs, and the more significant is the interference, the stronger is the effect. V.I. Vernadsky believed that the noosphere creation would provide a harmonious combination of social processes with the processes in the biosphere. And here it is impossible to overestimate the role of the moral state of society, since morality is a way of existence of rational beings, it represents a system of norms, rules, assessments governing communication and behavior of people in order to achieve social and personal interests. And ethics reflects morality, it is based on what has already happened in the real sphere of human behavior (Pruzhinin, et al., 2017).

Modern ethics is made up of many concepts, the main ones being the ethics of virtues, the ethics of duty, and the ethics of values. The basic ideas of the ethics of virtues were first developed by Aristotle, who by virtue understood man's qualities necessary to control his passions. He identified evil as the paucity of virtues (Aristotle, 2002). The ethics of duty is associated with I. Kant to imply the requirement to submit to the categorical imperative, the essence of which is to ensure that no one is harmed and never treat a person as a means (Kant, 1965). The ethics of values was developed by M. Scheler and was of a sociocentric character, with the values of justice and freedom being the main ones (Scheler, 1988). In the second half of the 20th century, H. Lenk proposed a new version of the concept of values and called it as the ethics of humanity's responsibility for its future, including inanimate nature and wildlife (Lenk, 1989). In this concept competence is highlighted. First, it is the scientists who should be responsible for the results of their activities, for the quality of researches, for the fulfillment of their professional duties. This is especially relevant today, because in the market conditions even scientific activity is actively involved in the market of goods and services and, therefore, is subject to the same aberrations as any other product; advertising also works, often manifesting charlatanism. The form of ethical self-control is the relevant charters and codes including the representatives of different professional communities, for example, engineers, physicians, environmentalists, etc. Thus, starting from the second half of the 20th century, theoretical ethics begins to give way to applied ethics, where morality is increasingly identified with the expediency and good quality of decisions in specific areas of human activity.

Environmental ethics emphasizes that respect for nature is important not only from the utilitarian and practical position, but from the moral one. Long before mankind almost felt the burden of environmental problems, some representatives of Russian cosmism stated this (N.F. Fedorov, V. I. Vernadsky and others), (Fedorov, 1995), (Vernadsky, 2014). Reckless activism to nature should be limited. And the education system should play a special role here. In 1979, the Club of Rome prepared a report entitled "There are no limits to learnability" emphasizing that it is necessary to overview moral guidelines to be suitable to the modern era, that the fate of the world depends not only on science and technology, but also on spiritual order. Human qualities and their formation depend on the education system (Pechchei, 1980; Radovic-Markovic,2017). In this sense, its mission is global since it is here that the spiritual, intellectual resource that is realized in the subsequent human life is laid. And since the rate of changes taking place in our days in society is unprecedented, the educational system must be continuous, multi-level and diverse. Every person during his life should be ready for professional retraining repeatedly, or radical professional changes.

5. CONCLUSION

This study is devoted to finding out the origins of the environmental crisis. The authors tried to understand the internal nature of the process of society's adaptation to the environment. For this purpose, material was used in relation to the anthropogenesis completion and the first stages of human history. The contradictory nature of the interaction between society and nature was shown, the dynamics of changes in their relationships and the origins of the consumer attitude towards nature were revealed. In the authors' opinion the ways to solve modern environmental problems depend on changing value priorities. It is necessary to agree with several modern researchers, that the most important task facing humanity today is the creation of a new ethic.

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ORIGINAL RESEARCH PAPER

ECOLOGICAL AND SOCIAL ASPECTS OF URBANIZED AGRICULTURE

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ABSTRACT

The social and environmental benefits of urbanized agriculture have determined the relevance and leading role of agrarian urbanism in solving the problem of uninterrupted food supplying to the areas of large cities. The contemporary level of technologies related to urbanized agricultural production makes it possible to grow a wide range of green vegetables containing important components (vitamins, antioxidants) at municipal educational facilities. To improve the efficiency of technologies and technical means related to urbanized agriculture, we developed a system for disinfecting nutrient solutions using physical methods (ultraviolet radiation and filtration). The object of this study was the process of hydroponic cultivation of green vegetables in the conditions of urbanized agriculture; the subject of the study was the regular patterns of change in green vegetables yield under various modes of ultraviolet irradiation and filtration of nutrient solution. The working hypothesis was formulated as follows: hydroponic solutions disinfected by filtration and ultraviolet irradiation will improve the conditions for growth and development of plants by removing and destroying pathogens. The conducted research proved that green vegetables cultivation using the developed system has higher technical and economic efficiency caused by an increased yield and improved product quality, reduced energy intensity and increased energy efficiency. The presented technical solutions are recommended for the technologies of urbanized agriculture and greenhouse vegetable cultivation. The field of further research relates to the development of systems for cultivating a great variety of plants including decorative, spicy, flavor and medical ones.

JEL classification: Q15, Q19

***Keywords:** social aspects of agrarian urbanism, ecological aspects of agrarian urbanism, urbanized agriculture, food safety, green vegetables, ecological purity, product quality, hydroponic system, technical and economic efficiency*

1. INTRODUCTION

The increase in the share of urban population and growing concentration of inhabitants in large cities result in escalating the problem related to uninterrupted food supplying to urban areas. In accordance with the prognosis of scientific and technological development of agroindustry complex in the Russian Federation for the period up to 2030, this problem can be solved by developing the infrastructure of urbanized agriculture (The prognosis of scientific and technological development of agroindustry complex in the Russian Federation for the period up to 2030, 2017).

This paper deals with the ecological and social aspects of urbanized agriculture. The purpose of the study is the development of innovative technical solutions aimed at improving its economic and energy efficiency.

The object of this study was the process of hydroponic cultivation of green vegetables in the conditions of urbanized agriculture; the subject of the study was the regular patterns of change in green vegetables yield under various modes of ultraviolet irradiation and filtration of nutrient solution. The working hypothesis was formulated as follows: hydroponic solutions disinfected by filtration and ultraviolet irradiation will improve crop yields and increase economic efficiency of green crops production, thereby resulting in profit growth which is one of the most important tasks of agricultural production.

2. LITERATURE REVIEW

The global challenges in the development of world agroindustry complex such as the loss of soil fertility, the lack of water for irrigation, the increasing demand for food, the ever-growing concentration of population in large cities, etc. definitely determine the relevance of agrarian urbanism (The prognosis of scientific and technological development of agroindustry complex in the Russian Federation for the period up to 2030, 2017). Urbanized agriculture, which implies the use of environmentally friendly agricultural technologies for the crop production in a closed, controlled environment, has several advantages (The prognosis of scientific and technological development of agroindustrial complex of the Russian Federation for the period up to 2030, 2017), (Blednykh, et al., 2003), (Fuldauer, Parker, Yaman, & Borrion, 2018), (Artmann & Sartison, 2018), (Khoneva, et al., 2018), (Atmadja, Liawatimena, Lukas, Nata, & Alexander, 2018), (Diekmann, Gray, & Baker, 2018) , (Lamba, Phogat, & Kumar, 2017), (Kline, et al., 2017), (Arrobas, Lopes, & Rodrigues, 2017), (Hong, Xie, Guo, Hu, & Liao, 2017), (Bellemare & Novak, 2017), (Pinna, 2017), (Attwater & Derry, 2017), (Zeleňáková, Diaconu, & Haarstad, 2017), (Kang, et al., 2017), (Delaide, Goddek, Gott, Soyeurt, & Jijakli, 2016), (Huang, Chen, & Tsai, 2016), (Liaros, Botsis, & Xydis, 2016), (Karras, et al., 2016), (Tsirogiannis, et al., 2016), (Shan, Wang, & Ma, 2016).

The ecological benefits (in comparison with traditional farming) include the preservation of soil resources, the decline of water and fertilizers consumption, the reduction of energy costs, etc. The social benefits comprise the improvement of working conditions, the employment of the population, the inculcation of ecological culture foundations, the possibilities of agritourism development. A visit to a nine-story office building in Japan with the unique systems of facade and interior landscaping can serve as an example of urban agritourism. Vegetables, fruits, cereals and flowers are grown by hydroponics technique on the area of 4000 m^2, which constitutes almost 20% of the total area of the building. Plants, which provide food, fresh air, protection from dust and additional coolness, have become a part of business environment. Employees are involved in growing and harvesting processes which are carried out under the guidance of experienced agronomists. Urbanized agriculture, that implies a year-round crop production, is associated with high energy costs, and therefore it seems appropriate to consider the length of the growing season and the content of environmentally friendly components (vitamins, antioxidants, etc.) in the selection of cultivated crops. The energy-biological assessment helped to reveal, that green vegetables (lettuce, basil, parsley, dill, sorrel, celery) and forcing crops (perennial onions, garlic and beets) are the most preferable (Tsittser, Basarygina, & Putilova, 2017), (Tsittser, Basarygina, & Putilova, 2013).

The contemporary level of agrarian urbanism development makes it possible to grow the listed plants in municipal educational institutions including colleges, universities, kindergartens and schools. Technical characteristics of several hydroponic systems are given in Table 1 (Tsittser, Basarygina, & Putilova, 2013).

Table 1: Technical characteristics of hydroponic systems

CHARACTERISTIC	SYSTEM	
	MHS-P	MHS-C
Hydroponic method	IONITOPONICS	
Watering schedule	MANUAL / AUTOMATIC	
Overall dimensions, mm height width depth	 2100 530 530	 1035 530 530

CHARACTERISTIC	SYSTEM	
	MHS-P	MHS-C
Total volume, m^3	0.58	0.29
The floor area occupied by the system, m^2	0.28	0.28
Supply voltage, V/frequency, Hz	220/50	220/50
Power consumption, W	27	27
Corrected sound power level, dBA	59	59
The total area of the vegetative surface, m^2	1.4	0.56
Cultivated crops	green vegetables	

Source: Author

The process of green vegetables cultivation includes the following technological operations: preparation of seed or planting material, preparation of the substrate (soil substitute), sowing, periodic watering, harvesting. Ecological purity of obtained food is achieved by eliminating the use of soil, water purification using ion-exchange and sorption materials contained in the composition of substrate, preparation of irrigation solutions based on fertilizers obtained from natural humic acids (Tsitser, Basarygina, & Putilova, 2013), (Simizu & Basarygina, 2015).

Hydroponic cultivation of vegetable crops can be implemented by the systems functioning in Green Plant Factory, Table 2 (Simizu & Basarygina, 2015).

Table 2: Technical characteristics of hydroponic system in Green Plant Factory

1	The floor area occupied by the system, m^2	1.89
2	Number of tiers	4
3	Supply voltage, V/frequency, Hz	220/50
4	Power consumed by the system, kW	0.9
5	Operation mode	automatic
6	Cultivation technology	deep-sea hydroponics
7	Root environment	nutrient solution
8	Plant placement	foam panels
9	Pre-germination	required
10	Cultivated plants	green, fruit vegetables

Source: Author

3. METHODOLOGY

The system approbation in Green Plant Factory (ESPEC, Japan) was carried out at the Federal State Budgetary Educational Institution of Higher Education "South Ural State Agrarian University" together with the researchers from Kyoto University.

To improve the efficiency of technologies and technical means of urbanized agriculture, a system for disinfecting nutrient solutions using physical methods such as ultraviolet radiation and filtration was developed.

The cultivation of lettuce variety *Moscovskiy* using the flow hydroponic method lasted thirty days (all the required microclimate parameters were met). The experiments were conducted in quadruplicate; the sample size was fifty plants; the randomization principles were used to ensure the enough accuracy of the experiment.

The methodology for evaluating the effectiveness of nutrient solution disinfection has been developed; it considers the ecological purity, the biological usefulness and the preservation of product quality using special coefficients (Table 3), that is its main difference from all previously known methods.

Table 3: Methodology for evaluating the effectiveness of nutrient solution disinfection: calculated coefficients

Coefficient	Function
$C_p=C_mC_bC_qC_i \geq 1$, where C_m, C_b, C_q, C_i are the coefficients which consider the effect obtained from purifying procedures affecting the conditions of mineral nutrition, biomass yield, product quality and its implementation, respectively.	Determines the effectiveness of hydroponic solution disinfection
$C_m=S_{mp} / S_{mb}$, where S_{mp}, S_{mb} are the content of pathogenic microorganisms in the nutrient solution for the projected and the basic versions, respectively.	Considers the conditions of mineral nutrition
$C_b=B_p/B_b \geq 1$, where B_p, B_b are the biomass yield in the projected and in the basic versions, respectively.	Considers the yield
$C_q= C_{pe1}\ C_{pe2} \geq 1$, where C_{pe1} is the production-ecological coefficient of the first kind; C_{pe2} is the production-ecological coefficient of the second kind.	Evaluates the ecological purity and biological usefulness of products
$C_i= C_pC_u$, where C_p, C_u are the coefficients of product quality preservation and biological products utilization, respectively.	Takes into account the preservation of product quality
$C_{ee}=E/E_t=(Y_cf_m)/E_t$, where C_{ee} is the energy efficiency coefficient, E is the energy content of products, kJ/m^2; Y_c is the yield, kg/m^2; f_m is the coefficient of energy content per unit of output, kJ/kg; E_t is the energy costs for the crop cultivation and harvesting, kJ/m^2.	Determines the energy efficiency

Source: Author

4. EMPIRICAL FINDINGS

The analysis of experimental results obtained during system approbation in Green Plant Factory has shown that its application makes it possible to successfully cultivate green cultures. The lettuce grown under the conditions of educational laboratory met all the requirements for ecological purity and biological usefulness; it had an excellent taste and attractive appearance (Simizu & Basarygina, 2015). According to the research results obtained by the scientists of the Federal State Budgetary Educational Institution of Higher Education "South Ural State Agrarian University" and Kyoto University, a project "Eco-factory of green plants" was developed. It represents an inter-university education-research-production plan for implementation of a year-round environmentally friendly crop production using modern technologies and equipment of Russian and Japanese manufacture; practical training of students in various spheres: engineering, agricultural, economic; environmental education; conducting research; language practice (communication with native speakers). The project “Eco-factory of green plants” became the winner of the National Award in the field of ecology. It was carried out by the support of the Ministry of Natural Resources and Ecology of the Russian Federation, the United Nations on the issues of Education, Science and Culture, UNESCO, the All-Russian Society for Nature Preservation, the Center for International Industrial Cooperation, the United Nations Industrial Development Organization (UNIDO) in the Russian Federation.

As a result of theoretical and experimental studies, the system parameters for ultraviolet irradiation and filtration of the nutrient solution were determined: filtrate volume ($0.06 \cdot 10^{-3}$ m$^{3)}$, bactericidal flow (0.75 W), electricity consumption for disinfection (0.2 kW·h/m^3), head losses ($0.01 \cdot 10^{-3}$ m). Analysis of the mathematical models obtained using the method of active experiment planning showed that in order to achieve the highest yield, an irradiation dose of 16 mJ/cm^2 is necessary (when a nutrient solution has a temperature of 293 K, absorption coefficient is 0.33; extinction is 0.14; transmittance coefficient is 74%).

The efficiency evaluation of nutrient solution disinfection revealed that the indicators of ecological purity and biological usefulness increased; the preservation of product quality was higher in the proposed version.

The production tests showed that green vegetables cultivation using the developed system has a higher technical and economic efficiency: in the experimental version the yield increases by 10–15%, there is a decrease in the energy intensity of production by 2.5–3.0 GJ/t and an increase in energy efficiency by 12–15%; the economic effect is about $14,800 (975 thousand rubles) for a standard hangar greenhouse with a production output of about 10 tons per year.

The presented technical solutions are recommended to be used in the technologies of urbanized agriculture and greenhouse vegetable production. The sphere of further research can be connected with the development of systems for cultivating an expanded range of plants such as decorative, spicy, flavor and medical ones.

5. CONCLUSION

Urbanized agriculture has social and environmental benefits over traditional farming. This fact determined the relevance and the leading role of agrarian urbanism in solving the problem of uninterrupted food supplying to the territories of large cities. The modern level of developing urbanized agricultural technologies makes it possible to grow a wide range of green vegetables containing environmentally friendly components (vitamins, antioxidants) in the facilities of municipal educational institutions. To improve the efficiency of technologies and technical means of urbanized agriculture, a system for disinfecting nutrient solutions using physical methods (ultraviolet radiation and filtration) has been developed. We propose this technique for evaluating the effectiveness of nutrient solution disinfection; it takes into account the ecological purity, biological usefulness and preservation of product quality. As a result of the research, the hypothesis has been confirmed. It has been proved that the cultivation of green vegetables using the developed system has higher technical and economic efficiency: the yield increases by 10–15%, the energy intensity of production decreases by 2.5–3.0 GJ/t, and the energy efficiency increases by 12–15%. The effectiveness evaluation of nutrient solution disinfection showed, that in the proposed version there is an increase in the indicators of ecological purity and biological usefulness and the improvement of product quality preservation. The economic benefit amounts to about $14,800 (975 thousand rubles) for a standard hangar greenhouse with a production output of about 10 tons per year.

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ORIGINAL RESEARCH PAPER

CAPITALIZATION AS A FACTOR OF AGRICULTURAL PRODUCTION INTENSIFICATION

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ABSTRACT

The purpose of the study was to identify the quantitative parameters of capitalization and its influence of effectiveness of resources of agricultural production. According to federal statistics data, some tendencies in changing labor resources were identified (the indicator concerning the number of agricultural workers per thousand people was analyzed) and shifts in wages in agriculture and in the country's economy. The reduction in the number of people employed in the agrarian sector of the economy (with the average annual outflow being 1.19 per thus. people) and low rates of wages convergence (by 14.7% over 13 years) made it possible to draw the conclusion about the labor factor replacing by the investment and intensification factors of the agrarian economy. To assess the effectiveness of agricultural production, the average per capita provision with agricultural products (gr. equiv. t) per capita was used, which in conditionally natural units characterizes the level of food security in tons of grain equivalent per capita of the country every year. A steady increase of this indicator in Russia has been observed since 2007. An annual increase in labor productivity being 4.26 gr. equiv.t is also established per employee, which made it possible to increase the level of efficiency when using labor resources by twice during 2003-2016. The dependence of labor productivity on its capital-labor ratio is close to linear. Each point of the capital-labor ratio increases equals to 5.4975 points of the effect increase given in standard-natural units.

JEL classification: Q10, E23

***Keywords** agriculture, production factors, capitalization, intensification*

1. INTRODUCTION

Agrarian intensification is understood to be the development of agricultural production by increasing productivity. Urbanization and the collapse of the social rural infrastructure predetermine the outflow of qualified labor from the sphere of agricultural production. In this regard, the preservation and enhancement of food security makes the study urgent. The main direction to expand agricultural production is to introduce automated capital-intensive technologies that do not require significant labor resources. Thus, the study of the process of replacing labor with capital as a capitalization process of resource potential characterizes the urgency of the study.

2. LITERATURE REVIEW

The analysis of publications on the studied topic showed the efficient use of resources in agriculture to be of primary interest in many countries.

The problems caused by the rural population downsizing and concerns over food security are characteristic not only of Russia, but also of similar agriculturally developed countries, particularly, of Australia (Millar, 2012).

The methods for studying are being developed in the direction of analyzing large amounts of data and including the maximum number of factors in the models. Cobb-Douglas production function, proposed in 1927, has been used by agrarian economists since the 30s-40s, and most widely since the 50s of the 20th century (Biddle, 2011). Its use makes it possible to assess the joint impact of the main production factors, though there are significant limitations due to the presence of the social factor that has a complex effect on the agricultural productivity, as well as the need to consider the price parameters of production resources. However, in its modified form, it is still used up to now (Uzawa, 1962), (Kubik, 2015), (Duffy, 2000). When assessing the influence of many factors, multifactor linear models are used (Gadanakis, 2015), the index method being also used to assess the influence of the dynamics of factors (Christensen, 1975), (O'Donnell, 2012).

3. METHODOLOGY

The hypothesis of the study. Along with the outflow of labor resources, the introduction of capital-intensive technologies forms the process of increasing capital to preserve the level of food security of the national economy. Therefore, the growth of labor productivity as a result of the supporting the labor resources with capital determines agrarian intensification. In this regard, capitalization is supposed to be a factor of agrarian intensification, and the growth of capitalization leads to an increase in the return of the production resources involved.

To confirm the hypothesis, the following tasks were consistently solved.

1. The economic security of the agrarian sector concerning labor resources and the wage level was analyzed.

2. The average people's supply with agricultural products (characterizes the effectiveness of agricultural production) and labor productivity (characterizes the effectiveness of the use of labor resources) were analyzed.

3. The capital-labor ratio (the indicator of available resources, characterizes the ratio of capital and labor resources) and capital productivity (characterizes the effectiveness of capital utilization) were analyzed.

4. The relationship of labor productivity and capital productivity were analyzed.

Materials and methods used to study. The adjusted data of the statistical registers of Federal State Statistics Service (Rosstat) were used as initial ones.

One of the main issues of economic research is the commensurability of cost data over time periods. The complexity of the issue lies in the significant variation of the inflation component for comparison. A typical solution is to introduce a neutral conventional unit, such as the US dollar, energy and other equivalents, which is also used to analyze the efficiency of resource usage in agriculture (Wang, 2014). In our case, we use a ton as the grain equivalent (abbreviated as gr. equiv. t), which corresponds to the statistical register indicator "agricultural producers' average prices in the Russian Federation, wheat average per year, rubles per ton"[1]:

$$WET = I : PW, \quad (1)$$

WET – the corrected indicator as wheat equivalent ton, Mt;

I – the value indicator, Rubles;

PW – wheat price, Rubles per Mt.

By transferring cost indicators into in-kind, it is possible to eliminate the influence of the price factor that is dependent on inflation, and thus the short- and medium-term price fluctuations. Long-term

[1] URL: http://www.gks.ru/wps/wcm/connect/rosstat_main/rosstat/ru/statistics/tariffs/#

changes of price ratios will obviously result in intersectoral flow of capital, which may cause changes in the size of investments considered in the models used.

To assess the supportability of agricultural production with labor resources a relative indicator characterizing the number of workers in agricultural production per thousand people (employee/thous.people) can be used. Indirectly, the indicator (in the absence of recommendations for optimizing the mutual ratio of productive resources) makes it possible to estimate the relative (compared with the other sectors of the economy) amount of labor resources in agriculture. It is calculated as the ratio of the indicators “average annual number of people employed in agriculture, hunting and forestry – total number” to the indicator “population in the Russian Federation”. The correlation with the indicator of the total number of people employed in all sectors of the economy is irrational, since the people employed in the agricultural sector satisfy the food needs of all the inhabitants of the country, and it is also necessary to bear in mind the existence of the problem of shady employment. Another argument for using this indicator is the possibility of comparing the indicators of the resource supportability (the supportability with labor resources) of various sectors of the economy.

The ratio of wages in the agricultural sector to the economy-wide level of wages is calculated as the ratio of the data “average monthly employees’ wages nominally accrued in organizations according to economic activities (in accordance with OKVED-2007) in the Russian Federation” for the sector “agriculture, hunting and forestry” to the similar indicator for "economy-wide." This indicator characterizes the differentiation of the cost of labor resources in the agriculture and the economy, as well as the level of income of workers in the industry compared with other sectors of the economy.

2. Average supportability with agricultural products gr. equiv.t /thous. people. To find this indicator, the statistical registers “Agricultural products according to farm categories (actual prices)”[5], “Export of food products and agricultural raw materials (except textiles)”[6], “Import of food products and agricultural raw materials (except textiles)”[7], “Population of the Russian Federation”[8]. By subtracting the export from the sum of production and import, the values of the population supply (the volumes of consumption and carry-over stocks) with agricultural products are obtained. The indicator of average supply is determined by dividing the obtained value of the population supply with agricultural products by the population size adjusted for the grain equivalent (see Formula 1). Average supply essentially characterizes the level of food security, i.e. the level of food security in tons of grain equivalent per inhabitant of the country per year. Obviously, the physical volume of food will depend on the degree of processing of agricultural products: the higher this degree, the more significant is the difference in the physical volume of food and the conventional ton of grain equivalent.

Labor productivity is found as the ratio of the indicator “agricultural products according to farm categories (actual prices)”[2] to the indicator “average annual number of people employed in agriculture, hunting and forestry – total number”[3].

3. The indicator “capital-labor ratio” is found as the ratio of the statistical registers “investment in basic capital according to the types of economic activity, agriculture, hunting and forestry”[4] to the indicator “average annual number of people employed in agriculture, hunting and forestry – total number”[5] adjusted for grain equivalent (see Formula 1).

The indicator “capital productivity” is defined as the ratio of statistical registers “agricultural production by farm categories”[6] to “fixed capital investment by economic activity, agriculture, hunting and forestry”[7] adjusted for the grain equivalent (see Formula 1).

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[2]URL: http://www.gks.ru/wps/wcm/connect/rosstat_main/rosstat/ru/statistics/enterprise/economy/#
http://www.gks.ru/wps/wcm/connect/rosstat_main/rosstat/ru/statistics/enterprise/economy/#

[3]URL: http://www.gks.ru/wps/wcm/connect/rosstat_main/rosstat/ru/statistics/wages/labour_force/#

[4]URL:http://www.gks.ru/wps/wcm/connect/rosstat_main/rosstat/ru/statistics/enterprise/investment/nonfinancial/#

[5] URL: http://www.gks.ru/wps/wcm/connect/rosstat_main/rosstat/ru/statistics/wages/labour_force/#

[6]URL: http://www.gks.ru/wps/wcm/connect/rosstat_main/rosstat/ru/statistics/enterprise/economy/#

4. The dependence of labor productivity as a criterion of production intensity on the capital-labor ratio as a criterion for the capitalization of labor resources determines the dynamics of the replacement of labor resources with capital. The ratio of these indicators determines the capital productivity as an indicator of the effectiveness of capital.

The obtained indicators formed dynamic series and according to the graph-functional analysis were approximated with functional dependencies based on the criterion of maximizing the accuracy of approximation R^2. One can note the following peculiarity of approximation in MS EXCEL: the construction of trend dependencies (tendencies) when using the function argument as the ordinal number of any year within the period under consideration, i.e. 2003 being the first year within the period 2003-2016, corresponds to the unit value of the approximated dependence.

4. EMPIRICAL FINDINGS

Analysis of the dynamics of the average per capita provision of agricultural workers (Fig. 1) reveals a tendency of the form $y = -1.1923x + 55.372$ ($R^2 = 0.9227$).

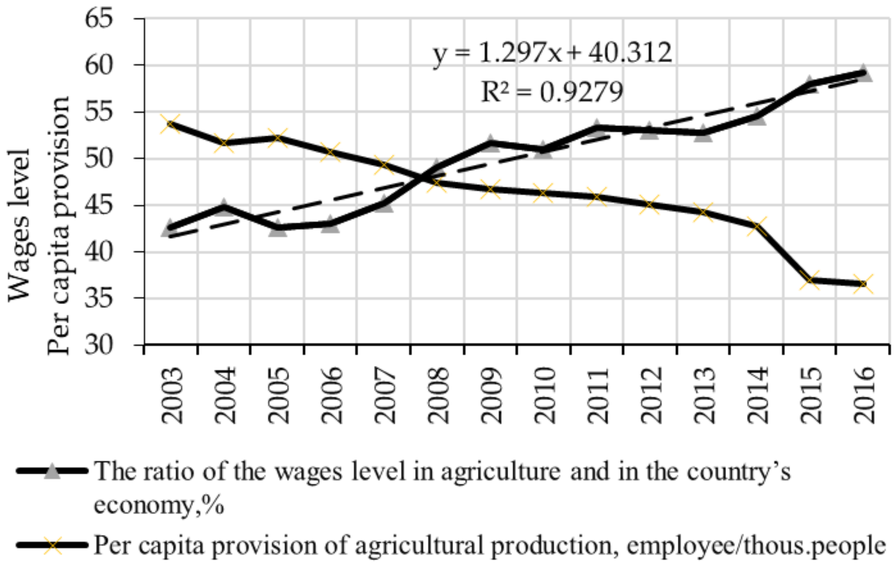

Fig.1 Dynamics of the level of income and the number of agricultural workers from year to year
Source: Author

Obviously, there is a steady outflow of labor resources from agricultural enterprises, with 1.19 people per thousand people being an average annual tendency. During 2003-2016, the load for ensuring food security per worker in agricultural production increased by 1.47 times. In 2003 and 2016 the employees' number was 53.79 and 36.61 per thousand people, respectively. Hypothetically, with such a tendency being stabile, in 30 years there won't be any labor resources in agriculture. This tendency corresponds to the general situation of reducing the employees' number in the agricultural sector of the economy in developed countries (Millar, 2012), (Ji, Yu, & Zhong, 2012), (McNamara & Weiss, 2005), (Mundlak, 2005), which is manifested in the employment growth in non-agricultural sectors of the economy and additional income from non-agricultural activities.

[7]URL: http://www.gks.ru/wps/wcm/connect/rosstat_main/rosstat/ru/statistics/enterprise/investment/nonfinancial/#

When considering the main driving force of inter-sectoral migration, i.e. the differentiation of wage levels, there was revealed a tendency to raise wages in rural areas up to the average level in the economy. This tendency is well approximated by a linear function of the form y = 1.297x + 40.312 with the approximation validity coefficient $R^2 = 0.9279$. Thus, the gap in wage levels in rural areas and in the economy decreased from 55.45% in 2003 to 40.74% in 2016. This tendency being kept to, the level of employees' wages in agricultural enterprises will correspond to the general economic level in 31 years. The upward tendency in the wage level in the agricultural sector is also observed in other countries, particularly in China, which leads to shifts in the proportion of agricultural production resources due to the substitution effect (Liu, Hu, Jetté-Nantel, & Tian, 2013).

Probably, such insignificant changes in the level of income cannot stimulate the attracting of labor resources in agriculture in the current situation. Consequently, the relative shortage of labor resources can be compensated by the investment factor, which replaces the labor one. Hence, the growth of capitalization can be the main source for intensification of agricultural production.

The analysis of statistical data proves that there are some positive changes in supplying the population with agricultural products (Fig. 2) as the main criteria for food security.

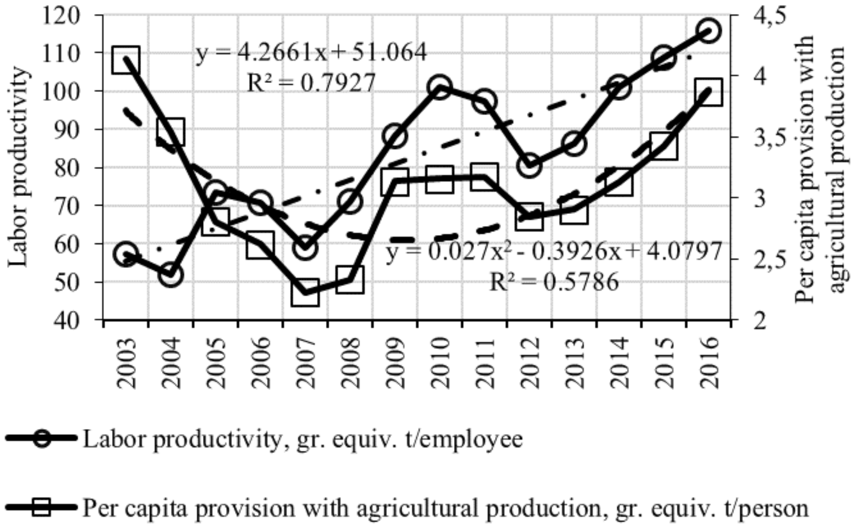

Fig. 2. Dynamics of the food security from year to year
Source: Author

The population's supply with agricultural products has a pronounced parabolic dependence with significantly varied values of indicators from year to year. The dependence has the form y = 0.027x2 - 0.3926x + 4.0797 ($R^2 = 0.5786$). The tendency towards a decrease in the value of the indicator of the population's supply with agricultural products, and consequently, the level of food security observed before 2007, is likely to be the starting point for the subsequent import substitution and domestic production increase. At the same time, labor productivity in agriculture grew throughout the analyzed interval (the tendency of the form y = 4.2661x + 51.064; $R^2 = 0.7927$).

Thus, the annual increase in labor productivity of 4.26 gr. equiv. t /employee resulted in a 2-fold increase in the efficiency of used labor resources from 57.21 (2003) to 115.93 (2016) gr. equiv.t per worker. This led to the population's supply with agricultural products at the level of 3.87 gr. equiv. t per person. From 2007-2008 the tendencies in labor productivity and the supply of agricultural products can be considered as synchronized, i.e. the increase in the level of food security of the Russian Federation is determined by labor productivity. Quite significant fluctuations in labor productivity could be caused by unaccounted factors leading to changing of the resultant mark, even if there is a constant tendency for changing the proportions of production resources (Tozer & Villano, 2013).

Let us consider the reasons for the growth of labor productivity along with the outflow of labor resources from the industry (Fig. 3). The growth factor is likely the process of capitalization.

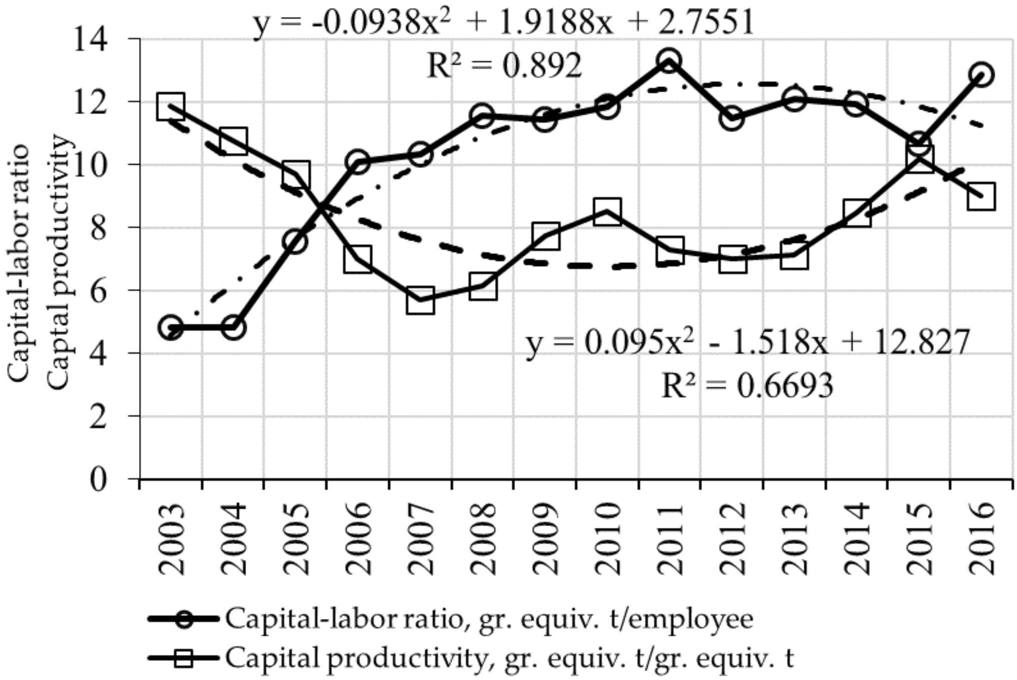

Fig.3 Capital-labor ratio and capital productivity from year to year

Source: Author

When analyzing the dynamics of capital-labor ratio, there occurs a tendency of the type y = - 0.0938x2 + 1.9188x + 2.7551; R^2 = 0.892. The capital-labor ratio increased from 4.82 (2003) to 12.87 gr. equiv. t /employee, i.e. by 2.67 times. Thus, the growth of capital-labor ratio by 2.67 times causes a 2-fold increase in labor productivity (compare Fig. 2 and 3). Since labor productivity is growing more slowly than the capital-labor ratio, it can be assumed that some part of the capital is spent on the compensation of the labor factor. The investments that lead to improved working conditions or a relative increase in wages (for example, because of a higher level of wages for more skilled labor) can serve as an example.

Let us consider the capitalization effectiveness as an indicator of capital productivity when increasing labor productivity and the revealed pattern of the form y = 0.095x2 - 1.518x + 12.827 (R^2 = 0.6693). A certain failure of capital return during 2006-2007 is obvious up to 5.70 points, but the subsequent (starting from 2008) increase in labor productivity (see Fig. 2) made it possible to increase the efficiency of capitalization up to 9.0 points by 2016, i.e. by 1.57 times.

Let us consider the dependence of labor productivity on its capital-labor ratio in the form y = 5.4975x + 26.17 (R^2 = 0.5535) (Fig. 4).

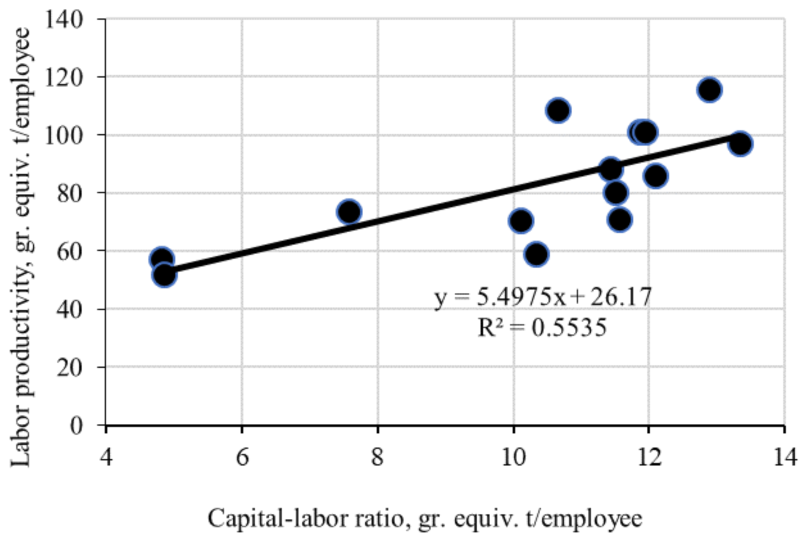

Fig.4. Capitalization efficiency during 2003-2016

Source: Author

Validation of models (Fig.1-4) is presented in Table 1.

Table 1Validation of models

Model	R^2	F-test	p-value
y = 1.297x + 40.312	0.9279	154.5102	0.0000
y = -1.1923x + 55.372	0.9227	143.2452	0.0000
y = 4.2661x + 51.064	0.7927	45.8769	0.0000
$y = 0.027x^2 - 0.3926x + 4.0797$	0.5786	2.1901	0.0904
y = -0.0938x2 + 1.9188x + 2.7551	0.8920	19.9437	0.0000
y = 0.095x2 - 1.518x + 12.827	0.6693	2.7912	0.0412
y = 5.4975x + 26.17	0.5535	2.0672	0.1072

Source: Author

Thus, a moderate tendency of productivity growth in increasing the capital-labor ratio is revealed. Each unit of capital equals to 5.4975 units of the result (effect). The level of capital (investment) efficiency in agricultural production in terms of labor productivity is more than 500%.

The objectives of this study did not include assessing the capital structure, but it can be assumed that it differs from the one in the developed countries due to the relatively underestimated land resources in Russia.

5. CONCLUSION

The average annual outflow of agricultural labor resources equalling 1.19 people per thousand people increased the load on agriculture by 1.47 times to ensure food security.

There has been an annual increase in wages in Russian agriculture by 1.29% against to the economy-wide one. According to this tendency the level of wages in agricultural enterprises will reach the economy-wide one in 31 years.

The annual increase in labor productivity of 4.26 gr. equiv. t /employee caused the increase in the efficiency level of used labor resources by 2 times. This led to restoring the level of food security as the people’s supply with agricultural products to the level of 3.87 gr. equiv. t per capita.

The capital-labor ratio during 2003-2016 increased by 2.67 times, which resulted in a 2-fold increase in labor productivity.

The increase in labor productivity during 2003-2016 increased the capitalization efficiency by 1.57 times. Each unit of the capital-labor ratio increase equals to 5.4975 points of the effect increase, given in standard-natural units.

Thus, as a result of solved tasks consistently, the hypothesis about the importance of capitalization as a factor of intensification of the agrarian economy has been confirmed. The goal of the study, i.e. to identify the quantitative parameters of the capitalization factor influence on the effectiveness of the used agricultural production resources, is achieved.

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ORIGINAL RESEARCH PAPER

ANALYSIS OF INDUSTRY PECULIARITIES IN THE FRAMEWORK OF TRANSITION TO INDUSTRY 4.0 (THE CASE OF THE FOREST INDUSTRY IN SVERDLOVSK REGION)

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ABSTRACT

The article discusses the theoretical background, institutional conditions, as well as industrial and regional peculiarities, which determine technological development within the fourth industrial revolution. This work aims to identify opportunities and risks that forest industry enterprises of Sverdlovsk region will likely face while engaging in their development prospects in the digital economy. The work systematizes findings of theoretical studies on the main development concepts of the fourth industrial revolution, describes governmental policies and initiatives, as well as defines the essence, characteristics and key technologies of "smart production". Based on the analysis of different studies, system-wide risks are identified, primarily including the deepening of inequalities in the society, such as social and gender inequalities. The main policy papers that determine the Russian national policy on the digital economy are also identified. Russia's position in the world in terms of the transition to digital economy is analyzed, based on which a lag developed countries is shown in the expansion of information and communication technologies (ICT). It is nevertheless found that ICT development indicators place the Sverdlovsk region as a leader not only of the Ural region but also in the whole Russia. Furthermore, in this regard, favorable economic conditions for forest enterprises are discovered, highlighting key growth potentials in digitalization of the forest sector in the region. The study is based on publicly available official statistics. The results of this work can be used in the development work of the regional "Digital Economy" project or by industry enterprises in defining their digital strategy. Promising areas of future research are model development for the transition to "smart production" and identifying factors of successful digital transformation.

JEL classification: Q18, Q57

***Keywords**: Industry 4.0, the fourth industrial revolution, forest industry, Sverdlovsk region*

1. INTRODUCTION

The contemporary modern industry represents the fourth industrial revolution. This is also referred to as Industry 4.0, which is a term that first appeared at Hanover Fair (Hannover Messe) in 2011.

Achievements of the third industrial revolution made it possible to manufacture and provide a variety of high-quality products to consumers. However, on the other hand, this came with a number of downsides, out of which highlights would be increased overconsumption of non-renewable resources, use of human labor to perform routine operations and increased environmental pollution.

The development and implementation of digital technologies allow to reduce, and potentially eliminate, these downsides. Deep integration of key digital technologies into business and production processes of individual industrial enterprises will ensure higher flexibility and adaptability of production (without loss of quality), cost reduction due to robotization of routine procedures, as well as decreased environmental footprint of value chains [1,2,3].

There is a clear and obvious case for industrial development to move towards Industry 4.0. This opens a need for thorough studies on the scale, complexity and interdependence of processes both in general, as well as in the context of individual industries and territories.

Although many publications discuss industrial revolution and digitalization of the economy, identifying key issues and challenges on the transformational path of individual industrial enterprises has remained beyond the scope of research attention. In particular, the forest sector is not a key specialization of Sverdlovsk region. However, 83% of the region's territory is covered with forests, the annual allowable cut is 24.8 million cubic meters and the region is one of the leaders in plywood and sawn timber production in Russia.

2. LITERATURE REVIEW OF INTERNATIONAL SOURCES FROM THE LAST FIVE YEARS

Different approaches to the definition of the information society concept can be considered as a theoretical basis for the modern industrial revolution.

Theoretical approaches are identified by F. Webster in his fundamental and widely cited monograph, "Theories of the information Society". In his work, he systematizes the theoretical approaches to two basic groups. On the one hand, there are supporters of the idea of social continuity, who do not deny the key role of information in the modern world but believe that its forms and functions were already defined earlier. On the other hand, there are supporters of the idea that a new type of society is emerging [5].

The first group includes theories of neo-Marxism (H. Schiller), reflexive modernization (A. Giddens), flexible accumulation (D. Harvey), the public sphere (J. Habermas) and the regulatory theory (M. Aglietta).

The second group includes representatives of post-industrialism (D. Bell), postmodernism (J. Baudrillard), the informational development (M. Castells) and flexible specialization theories (M. Piore and Ch. Sabel).

Debates regarding the impact of technologies on transformation of society in the framework of selected theoretical views continues to this day. At the same time, there are ongoing discussions on whether to consider digitalization as a continuation of the third industrial revolution or to recognize its revolutionary nature.

Professor Klaus Schwab, founder and president of the World Economic Forum, identifies three factors which allow the recognition of Industry 4.0 as the fourth industrial revolution [4, p.9]:

- development at an exponential pace resulting from global interdependence;
- width and depth of transformations based on a combination of various technologies;
- systemic impact related to all countries, industries and society.

The presence of such transformational forces requires an active participation of governments in the development and implementation of sound industrial policies [4,6].

Several studies are devoted to analysis of state initiatives related to the industrial revolution. One of the first ones, written by a group led by H. Kagermann, contains recommendations for the creation of state initiatives to develop key growth drivers for the German industry [3].

A second study, prepared by a group of Korean researchers, made a comparison of government programs and initiatives on the development of the fourth industrial revolution’s concept in Germany, the United States and the Republic of Korea. Based on this comparison they concluded that the list of cross-cutting technologies supported by the state is somewhat different. For instance, German and American government strategies pay extra attention to infrastructural support for production, such as organization of work, safety, resource efficiency, etc. [7].

Russian state initiatives related to the fourth industrial revolution mainly focus on digitalization technologies. The Decree of the President of the Russian Federation “On the Strategy of Scientific and Technological Development of the Russian Federation” No. 642 of December 1, 2016, points out the need for industrial enterprises "to switch to advanced digital ("smart") production technologies, robotic systems, new materials and design methods, creation of systems for processing large amounts of data, machine learning and artificial intelligence".

Research conducted by O. Romanova is devoted to the identification of priorities of Russian industrial policy in the context of the challenges of the industrial revolution [8,9]. This research also shows that the digital economy has become a key feature of the fourth industrial revolution.

Government Decree of Russian Federation No. 1632–p of July 28, 2017 approved the program of “Digital Economy”, listing several actions to improve the necessary conditions for the development of the digital economy with the ultimate goal to contribute to the economic growth and higher competitiveness of the country.

Research led by A. Babkin was devoted to developing a roadmap for the implementation of the state program [11]. Research work of B. Panshin and S. Tolkachev is also devoted to identifying opportunities to implement the state program [12, 13].

“Digital economy” has become one of the priority national projects defined by the Decree of the President of the Russian Federation [10]. According to this, the Government of the Russian Federation, together with regional government bodies, should ensure the implementation of the following objectives by 2024: threefold increase in the budget of digital economy development, achievement of import substitution in software, creation of a sustainable and secure information and telecommunications infrastructure for high-speed transmission, processing and storage of large amounts of data that is accessible to all organizations and households.

This project will form the basis for the development of a digital economy projects also on a regional level.

In the context of the fourth industrial revolution, the industrial enterprises must move towards the concept of “smart production”. The works of A. Radziwonetal (2014), S. Wang etal (2015), D. Luckeetal (2008) and M. Brettel (2014) describe the concept of smart industries [14-17].

In recent years, a lot of research has emerged devoted to individual technologies of “smart” production, which include the Internet of Things (IoT), big data, cyber-physical systems, additive manufacturing, virtual and augmented reality etc., and their convergence [18-21].

In summary, studies related to the development of enterprises in the context of the fourth industrial revolution can be divided into conceptual and theoretical studies which describe government policies and development initiatives, as well as studies that determine the essence, characteristics and key technologies of smart production.

3. DATA AND METHODS

A systematic approach to analyzing opportunities and risks of the forest industry of the Sverdlovsk region is used as a methodological basis.

Governmental statistics are used as a data source.

3.1. RESEARCH MODEL

In order to identify risks at various levels of the fourth industrial revolution, the study proposes the following model for analysis:

- system-wide risks related to the concept;
- country-level risks driven by institutional conditions and general development of digital technologies in Russia, compared to the global level;
- regional risks associated with the growth opportunities in Sverdlovsk region;
- industry risks associated with the dynamics of the forest industry markets and peculiarities of the regional industry business.

4. RESULTS

4.1. SYSTEM-WIDE OPPORTUNITIES AND RISKS

An increased use of technologies of the fourth industrial revolution would result in the following opportunities to improve efficiency of industrial enterprises:

- full automation of production processes;
- reduction of transaction costs due to the easier access to global raw material markets, labour and funding;
- global economies of scale;
- increased flexibility and adaptability of production via the utilization of dynamically reconfigurable production lines.

Various case studies confirm an exponential increase in productivity after the introduction of technologies of the fourth industrial revolution. For example, the collection and analysis of data obtained via sensors on cargo ships in the port of Hamburg resulted in an increase of port capacity by 178% [25, p. 1345].

In the work of Klaus Schwab, it was identified that one of the most significant problem associated with such development was the growing inter-country and social inequality [4].

A World Bank report also points out that the growing popularity of digital technologies does not lead to an increase in “digital dividends” in developing countries. Instead, automation and robotization will likely lead to further increase in unemployment and gender inequality. Protectionist policies of developed countries will risk leading to increased monopolization of business [23].

The first signs of materialization of these threats was already confirmed at the International Economic Forum in 2015 [24].

One of the largest scale research on the readiness of organizations for the fourth industrial revolution was a survey conducted by Deloitte. The survey covered about 1600 managers from 19 countries [22]. The results show that despite the recognition of the significance of digital transformation, 86% of respondents reported not being ready to use increased digital capabilities and not taking them into account when developing organizational strategies, defining areas of investment and creating personnel structure.

4.2. COUNTRY-LEVEL OPPORTUNITIES AND RISKS

As shown in Figure 1, Russia lags leading countries in the development of information and communication technologies (ICT). In “practical skills”, Russia ranks 13th, and in the “use of ICT” it holds the 51stposition. This indicates technological backwardness with high quality human assets. At the same time, in terms of “use of ERP systems”, which is one indicator of digital business development, Russia is at the average European level. This shows compliance of large enterprises with the level of leading countries in digitalization. The cybersecurity rating value demonstrates the smallest lag. The value of cybersecurity technical support subindex is lower than the assessment of skills, as well as organizational and legislative aspects.

To determine the possibilities to overcome the lag, one should analyze the innovative potential and competitiveness of the country's economy (Figure 2).

The values of the index generally correspond to the development of the digital economy. The value of the global innovation index is negatively affected by the associated subindexes, such as the development of creative activities and, in particular, institutional obstacles to the development of new business models.

The global competitiveness index is positively influenced by the spreading of mobile communications and negatively influenced by the low development of broadband Internet, which puts Russia to the 74th place in the world ranking.

Low impact assessment of ICT on the development of new services and products has a negative influence on the rating of production drivers.

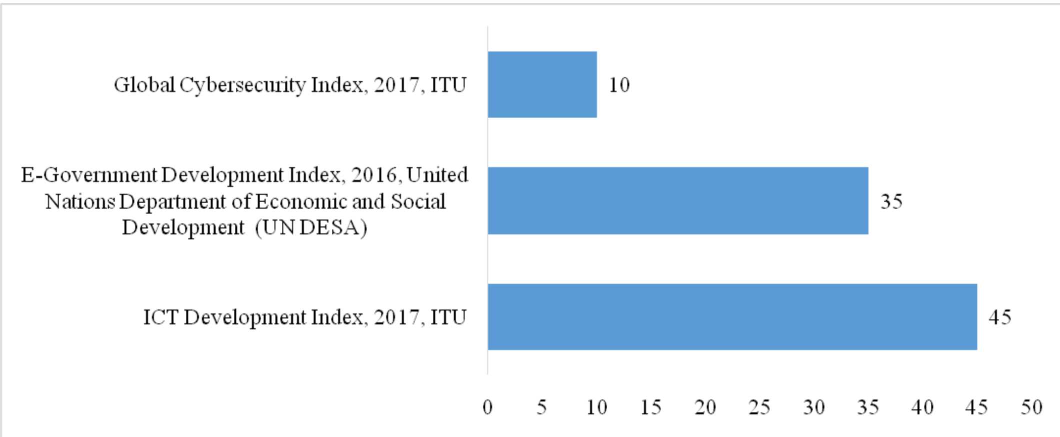

Figure 1. Russian position in international ratings of the digital economy development
Source: Author

The “Economy of Runet-2017” notes that companies generally observe a positive effect from the implementation of digital technology projects. Meanwhile, the lack of clear digital strategies at 83% of companies is recorded in parallel [27]. Among the obstacles are listed the lack of investment, external causes (such as economic downturn), low level of ICT infrastructure and unpreparedness of stakeholders.

Based on the above, it can be concluded that Russian enterprises understand the significance of the advantages and prospects of digitalization. At the same time, government support is essential to promote the development of the digital economy. This would include, for instance, the development of relevant legislation, support for the creation of technological platforms and help with overcoming the infrastructure gap (4G and broadband Internet).

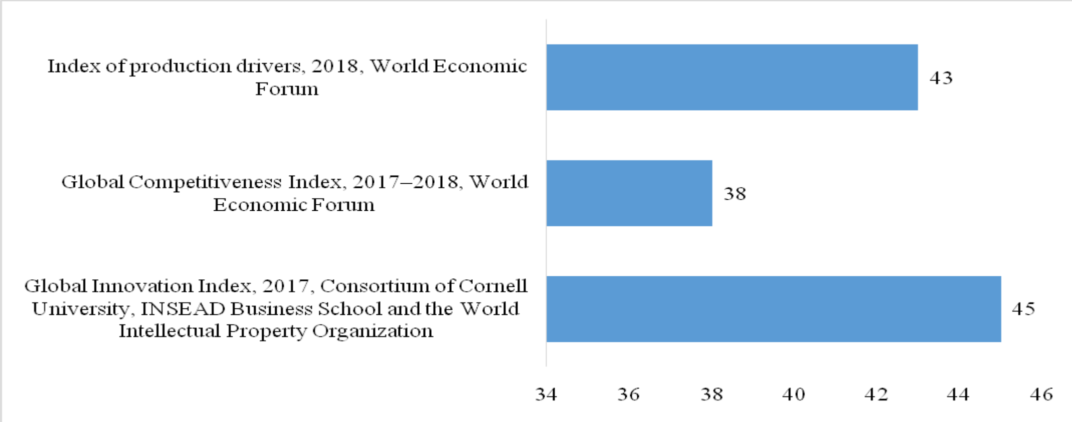

Figure 2. Russian position in international ratings of economic development

Source: Author

4.3. REGIONAL OPPORTUNITIES AND RISKS

O. Romanova notes that in addition to the inter-country "digital divide", there is an inter-regional digital divide in Russia too. The indicators characterizing the development of information and communication technologies in various regions of the country may differ by more than 300 times [8]!

On average, the indicators of digitalization development in Sverdlovsk region are higher than the average Russian values (Figure 3). It should be noted though that the regional business has high level of digitalization. Values for business are even higher than for the population.

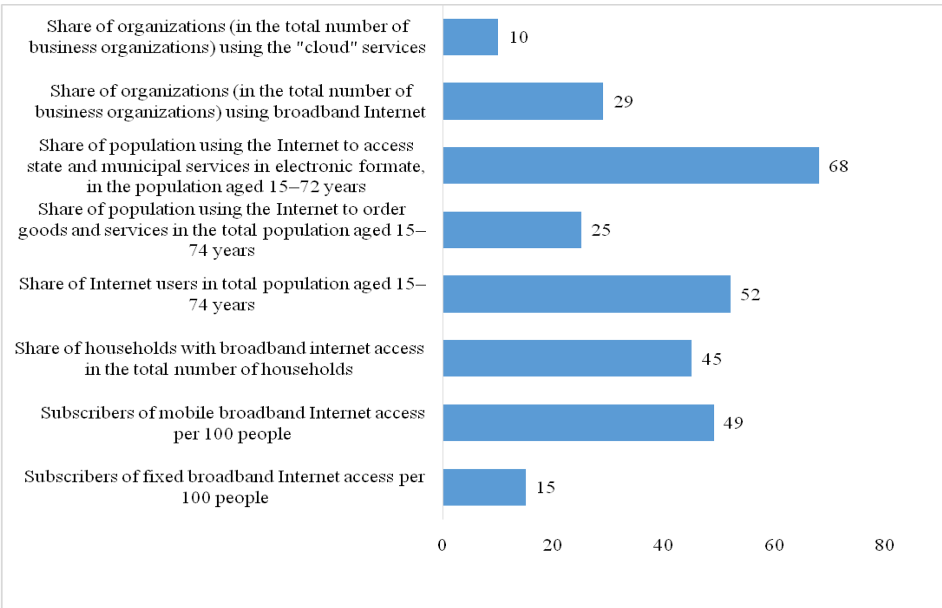

Figure 3. The rating of Sverdlovsk region in terms of digitalization development

Source: Author

Looking at the dynamics observed in the ICT usagedevelopment indicators of Sverdlovsk region (Table 1) reveals the following trends:

– an increase in Intranet and Extranet usage indicates the presence of inter-organizational digital transformation, which in turn allows to improve the quality and speed of information exchange, to reduce transaction costs and to minimize the risk of personnel errors;

– the growth of cloud computing, which increases staff mobility and helps to reduce the cost of servicing digital infrastructure, also shows that information network indicators are in line with the growing user demand;

– the growth of organizations that use websites for commercial purposes, primarily for interaction with contractors, indicates the development of e-commerce in the region.

Table 1. Indicators on the usage of information and communication technologies in organizations of Sverdlovsk region (excluding the small business)

Share of organizations	2011	2012	2013	2014	2015	2016
Usage of personal computers	97,07	97,83	98,43	98,05	97,07	96,39
Usage of other types of computers	24,22	20,46	22,67	32,10	n/a	n/a
Usage of local area networks (LAN)	76,72	79,63	81,63	76,42	69,05	67,36
Usage of e-mail	87,94	91,26	93,47	91,28	89,60	93,14
Usage of "cloud" computing	n/a	n/a	14,10	17,53	21,60	24,86
Usage of global information networks	90,85	93,43	95,04	95,71	93,42	93,20
Internet	89,95	92,99	94,53	94,95	92,45	92,17
Intranet	17,96	16,61	20,35	21,94	22,32	23,84
Extranet	6,93	8,34	10,50	17,78	18,73	16,10
Other global networks	7,50	6,84	8,10	10,18	11,51	11,03
Usage of dedicated communication channels	47,15	48,64	50,40	n/a	n/a	n/a
Have websites on the Internet	36,71	42,56	49,24	50,47	47,22	50,27
of which usage of Internet for commercial purposes	36,69	42,52	49,18	50,43	44,95	46,53

Source: Sverdlovskstat

Today, Sverdlovsk region is an ICT leader in the Ural district. This in turn places the regioninto a leading position in the country. Regional organizations extensively utilize global information systems. There is a visible increase in complexity and specialized application of information technologies at business entities and an expansion of inter-organizational interaction in the field of information exchange.

4.4. INDUSTRIAL OPPORTUNITIES AND RISKS

Manufacturing industries, including the forest industry, are leaders among the business sector organizations measured by intensity of the usage of digital technologies.

The forest industry of Sverdlovsk region has a significant production potential. The region is eleventh in the country in the production of raw timber, the fourth in the production of plywood products, and the sixth in the production of sawn timber.

In 2017, an increase in the indicators of the woodworking industry was observed against the recession of previous years. According to Rosstat, the growth in the forest complex of the region in 2017 accounted for 1.9%, which exceeded the growth of industrial production (1%). At the same time, there was also a slight increase in investments in fixed assets (0.8%).

A favourable situation on world markets contributes to the development of wood processing. The markets for soft sawnwood, pellets, pulp and cardboard continue to grow.

The digitalization of the global economy leads to changes in the industrial product portfolio. Thus, a global reduction in the production of regular and irregular print press leads to a corresponding reduction in the production of newsprint paper. At the same time, the development of e-commerce leads to an increase in the containerboard market.

The growth drivers of the fourth industrial revolution in the region's forest industry are presented in Table 2.

Table 2. Perspectives for developing the forest sector in Sverdlovsk region

Area	Municipalities - potential centers for competence development	Potential markets for product sales
Production of biodegradable single-use products	Turinsk, Novaya Lyalya	1) hygienic products; 2) consumer goods; 3) personalized medicine (emerging)
Smart control systems for logging equipment	Yekaterinburg	1) high-precision instrument making; 2) transport engineering; 3) man-machine communications based on achievements in neuroscience (emerging)
Alternative energy - bioenergy, bioelectricity, biofuel	Serov Alapayevsk Novaya Lyalya	1) международный рынок энергоресурсов; 2) рынок малой энергетики; 3) формирующийся рынок распределенной энергетики, обеспечивающий интеллектуальный характер сетей 1) international energy sources; 2) small-scale power generation; 3) energy distribution through "smart" grids (emerging)
Furniture	Yekaterinburg VerkhnyayaPyshma Nizhniy Tagil Alapayevsk	1) housing; 2) consumer goods; 3) personalized medicine (emerging)
Sustainable construction	Nizhniy Tagil Verkhnyaya Tura Alapayevsk	1) housing and renovations; 2) industrial construction; 3) personalized medicine (emerging)
Production of modern import-substituting building and finishing materials	VerkhnyayaSalda Krasnotur'insk Alapayevsk	1) housing; 2) industrial construction
Forest chemistry	Kirovgrad Serov Verkhnyaya Tura Alapayevsk	1) paintwork materials; 2) perfumery and medical industry; 3) adsorbents; 4) chemical industry; 5) metallurgy; 6) personalized medicine (emerging)

Source: Author

The development of selected areas becomes possible with the development of the innovative potential of the industry, provided by the cooperation of industrial enterprises and research organizations specializing in industry research. The results of the conducted analysis are systematized in Table 3.

Table 3. Opportunities and risks for the forest enterprises of Sverdlovsk region

Opportunities	Risks
System-wide	
Reducing costs through increased automation and global competition	Strengthening of inter-country inequality
Increasing flexibility and adaptability of production	Lack of understanding by enterprise management of practical implementations of key technologies within the organization
Country-level	
High quality research and human capital	Development lag in ICT, lack of access to broadband Internet
Acceleration and simplification of business processes	Institutional barriers to the development of new business models
	Gaps in digital economy legislation
	High cost of technical solutions during economic downturns
Regional	
The level of business digitalization is higher than the average digitalization in Russia	Growing requirements for information networks
Development of e-commerce and inter-organizational information exchange	Increasing damage caused by access to confidential information
Industrial	
Favourable environment in global markets	Aging of fixed assets
Potential market growth	Outdated production technologies
Availability of promising trends	Lack of inter-organizational cooperation experience

Source: Author

5. CONCLUSIONS. DISCUSSIONS AND IMPLICATIONS

Based on the conducted analysis, it can be concluded that the widespread introduction of actions to digitalize the market in the forest industry is one of the priorities that regional enterprises will have to solve soon.

At the same time, the most important conditions ensuring the effectiveness of digitalization of the industry are an adequate and targeted state industrial policy which includes the elements of motivation for the management of enterprises, as well as the development and implementation of well-thought-out strategies for transition to new business models at the enterprise level.

The promising area for the further research, in our opinion, is the creation of transition models from traditional to “smart production” highlighting the necessary conditions and success factors for this transition.

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ORIGINAL RESEARCH PAPER

BIOENERGY AS THE DRIVER OF RURAL AREAS DEVELOPMENT IN RUSSIA

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ABSTRACT

Nowadays renewable energy, especially bioenergy, is one of the most important priorities of the sustainable development. We investigate this question by case study of Russia, because Russia is the first in the world by the resources of biomass and forest. Also the country has problem in energy supplying in rural remote areas and it is connected with infrastructure. That is why, the authors investigate using of renewable forest resources for energy supplying in rural areas. In the same time, this aproach is activly investigate in the world science and many scientists resuming about effectivness of the development of bioenergy based on wood chips in rural areas. But in all these works the question of chips recycling in bioenergy is concentrated around logging waste mainly. From the authors' point of view the most effective for processing is the combination of the chipper operations felling and debarking after preliminary hydrothermal treatment. The issues of low-quality wood utilization after sanitary and cleaning cuttings in forestry are not considered deeply. Mobile bioenergy generation units based on woodchips settle the complex of environmental, social, economic problems in rural areas, especially remote, and can become the driver of the region development in remote areas. Thus, the development of small bioenergy productions based on wood chips from low-quality wood in remote areas solves a set of strategic objectives and contributes to the sustainable development of the territory. Consequently, the implementation of wood chips-based bioenergy in remote areas has the complex multisectoral effect for the area economy, ecology (forestry) and social sphere and significantly stimulates territorial development.This approach is applicable in forested rural area all over the world.

JEL classification: Q42, Q49

***Keywords**: bioenergy; renewable energy; wood chips; energy supply chain; rural development; remote areas; regional green economy.*

1. INTRODUCTION

Energy consumption is an objective condition for the existence of mankind. The population is growing steadily. Naturally the amount of consumed resources is increasing continuously. This fully applies to the energy resources that are used in all sectors of the economy and spheres of social life. The growth of consumption of various kinds of energy and resources sharply increases as the promotion of world economy on the path of industrialization and accelerated economic development. So, compared to the mid-twentieth century, the consumption and generation of electricity in the world has increased more than 15 times, and during the last 5 years, energy consumption in the dynamically developing countries has increased: in China by 76%, in India - by 31%, Brazil - by 18%. At preservation of existing rates of growth of economy and the consumption of resources or traditional sources of fuel and energy (coal, oil, gas, etc. would be exhausted in the next 100-150 years. Thus the cost of their extraction is constantly increasing.

In addition to the physical limits and the impossibility of renewal of existing technologies of processing of traditional fuel and energy resources adversely affect to the environment. Waste of energy facilities in the form of gaseous, liquid and solid phases cause negative changes in ecosystems at all levels, from local to global. Heat power engineering is a "producer" of the great masses of solid waste (tailings coal, ashes, slags, etc.), which also violates the balances of the existing ecosystems. Therefore, in recent times, the leading countries of the world has determined its strategic priority of the transition to alternative energy sources, first of all they are focuse on bioenergy, and widespread introduction of "green technologies". Modern bioenergy uses renewable biofuels for energy production and allows to solve the problem of power supply with substantial economic effect, reduction of the technogenic load on the ecosystems of the regions, increased autonomy for power supply of production, and social spheres of the society. One of such alternative sources of energy is wood raw material, consisting primarily of the waste of timber cutting and woodworking.

For Russia the decision of problems of increase of economic returns and reduce waste in the forest industry is of high relevance and practical significance. On the other hand, the existence of huge stocks of forest resources (first place in the world), which also must be used rationally, forms the objective preconditions for the development of bioenergy with a focus on wood fuel with simultaneous introduction of principles of "green" economy. High economic and social importance of bioenergy development at the modern stage also related to the fact that the manufacture and use of bioenergy installations on the first stages of development of bioenergy provides creation of new high-tech jobs and increase employment of the population, both in the field of energy and related industries. This is especially true for economically underdeveloped or monoindustrial regions of the country.

The main task of the research is the aggravation of the worldwide problem of limited access to traditional energy sources, and finding alternative sources of energy for provision of industrial needs and quality of life of the population at a high level simultaneously with increasing of requirements to ecological safety of production and consumption of various types of energy.

The actuality of the research is determined by the aggravation of the following contemporary issues, vital for human development and requiring immediate solutions:

• the depletion of natural capital as a factor of economic growth;

• absolute decreasing population of the Earth natural resources in connection with exhaustion of the whole range of non-renewable resources and the growth of world population, which according to the forecast of the United Nations in 2050 (medium variant of development) will be 9 billion people (compared with 7 billion in 2011). However, more than half the world's population will live in Asia, one quarter in Africa, 8.2% in Latin America, 7.4% in Europe, 4.7% in North America. This will require changes in the structure of resourcing, including energy, society for preservation of quality of people life;

• increase in the share of nature exploration and polluting industries, caused by the increase of volumes of industrial production in the economy of developing countries, strengthening of the environmental impact on the economy of these countries and the global ecosystem as a whole from these countries;

• increasing environmental risks and risks of technogenic catastrophes, connected with the physical deterioration of the equipment of many enterprises, including in traditional sectors of energy production, and also the systems of transportation of oil and gas;

• adverse climate change and global warming, due to the economic activities of people. The share of the four countries (China, USA, India and Russia) accounted for more than half of GHG emissions and their environmental policies, national programs of environmental safety of production and consumption, applying the principles of "green" economy, depends largely on the future of our planet;

• the growing negative impact of environmental pollution on human health (according to modern studies established that the health of a person at least 30% depends on the environmental situation in the region and many diseases are directly dependent on ecosystem state territory). These and some other problems threaten the existence of man on Earth and the leading countries of

the world are now actively searching for ways of addressing them, including through the transition to the ecology-oriented production and implementation of the principles of "green" economy. Together the key issues of modern economy energy supply issues play an important role. Energy production and energy consumption in real time all over the world were based mainly on the use of traditional renewable energy sources (coal, oil, gas, mining and processing of lead pollution. The existing imbalances in the sphere of production and use of hydrocarbon exacerbate the problem of energy poverty in many regions of the world.

The successful implementation of the objectives under the project will make a significant contribution to a comprehensive solution of world problems reduce the efficiency of energy supply, environmental pollution and deterioration of the global climate. The world's major scientific research centers in the project area are:

1. Green Economics Institute - an integrated research project, launched with the support of the European educational and scientific grant Erasmus and supported by leading universities of the USA, Europe, China and Africa. The most active participants of the project are the University of Oxford and the University of Leeds (UK). Russian universities among the main participants of this project are not presented. The aim of the project "Green Economics Institute " - the formation of the interaction between the scientific community on the issues of "green" economy, including the organization of scientific conferences and the development of this direction in modern science. Results of the project activity are regularly placed on the english site http://www.greeneconomics.org.uk/page0.html/. Since 2006, also the project publishes the journal "International Journal of Green Economics". The main difference of our project from the scientific activity of the Green Economics Institute is that in the research of the Green Economics Institute the works of Russian scientists are presented not completly and interests and needs of Russian economy and energy shperes are totally ignored.

2. Finnish project Cleantech is the network of leading scientists and experts in the area of clean technologies, which work in different industry sectors for many companies. They are united by the work on creation of technologies of increasing of efficiency of usage of natural resources, creation of technologies for conservation and increase of natural capital. Special attention is paid to the issue of processing and recycling of industrial and household waste, energy efficiency, including the construction technology for energy passive houses. Network Cleantech Finland provides the link between the Finnish experts in the field of net technologies and the world demand for Finnish technology. Unlike Cleantech project, our project focused not on the processing of technogenic waste, and for the development of bioenergy from wood fuel. It is also important that the offered project in comparison with Cleantech project includes scientific fundamental and applied economic research, while the main range of problems to be solved in the framework of the project Cleantech refers to the development of new engineering and technological solutions.

3. The Bioeconomy centre and eco-innovation economic faculty of Moscow state University of a name of M. Lomonosov. The management Centre is an Honored scientist of Russia, Professor S. Bobylev in cooperation with Professor N. Ivashchenko. Development Director of the Center - P. Kiryushin, Ph.D. associate Professor, Master of environmental science, policy and management. The center was created for the implementation of research, educational, innovation-implementation and expert activities in the areas of bio-economics and economy, biotechnology, green economy, eco-innovation and sustainable energy development. The Centre's activities are based on interdepartmental cooperation, including with the Department of Environmental Economics and the chair of Economics of innovation and inter-faculty interaction with the biological faculty of Moscow State University. In the basis of the Centre is responsible for the work begun in the 1960s under the of academician of the Academy of Sciences of the USSR S. Khachaturov. The employees of the Centre have significant experience in implementing projects, including cooperation with the United Nations Development Programme (UNDP), the Institute of Sustainable Development of the Public Chamber of the Russian Federation, World Wildlife Fund (WWF), the World Bank, as well as implementing projects supported by Russian Foundation for Basic Research and Russian Foundation for Humanities. Also we offer the project differs from the ongoing areas of research of leading world and domestic competitors because it is the first time the complex approach to creation of a Russian national model of "green" economy based on a wide adaptation of existing in the world of concepts, methods and techniques "green" economy to the conditions of the Russian Federation with active participation in the development of models and

program of complex of measures on development of high-tech industries bioenergy in the largest forest regions of Russian researchers, state and municipal officials, representatives of business, public and youth from different countries due to the use of the tool of international, interdisciplinary network interaction.

2. LITERATURE REVIEW

In the same time, this aproach is activly investigate in the world science and many scientists resuming about effectivness of the development of bioenergy based on wood chips in rural areas. In Europe the problem of forest biomass sustainable utilization, especially wood chips, for energy is investigated by many scientists (Sikkema, R., & Fiorese, G. ,2014; Busch, G., Thiele, J. C.,2015; González, A., Riba, J. R., Puig, R., Navarro, P., 2015; Gingrich, S., & Krausmann, F. , 2018; Vukovic, N. A., Larionova, V. A., & Biryulina, V. V. , 2018; Ingrao C., Bacenetti, J., Bezama, A., Blok, V., Goglio, P., Koukios, E. G., ... Jin, E., & Sutherland, J. W. , 2018). The experience of bringing a low carbon energy supply for rural areas into practice in Germany is investigated by Jenssen, T., König, A., Eltrop (Jenssen, T., König, A., Eltrop, L. ,2014). In Belgium it is researched by Rugani, B., Golkowska, K., Vázquez-Rowe, I., Koster, D., Benetto, E., Verdonckt, P. (Rugani, B., Golkowska, K., Vázquez-Rowe, I., Koster, D., Benetto, E., Verdonckt, P. , 2015). In Italy the economic assessment of biomass production is studied by Sgroi, F., Di Trapani, A. M., Foderà, M., Testa, R., Tudisca, S. (Sgroi, F., Di Trapani, A. M., Foderà, M., Testa, R., Tudisca, S. ,2015). In Norway - Cavicchi, B., Bryden, J. M., Vittuari, M.(Cavicchi, B., Bryden, J. M., Vittuari, M.,2014). In Sweden this scientific question is investigated by Waldenström, C., Ferguson, R., Sundberg, C., Tidåker, P., Westholm, E., Åkerskog, A. (Waldenström, C., Ferguson, R., Sundberg, C., Tidåker, P., Westholm, E., Åkerskog, A. ,2016). In UK we can find the same research in works of Sinclair, P., Cohen, B., Hansen, Y., Basson, L., Clift, R. (Sinclair, P., Cohen, B., Hansen, Y., Basson, L., Clift, R. , 2015).

In Latvia Sikkema, R. and Fiorese, G. study the using of forest based biomass for bioenergy (Sikkema, R., Fiorese, G. ,2014).

The other continents are not so active as Europe in researching this topic, but we can find scientists intrested in this problem everywhere: in South Korea - Kraxner, F., Aoki, K., Leduc, S., Kindermann, G., Fuss, S., Yang, J., Obersteiner, M. (Kraxner, F., Aoki, K., Leduc, S., Kindermann, G., Fuss, S., Yang, J., Obersteiner, M.,2014), in the USA - Hendricks, A. M., Wagner, J. E., Volk, T. A., Newman, D. H. ; Beeton, T., Galvin, K. (Hendricks, A. M., Wagner, J. E., Volk, T. A., Newman, D. H. ,2016; Beeton, T., Galvin, K. , 2017), in South Africa - Stafford, W., Blignaut, J. (Stafford, W., Blignaut, J. ,2017), in Australia- Chaffariyan, M. R., Spinelli, R., Magagnotti, N., Brown, M. (Chaffariyan, M. R., Spinelli, R., Magagnotti, N., Brown, M.,2015), in New Zealand- Rhodes, D., Stephens, M., Hall, P., Jack, M. (Rhodes, D., Stephens, M. ,2014; Hall, P., Jack, M., 2014). In each continent there are not too much publication about bioenergy based on wood chips and its application for rural territories. It is mainly connected with the level of interest and relevance of coun-tries' economies to alternative energy, density of population and level of infrastructure development.

Other way, the opportunity to settle the energy problem of rural remote areas by the development of bioenergy based on wood chips is very attractive for Russia. That is why we can find so many scientific articles, investigating it (Pristupa, A. O., Mol, A. P., Proskurina, S., Heinimö, J., Mikkilä, M., Vakkilainen, E., 2015 ; Trishkin, M., Goltsev, V., Tolonen, T., Lopatin, E., Zyadin, A., Karjalainen, T. , 2017, Goltsev, V.,2014; Medvedeva, E. A., Ryapin, I. Y., Urvatsev, I. V., Tsyba, V. Y. ,2016; Gerasimov, Y., Senko, S., Karjalainen, T. , 2013;Chaika, L. V. ,2015). Some of the authors tries to adopt successful EU experience in Russia (Sinclair, P., Cohen, B., Hansen, Y., Basson, L., Clift, R., Karjalainen), some is making the new model, but all of them are agree that application of bioenergy based on wood chips has positive prospects in Russia.

3. METHODOLOGY

From the authors' point of view the most effective for processing is the combination of the chipper operations felling and debarking after preliminary hydrothermal treatment. According to the research of Rubtsov Yu., Konnova V., Rud'ko S. (2011) the technology of processing of wood into chips in Russia is carried out the most efficiently by using disk chippers because it minimizes requirements to the quality of wood.

But in all these works the question of chips recycling in bioenergy is concentrated around logging waste. The issues of low-quality wood utilization after sanitary and cleaning cuttings in forestry are not considered.

Therefore, implementation of the proposed approach in regional development of remote forest territories allows obtaining the synergetic effect in the environment, economic and social spheres.The research focuses on a new pragmatic methodological approach in modelling of regional development based on implement of wood chips bioenergy, modifications of existing theoretical methods, and discussions of analysis and synthesis of data evaluations. In recent years, interest to the models of regional development is still high as it was before, because in spite of strong global urbanization process in any country, from economic point there are problematic areas with low-developed infrastructure due to different reasons. The most famous scientific theories (models) of regional development are the following:

-model of growth and development of poles (Perroux, F. 1950),

-model of unbalanced development (Hirchman, A. 1958),

-model of circular cumulative causality (Myint, H. 1954),

-dependence model (PraŠo, M. 2011),

-model of exporting base (North, D., Klassen, L., Thomson, W. 1964)

-model of central place and gravity (Christaller, W.1993),

-model of production specialty (IbreljiĆ, I. (1994).).

Also, usage of low-quality wood plays a special role in the process of logging wood. On the one hand, it allows increasing the production volume of wood products due to processing of unclaimed wood raw material, and on the other hand it contributes to the growth of efficiency in the forestry sector. The usage of low-quality wood in processing industries increases the threshold level of the wood raw material prices, which positively affects the estimates of the economic accessibility of forest resources. It is well known that such natural disasters as hurricane-force winds, loss of wet snow, freezing rain, etc., lead to the formation of forest trash.

Table 1. Models of the "growth poles" determination and development for remote areas based on woodchips bioenergy

Model types (Perroux 1950)	Characteristics	Special Fitures
Growth poles	Dense location of industries that are dynamically developing leads to synergistic effect and appearance of industrial centers and peripheries.	The main characteristics of regional enterprises are accent on chip energy. The main enterprise is the bioenergy generation company, which has function of the pole's development center. All synergy effects relate to forestry and wood-working.
Agglomerates	Dense location of urban settlements united into a certain integral unit with	Main local resources are forest, wood, chips, energy. All business activity in the territory connected with these resources.

Model types (Perroux 1950)	Characteristics	Special Fitures
	developed production.	
Clusters	Concentrated on the territory of interrelated companies of different profile, which and strengthen supplement each other.	The main enterprise is bioenergy generation company which has function of the cluster development center.

Source: Author

In the future, the risk of multiplying secondary pests and increasing forest fires increases sharply. Recycling of this trash, due to the low marketability of wood, is ignored by forest users as well. The use of this wood as a biofuel will allow solving the major environmental problems to prevent the spread of hotbeds of forest pests and minimize wildfires.

The following points are among the silvicultural measures to procure a significant amount of wood for bioenergy (Figure 1):

1.To clean up the territory after logging. Potential resources of logging residues depend on the type of logging and inventory indices on cutting down the forest stands and applied technologies of logging operations.

2.To clean up burnt forest areas and burnt wood. Unfortunately, forest fires are frequent events on the territories of many countries all over the world up to the present time. Part of the mature wood, burnt by forest fires, dies, but the main area, especially of low-grade plants, are transformed into dead zones or dead forest and remains on-site undeveloped, creating a real threat of new fires and hampering the process of reforestation. The average range of these stands is 97 m3/ha.

3. To perform continuous and selective sanitary cuttings. In addition to forest fires actual problems for modern forest management are storm winds, harmful insects and diseases. The possibility of low-quality wood using as raw material for bioenergy opens unlimited possibilities for the continuous and selective sanitary cuttings, and thus, improves forest health a lot. The most conservative estimate of raw material resources for bioenergy is continuous and selective sanitary cuttings.

4. Conducting of thinning and improvement of young stands. Thinning is one of the most important items of forest care by silvicultural point of view.

However, the volume of these cuttings is extremely small, because the young wood is not in demand. The transition to intensive care can produce 50-75 m3 of timber per 1 ha. The implementation of the projects of bioenergy connected with modern research-based scientific recommendations will start the actual care about the forest.

5. Logging reformation. Consequence of the sanitary cuttings is a massive change of fir trees derived softwood. From silvicultural point of view, these forest stands need operations aimed at reforestation of indigenous conifers. Such generations are developed, but their implementation is hampered by lack of marketing of hardwood timber. With the statistics of 300-350 m3 of such forest per 1 ha demand is not more than 50% of the stem wood. The usage of low-quality deciduous wood as raw material for bioenergy would allow reshaping and rejuvenating the derived softwood plantations.

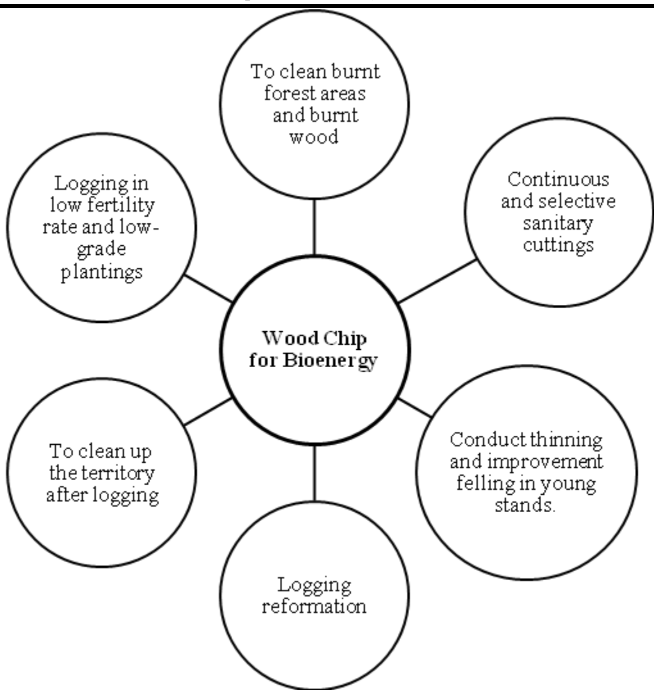

Figure 1. Activities on preparation of wood chips for bioenergy
Source: Author

6. Logging in low fertility rate and low-grade plantings. Establishing the annual allowable forest cuttings, both for mature and low fertility rate and low-grade plantings, is calculated. However, this cut has never mastered because of the factual lack of sales of timber. The result was the accumulation of over-mature plantings. It is logical that these trees can be mastered if you use part of commercially harvested wood as raw material for bioenergy.

7. Other cuttings. Considerable volumes of timber harvested in the process of conducting other fillings. They include the development of communication routes, area features, etc. The enterprises of bioenergy allow the use of specified wood as well as wood produced in the care cuttings on the area of green zones in settlements and cities. The efficiency of biofuel production from wood biomass depends on many factors, including transportation costs of energy wood from cutting areas to the terminal. The distances of transportation of wood chips and the time required for loading and unloading operations directly influence on the efficiency of energy generation. Accordingly, to current prices, the collection of logging residues for recycling into wood chips is effective by its cost, if the distance to the consumer is not more than 50 km. In the case when distance is over 100 km, the transportation costs are too high. For this case the production of fuel chips is economically more profitable than use of logging residues, because of fuel chips can be transported to 150 km (Niskanen A., Petrov A., Filoushkina G. 2002). So optimal location of bioenergy enterprises based on wood chips must be distributed on the distance not more than 100 km.

5. CONCLUSION

Thus, the development of small bioenergy productions based on wood chips from low-quality wood in remote areas solves a set of strategic objectives and contributes to the sustainable development of the territory. The production of alternative energy based on biofuels in remote areas provides the following positive results for the regional economy:

- improving the environmental situation in the region through the implementation of high-quality cleaning cuttings in forest and environmental processing of wood waste generated by logging and forestry;

- sustainable generating of cheap and affordable energy for remote settlements: electricity and heating systems;

- creating new industries for investmenting;

- creating new jobs.

Consequently, the implementation of wood chips-based bioenergy in remote areas has a complex multisectoral effect for the area economy, ecology (forestry) and social sphere and significantly stimulates territorial development.

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ORIGINAL RESEARCH PAPER

EFFECTIVENESS OF LARCH STANDS CREATION ON FORMER AGRICULTURAL LANDS

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ABSTRACT

On the base of 5 sampling plot materials silvicultural economic effectiveness of artificial larch stands growing on plough lands excluded from agricultural usage have been analysed. The experiments have been carried out on the territory of preforest steppe pine birch forests okrug of Zauralsky plain province (West Siberian forest vegetation region). It has been established experimentally that on former plough lands the artificial stands of Sukhacheva larch (Larix sukaczewii Dyl.) formed by 2-year-old seedlings planting 61 year after planting posess bole (stem) wood deposit from 449 to 739 m^3/ ha. Grown wood value in this case amounts from 2078.99 to 3450.59 th. r. /ha. Average annual income from wood growing is varied in dependence on stand thick ness from 32.999 to 54.771 th. r./ha. Income from sukhacheva larch stands growing is 3 times as much as compared with cereals growing.

JEL *classification: Q10, Q15*

Keywords: *agricultural lands, plough land, wild land, forest cultures, sukhacheva larch, deposit, wood value.*

1. INTRODUCTION

Development of mankind is inseparably connected with agriculture. In taiga zone and forest steppe subzone agricultural lands formation is inseparably connected with cutting down the area covered with forest vegetation. At present most, agricultural lands in taiga zone are anthropogenically changed landscapes formed in the place of forest ecosystems and they are being existed only thanks to the man's supporting. In the case that they are deprived of regular care and stopped to be used for direct purposes they are mostly became overgrown with woody brush vegetation.

Changing of economic system in Russian Federation calls forth bankruptcy of a significant number of agricultural enterprises. As a result, according to the official sources, more than 40 mln plough lands have been withdrawn out of agricultural turnover. The above-mentioned lands are overgrown with woody brush vegetation, became ramped and swamped. Agricultural usage ceasing, besides agricultural enterprises bankruptcy in many cases is provoked by cut up borders of agricultural lands, their remoteness from populated areas, low soil fertility.

Overgrowing of lands removed from agricultural turnover with woody brush vegetation should be considered as a real fact of a large-scale forest ecosystem reforestation [10]. Of a special notion is the fact that former agricultural lands soil with nonstructural and poorly developed ploughed horizon, laid under with thickened layer as a result of even nonsystematic, application of fertilizers is rather fertile for cultivation of productive forest stands [7, 21]. Regretfully, on former agricultural lands brush wood and low productive soft leaved stands are formed the most often, and the process of native coniferous stands proceeds for many decades [1, 5, 20].

Rational utilization of excluded from agricultural application lands can be provided at the expense of creating artificial forest stands on former plough lands, haymaking lands and practice. The similar practice is applied in our country as well as beyond its boundaries. The authors in such a case prefer the process of plantation wood growing for industrial purposes in short time periods [9, 11, 16, 17, 19]. There exists the experience of such growing on former agricultural lands artificial stands as well. The most authors marked off [13, 15, 18] their heightened productivity as compared with analogous age stands formed on logged sites. The same time artificial stands growing on former agricultural lands relates to specify of soil treatment [3] and danger of them to be injured by root fungus (*Heterobasidion annosum* (Fr.) Bref. S. Str.) [6, 14].

As far as artificial stands creation on former agricultural lands is one of the rational land utilization trends it is of special interest the data on productivity and stability of above-mentioned stands. Unfortunately, there are no works on analysis of artificial stands productivity on former agricultural lands in subzone of pril forest steppe coniferous birch forests of the Ural.

The latter has predominated the trend of our researches.

The purpose of our researches has been to analyses productivity of the oldest Sukhacheva larch artificial stands (*Larix sukaczewii* Dyl.) formed on the former plough land in Sukholozhsky forest district subzone. As well as possibility to minimize the damage caused by agricultural using abandonment.

2. OBJECTS AND METHODS OF RESEARCHES

In correspondence with the aim and purpose of researches 63-year old artificial stands of Sukhacheva larch (*L. Sukaczewii* Dyl.) created on the forms agricultural land in condition of Sukholozhsky forest district (Sverdlovsk region department of forestry) according to the scheme of forest growing regions [8] the territory of the mentioned forest district refers to the Okrug of pre-forest steppe pine-birch forests of Zauralsky plain province (West Siberian forest growing region).

The researchers are based on the sp method, when sp laying out the requirements of normative document into account and approbated recommendations that are in force now have been taken into consideration [2, 12] stands deposit.

Stands deposit on sampling plots has been determined on the base of all-round forest inventory according to assortment and commercial tables for stands of Western and East a Siberia [4]. The grown wood estimation was calculated considering its large sizes according to commercial value.

3. RESULTS AND DISCUSSIONS

According to researches programmed the works have been carried out in 63-year-old larch stands created in 1953 on former given up plough land by 2-year-old sukhacheva larch seedlings planting.

Planting has been carried out manually with Kolesova sward using. Researches carried out 63 years after planting have shown that highly productive artificial stands have been formed on the site (tabl. 1).

Table 1. The main inventory data of 63 - year old artificial larch stands created on former plough land

№ SP	Composition	Average		Density, p/ha	Fullness		Deposit, m^3/ha
		Height, m	Diaweter, sm		Absolute, m^2/ha	Relativ	
1	10L.	28,0	23,2	1272	53,8	1,16	739
2	10L.	27,2	25,4	908	45,9	1,01	648
3	10L.oneB	26,5	23,2	1087	45,8	1,01	627
4	10L.+B	27,5	22,9	800	32,9	0,73	449

№ SP	Composition	Average		Density, p/ha	Fullness		Deposit, m^3/ha
		Height, m	Diaweter, sm		Absolute, m^2/ha	Relativ	
5	10 L.	26,9	22,8	1000	40,7	0,90	560

Source: Author

Data of the table 1 testify to the fact that 5 laid out sampling plots are characterized by density from 600 to 1272 p/ha. In such a case even at the age of 63 the tree stands average height is varied in dependence on density - from 26.5 to 28.0 m and the average diameter at the height of 1.3 - from 22.8 to 25.4. The tree stands of all the sampling plots poses good sanitary condition (fig. 1).

Of special notion is the fact that Sukhothai larch stands created on former plough land are characterized by a significant stem wood deposit. The latter in dependence on stand density is varied from 10 to 40 sm (fig. 2).

The measured trees availability testifies to expediency of systematic improvement felling carrying out.

As far as the researches task comprised determination of possibility to minimize the damage caused by **abandonment** plough lands abandonment to be used for artificial stands creation, we have determined the grown wood value (tabl. 2).

Fig. 1 Outward appearance of 63-year-old larch stand on SP -2
Source: Author

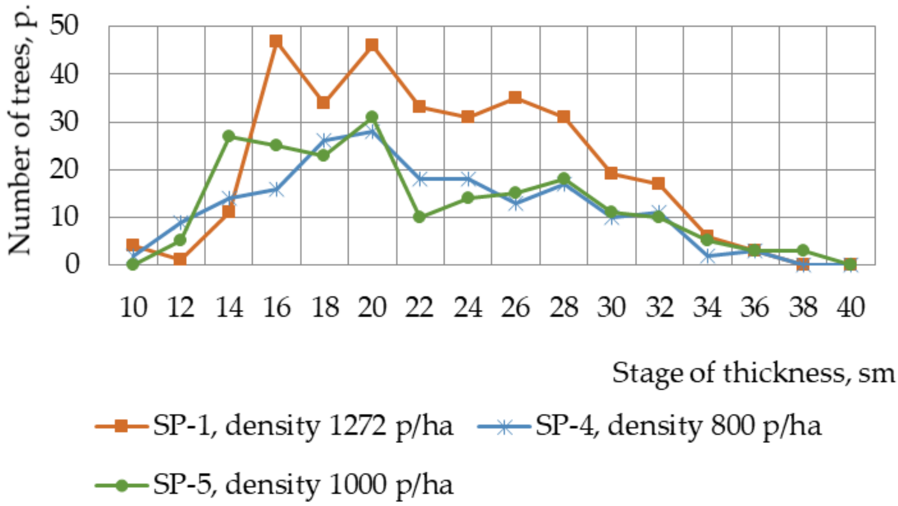

Fig. 2. Distribution of larch trees on sampling plots according to thickness stage
Source: Author

Table 2. Material monetary valuation of 63 - year old larch stands formed on overgrown plough land

Indices	Number of sampling plot				
	1	2	3	4	5
1	2	3	4	5	6
Height category	1	1	2	1	2
Density, p/ha	1272	908	1087	800	1000
Merchantable boles, p/ha/%	1091 85,8	840 92,5	919 84,5	647 80,9	782 78,2
Fuel wood, p/ha/%	181 14,2	68 7,5	168 15,5	153 19,1	218 21,8
Bulky wood deposit value, th.r./ha	62,52 456,39	76,98 561,93	49,64 362,38	42,26 308,49	62,30 454,80
Medium wood deposit m^3/ha value, th.r./ha	364,10 2366,65	338,69 2201,46	317,48 2063,64	212,97 1384,32	257,39 1673,04
Small wood deposit, m^3/ha value, th. r/ha	117,02 526,61	78,61 353,74	94,74 426,35	71,44 321,48	83,24 374,57
Marketable wood, total, m^3/ha value, th. rl/ha	543,63 3349,65	494,27 3117,13	461,87 2852,37	326,67 2014,28	402,93 2502,40
Fuel wood and raw material, m^3/ha value, th. rb.	45,61 41,05	23,20 20,88	37,93 34,14	31,55 28,40	44,59 40,13
Liquid assets wood, m^3/ha value, th. rb.	589,25 3390,70	517,47 3138,01	499,80 2886,51	358,22 2042,68	447,52 2542,53
Wastes, m^3/ha	149,75	130,53	127,20	90,78	112,48

Indices	Number of sampling plot				
	1	2	3	4	5
1	2	3	4	5	6
value, th. rb.	59,90	52,21	50,88	36,31	44,99
Wood total volume in bark, m^3/ha Total value, th. rb.	739,00 3450,59	648,00 3190,22	627,00 2937,39	449,00 2078,99	560,00 2587,53
Average value of 1 m^3 wood	4,67	4,92	4,68	4,63	4,62
Annual income of wood growing (63-year-old) th. rb./ha	54,771	50,638	46,625	32,999	41,072

Source: Author

Table 2 materials testify to the fact that wood value in 63-year-old larch stands are varied from 2079.99 to 3450.59 th. rb. / ha and the mean value of undefined wood cubic meter is varied from 4.62 to 4.92.

The total value of growing wood depends on density of stands that is shown on figure 3.

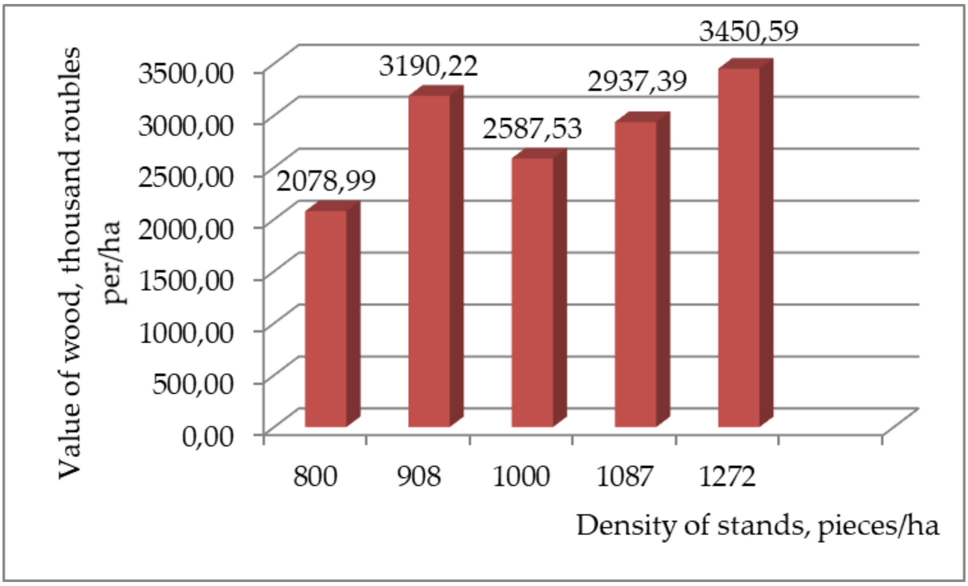

Fig. 3. Dependence of total wood value in 63-year-old larch stands created on former plough land on tree stands density on SP

Source: Author

Figure 3 materials visually demonstrate that the stand with 1272 p./ha density is characterized by maximum value. Natural trees lands density decreasing results in overall wood value decreasing.

When growing of wood is considered from economic point of view it is important to pose objective data on average income gained annually for the whole period of forest growing.

The materials obtained have shown that average annual income from artificial stands growing on former plough land amounts in dependence on tree stand density, from 32.999 to 54.881 th.rb. / ha.

The average in Sverdlovsk region cereals crop capacity amounts 1.5-2.1 t/ha and annually from 1 ha of plough lands it is possible to get production valued from 13.5 to 18.9 th. rb. For comparison sake, annual income from larch stands growing on abandoned agricultural lands in Sverlovsk region according to the results we have got amounts from 32.9 to 54.7 thousand robles per 1 ha. The data we have got testify by to the fact that annual income from larch stands growing will constitute 2.4-2.9 time as much in comparison with cereals cultivation.

It is naturally, that we do not claim to create Sukhothai larch forest cultures on the whole plough land territory of pre-forest steppe pine birch subzone. However, even with maximum average value of agricultural production (18,9 th. rb. the income will be significantly less as far as annual spending will be required for seeds purchasing, soil preparation, care of crops. Artificial stands growing will require significantly less spending and only during the first stage of forest growing.

They will comprise: planting material cost, the process of planting and agrotechnical care. As species change in artificial stands growing on former agricultural lands is impossible of for lack of vegetative specimen of soft leaved kinds silvicultural care in young stands is not projected and spending for thinning carrying out is compensated by harvested wood cost.

4. CONCLUSION

1. An effective trend to minimize damage as a result of agricultural usage abandoning in condition of preen-forest-steppe pine birch forest in Sverdlovsk region is artificial reforestation.

2. Income from Sukhothai larch stands growing according to the modest calculations is 3 times as much in comparison with that in cereals growing.

3. To leave former agricultural lands for natural growing is inexpedient as in the most cases low productive soft leaved stands and tangled vegetation are formed on them.

4. As the main species in artificial forestation it is advisable to use Sukhacheva larch (*L. Sukaczewii* Dyl.) which by 62 already forms stands with bole wood deposit up to 739 m^3/ha.

5. Larch stands creation on former plough land makes possible to get average annual income from 32.9 to 54.7 th.rb./ha.

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ORIGINAL RESEARCH PAPER

IMPROVING THE METHODS FOR PLANNING THE ORDER AMOUNTS OF SPARE PARTS

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ABSTRACT

The article proposes to consider the issue of determining the optimal order amounts of spare parts for technical service enterprises through the relationship system, which forms the demand and supply model. The article shows that due to random demand for spare parts it is advisable to put and explore in terms and concepts of stochastic programming, when the elements of a linear programming problem are often random.

JEL *classification: Q21, Q11*

Keywords: *stochastic demand and supply system, supported demand, unsupported demand, used supply, unused supply*

1. INTRODUCTION

In the process of managing a technical service enterprise, the main problem is to assess the need for spare parts at some given time (Irgashev & Irgashev, 2015). The most well-known forecasting methods usually do not give satisfactory results, since they do not reflect the essence of demand nature (Kleber, Zanoni, & Zavanella, 2010).

The demand for spare parts at technical service enterprises cannot be described according to the known laws of distribution of random variables (Lukinsky & Zamaletdinova, 2015). The peculiarity of the problem of providing enterprises with spare parts lies in the fact that the pre-failure lives of parts, units, assemblies are random. As a result, for the periods of the same duration and purpose, different amounts of spare parts are required, while producers, dealers, technical service companies have them in deterministic quantities. Therefore, the demand, depending on the type of spare parts, may be a set of probability distributions (Sleptchenko, van der Heijden, & van Harten, 2003). All this leads to low rotations of stocks of spare parts often leading to illiquid stocks (Kappauf, Lauterbach, & Koch, 2012).

Rational provision of technical service enterprises with spare parts will help to balance the costs due to machine downtimes and the “immobilization” of funds, and increase capital turnover (Walker, 1997).

2. LITERATURE REVIEW

After studying foreign literature, it should be noted that if capacity is lower than demand, neck stages restrict the movement of materials and customer service quality decreases, if capacity is higher than demand, an organization can move all its materials, but some of the capacity will remain unused, and capacity is also a resource (Wright & Mehrez, 1998). The application of a standard approach to any type of planning – planning resource requirements is the most developed (Watters, 2003).

To determine the required inventory level, it is necessary to analyze data on past experiences and the smallest error in forecasting demand for the forthcoming period is determined:

2.1. MODULUS DIFFERENCE (PREDICTIVE VALUE – TRUE VALUE)

2.2. SMALLER OF PREDICTED AND TRUE VALUES

It is also necessary to emphasize that products of the same category often have different consumption patterns (Louit, Banjevic, Jardine, & Pascua, 2011). Therefore, they need to use different prediction formulas so that the error is minimal, and the resulting forecast is as accurate as possible (Shchreibfeder, 2005).

Market models (Rosenberg model, model with an ideal point, model built based on market adequacy) (Nelson, 1959) can be considered as the most suitable for solving the problems of planning assortment policy for technical service enterprises according to stochastic factors.

In addition to the existing methods of studying the market, the following models should be highlighted to assess the attractiveness of the product.

Rosenberg model is since consumers evaluate a product according to its suitability to meet certain needs (Rosenberg, 1971):

$$Q_i = SX_k Y_{jk}, \tag{1}$$

where Q_i is the consumer's assessment of the brand j;

X_k is the importance of the characteristic k (k = 1, n) for the brand j from the consumer's point of view;

Y_{jk} is the assessment of k characteristic for the brand j from the consumer's point of view.

Different consumer requirements for products provide ideal prerequisites for market segmentation, as well as information about the importance of individual product characteristics (Teunter & Haneveld, 1998).

In the model with an ideal point, in contrast to Rosenberg model, an additional component is introduced – the ideal (from the consumer's point of view) value of the product characteristic (Nelson, 1959):

$$Q_i = SW_k \left| B_{jk} \quad I_k \right| r, \tag{2}$$

Where Q_i is the consumer's assessment of the brand j;

W_k is the importance of the characteristic k (k = 1, n)

B_{jk} is the assessment of the characteristic k for the brand j from the consumer's point of view;

I_k is the ideal value of the characteristic k from the consumer's point of view;

r is the parameter that shows a constant for r = 1, and a decreasing marginal benefit for r = 2.

It is logical that the consumer will prefer the product that is the closest to the ideal one. Thus, this method gives an idea of the ideal, from the consumer's point of view, product (Rosenberg, 1982).

3. METHODOLOGY

This study was conducted by Legion Motors, the official ŠKODA dealer. The service center is equipped with all the necessary special means and diagnostic equipment in accordance with the requirements of ŠKODA concern group. They use only original parts, oils and liquids.

The interaction of the buyer and the company in terms of the sales of spare parts can be described by a stochastic model of supply and demand (Korolkov & Korolkova, 2006).

The input parameters of the stochastic model can be divided into real and cost ones (Table 1).

Table 1. Real and cost parameters of the stochastic model

Definition	Entity
Real parameters	
Reference period	the period with the replenishment of stocks; in general, it can be a day, a week, a decade, a month, a quarter, a half year, a year, etc.
Demand N	the quantity of goods requested from a specific trade organization during the reference period
Supply z	the number of goods offered for sale during the reference period
Cost parameters	
s_{NZ}^{1}	unit sales price
s_{Z}^{1}	unit purchase price
$s_{N\_}^{1}$	cost of unsupported demand
$s_{Z\_}^{1}$	cost of unused offer

Source: Author

As a result, in the calculation method described below, demand and supply are understood to be in every period of demand N and every period of supply Z.

Thus, in the case of random demand and (or) supply, the demand-supply model will be characterized by four indicators:

1) the supported demand N+ and equal to it the supply Z+;

2) the unsupported demand N-;

3) the unused supply Z-.

Unsupported demand characterizes lost opportunities: non-receipt of additional income, partial loss of customers (demand) in the future, various kinds of sanctions (fines) related to the failure to meet demand, etc. (Korolkova & Mashrabov, 2016).

The unused supply makes it possible to take into account losses due to failures of selling goods: storage costs, damage to goods during storage, freezing of funds instead of buying and selling other goods which are in demand, placing funds in a bank, investments (Korolkov & Korolkova, 2001).

A simplified structural diagram of the supply and demand system is presented in Figure 1.

In the general case, demand N and supply Z can be both deterministic N = n0, Z = z0, and random, represented by arbitrary distribution functions A (n) = P (N ≤ n) and C (n) = P (Z ≤ n) and distribution densities a (n) and c (n) (Korolkov & Korolkova, 2002).

The output parameters of the model are the functional, numerical and cost characteristics of the supported demand N+, the used supply Z+(N+ = Z+), the unsupported demand N– and the unused supply Z–. If at least one indicator at the input is a random variable (namely, the demand N is a random quantity), then the model’s output indicators will also be random variables (Korolkova & Mashrabov, 2015). Such indicators are characterized by functions and densities of distribution, for which basic numerical characteristics are easily calculated: mean, mean-square deviation, etc.

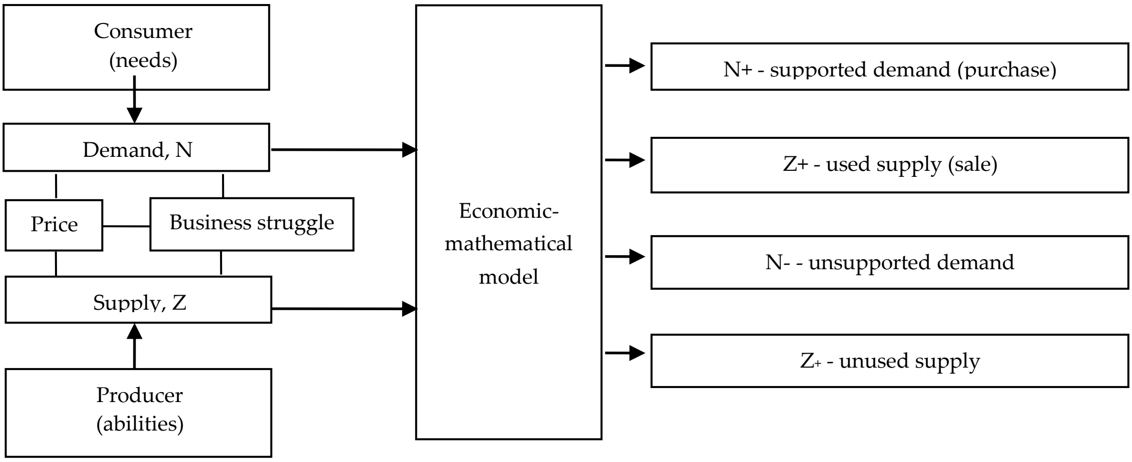

Fig.1. Simplified structural diagram of the supply and demand system
Source: Author

The functional characteristics of the desired indicators are found due to the following ratios.

The function A(n) and the density a(n) of the demand distribution are found according to the formulas:

$$A(n)=P\{N \le n\} = m\{N \le n\} / M, \tag{3}$$

$$a(n)=dA(n)/dn= [A(n) - A(n-1)] / 1 = \Delta m\{n-1 \le N \le n\} / M, \tag{4}$$

where $m\{N \le n\}$ is the quantity in the variation range of the allotted periods of time (days), the demand not exceeding a specific given value n in each of them.

1. The distribution function of the supported demand N+ and equal to it the used supply Z+:

$$H(n) = P\{N_+ = Z_+ = NZ \le n\} = P\{\min(N,Z) \le n\} = \begin{cases} A(n)\,\text{при}\, n < z_0, \\ 1\,\text{при}\, n \ge z_0. \end{cases} \tag{5}$$

the distribution density

$$h(n) = P\{N_+ = Z_+ = n\} = H(n) - H(n-1) \tag{6}$$

2. The distribution function of the unsupported demand N–

$$Q(n) = P\{N_- \le n\} = A(n+z_0),\ n \ge 0 \tag{7}$$

the distribution density

$$q(n) = P\{N_- = n\} = Q(n) - Q(n-1) \tag{8}$$

3. The distribution function of the unused supply Z–

$$G(n) = P\{Z_- \le n\} = 1 - A(z_0 - 1 - n), n \ge 0 \tag{9}$$

the distribution density

$$g(n) = P\{Z_- = n\} = G(n) - G(n-1), n \ge 0 \tag{10}$$

4. EMPIRICAL FINDINGS

Based on the data of the company, we will form a sample demand for spare parts in 45 days with values from 15 to 18 (Table 2).

Table 2. Sample demand

15	18	16	15	18	16	18	15	16
16	16	16	16	17	16	16	16	15
18	15	15	17	15	15	15	17	17
17	16	18	18	17	18	16	16	15
15	17	17	17	16	17	17	16	17

Source: Author

Let us calculate the frequency of occurring values in the sample and draw up a demand variational series (Table 3).

Table 3. Demand variation series

n	15	16	17	18	Total
Δm	11	15	12	7	45

Source: Author

The calculation of the real characteristics of the supply and demand model for different values of z is presented in Table 4. The calculations were performed in a MS Excel spreadsheet processor in accordance with the methodology presented above (formulas 5-10).

Table 4. Calculation of the average value and the distribution function of demand

Value	**Formula**	**Demand value ai**				**Total**	**Total designation**
		15	**16**	**17**	**18**		
Frequency of occurrence	ni	11	15	12	7	45	N
Probability	Pi=ni/N	0.244	0.333	0.267	0.156	1.0	
Product of probability and value	aiPi	3.666667	5.3333	4.533	2.8	16.333	$\bar{n}$
Deviation from the mean value	ai-ncp	-1.333	-0.333	0.667	1.667		
Deviation square	(ai-ncp)^2	1.778	0.111	0.444	2.778	5.111	σ_n^2
Product density	a(n)	0.244	0.333	0.267	0.156	1.0	
Distribution function	A(n)	0.244	0.578	0.844	1.000		
Mean-square deviation	2.261						

Source: Author

The distribution density and demand distribution function were found.

And the curve of distribution density was constructed (Fig. 2).

The curve of distribution density probability makes it possible to estimate the type of distribution.

According to the curve of distribution density, one can see that the distribution has a form close to the normal distribution.

It is necessary to find the average values and distribution function for each demand value (Tables 5-8).

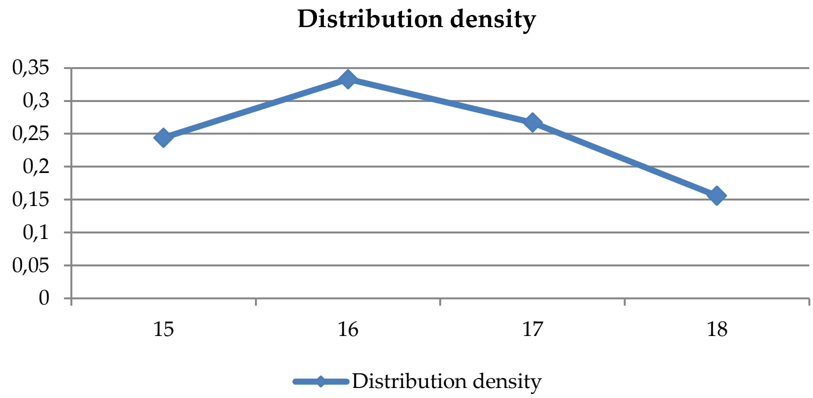

Fig.2. The curve of demand distribution density

Source: Author

Table 5. Average values and distribution functions for n = 15

Value	Formula	Demand value				Total	Total designation
		15	16	17	18		
Distribution function	A(n)	0.24	0.58	0.84	1.00		
Product density	a(n)	0.24	0.33	0.27	0.16	1.00	
Supported demand	H(n)	1.00	1.00	1.00	1.00		
Density of the supported demand product	h(n)	1.00	0.00	0.00	0.00		
Product of the probability and the demand value	h(n)n	15.00	0.00	0.00	0.00	15.00	$\bar{n}_+ = \bar{z}_+$
Unsupported demand	Q(n)	0.24	0.58	0.84	1.00		
Distribution density of unsupported demand	q(n)	0.24	0.33	0.27	0.16	1.00	
Product of the probability and the demand value	q(n)n	0.00	0.33	0.53	0.47	1.33	$\bar{n}_+$
Unused demand	G(n)	1.00	1.00	1.00	1.00		
Distribution density of unsupported demand	g(n)	1.00	0.00	0.00	0.00	1.00	
Product of the probability and the supply value	g(n)n	0	0	0	0	0	$\bar{z}_-$

Source: Author

According the same principle, the values for each demand were found.

It is necessary to check the correctness of the calculated average values using the rules:

$$\bar{n} = \bar{n}_+ + \bar{n}_- , \qquad z_0 = \bar{z}_+ + \bar{z}_-$$

The results are given in Table 9.

As we see, both equalities are fulfilled, which means that the functions were calculated correctly.

Table 9. Checking the correctness of the calculated average values

n	$\bar{n}_+ = \bar{z}_+$	$\bar{n}_-$	$\bar{z}_-$	$\bar{z}_+ + \bar{z}_-$	$\bar{n}_+ + \bar{n}_-$
15	15	1.3333	0	15	16.3333
16	15.7556	0.5778	0.2444	16	16.3333
17	16.1778	0.1556	0.8222	17	16.3333
18	16.3333	0	1.6667	18	16.3333

Source: Author

It is necessary to set the unit cost:

$$S^1_{N+}=600$$
$$S^1_{N-}=0{,}2S^1_{N+}=120$$
$$S^1_{Z-}=0{,}15S^1_{N+}=90$$

The total costs of the supply various values will be calculated by the formulas:

$$S_{N+} = S^1_{N+} \cdot \bar{n}_+ \quad (11)$$
$$S_{N-} = S^1_{N-} \cdot \bar{n}_- \quad (12)$$
$$S_{Z-} = S^1_{Z-} \cdot \bar{z}_- \quad (13)$$

The calculation of the producer's total costs for various supply values are given in Table 10.

Table 10. Calculating full and total values for different supplies

n	$\bar{n}_+ = \bar{z}_+$	$\bar{n}_-$	$\bar{z}_-$	S_{N+}	S_{N-}	S_{Z-}
15	15	1.3333	0	9000	160	0
16	15.7556	0.5778	0.2444	9453.33	69.3333	22
17	16.1778	0.1556	0.8222	9706.67	18.6667	74
18	16.333	0	1.6667	9800	0	150

Source: Author

It is necessary to calculate the purchase cost by the formula

$$S_Z = S^1_Z \cdot Z (14)$$

And also, it is necessary to calculate profit and the profit with the unsupported demand and unused supply taken into account (Table 11).

Table 11. Profit calculation

n	S_z	**Profit**	**Profit with SN- and SZ+**
15	7659	1350	1190
16	8160	1293.3	1202
17	8670	1036.7	943.99
18	9180	620	470

Source: Author

According to Table 11, we construct a curve (Fig. 3).

As we see, the maximum profit coincides with the supply equaling to 15, therefore, the order of 15 units of spare parts will be optimal.

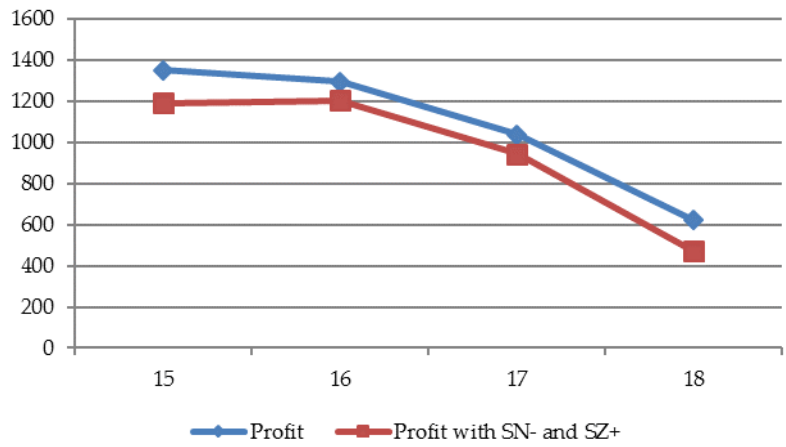

Fig. 3. The curve of profit depending on demand
Source: Author

5. CONCLUSION

In the first part of the article, we consider the approach of controlling the stock of spare parts, the demand for them being of a random nature, consisting in the calculation of indicators of the stochastic supply-demand system (Korolkov & Korolkova, 2006).

In the second part of the article, in order to automate the calculations given above, a program is developed that performs these calculations. The software product is implemented in the programming language VisualBasic. The program calculates the complex of real and cost output parameters of the model for some demand value.

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Part II - Rural Entrepreneurship, Risk and Forecasting in Business

ORIGINAL RESEARCH PAPER

THE DEVELOPMENT OF RISK-ADJUSTED RURAL ENTREPRENEURSHIP

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ABSTRACT

The article shows the impact of business risks on the efficiency of doing business in agriculture. The method Direct Costing should be used as a basis for determining acceptable risk limits. The minimum volume of production by the farmer must exceed the breakeven point by the amount of predicted damage. Zones of business risk should be determined according to the variance of the determining factor (gross yield or yield of cultivated crops) as a random variable. The law of normal distribution (Gaussian distribution) should be used as the basic law of distribution of gross harvest or yield of cultivated crops (random variable). The main sought characteristics of the distribution law are: expectation, standard deviation, coefficients of asymmetry and kurtosis. As a result of the research, it is predicted that by 2020 in the Russian Federation the average yield of wheat will be about 22.4...22.8 C/ha, with a standard deviation being 2.8...3.0 C/ha. Considering business risks, the planned yield of cultivated crops can be adopted at the level of 19.4...20.0 C/ha. With the current structure of costs in agriculture, the price of wheat and the degree of entrepreneurial risk, the minimum size of the land for its profitable cultivation should be at least 200...300 ha per farm.

JEL classification: Q1, Q13

Keywords: *entrepreneurship, agribusiness, entrepreneurial risk, direct costing, breakeven point*

1. INTRODUCTION

It is impossible to imagine the development of market relations in agriculture without considering business risks. The very essence of business involves considering the risks arising in the external environment.

The main causes of risk in rural entrepreneurship are (Lukyanova, 2005, Roshko, 2011):

– random nature of climate and weather events;

– incomplete knowledge of the entrepreneur about the world;

– unpredictability and uncertainty of the market situation;

– contradictory actions of market partners;

– opposition from competitors, etc.

Currently, many methods of risk assessment have been developed. However, they refer to the object, not to the type of activity (Badalova & Panteleev, 2016, Baldin & Perederyaev, 2015, Bautin & Lazovsky, 2007, Barakaev & Eriashvili, 2015, Belov, 2016, Fedorova, 2013, Kardash, 2006, Kosolapov, 2012, Mamayeva, 2013, Novikova & Solodkaya, 2015, Plashkin, 2013, Rudko-Selivanov, 2013, Urodovsky, 2012, Vorontsovskiy, 2016, Zadkov, 1998). For example, a person insures a bank deposit, a car, a house, etc. (a certain object), but not the way it is used. In our case, we are not interested in the fate of the object. In business risks, we are interested in the fate of the business itself. In other words, we are interested in the degree of potential damage that threatens the entrepreneur in the course of its activities in the current environment.

2. LITERATURE REVIEW

For a long time in business economics, the problems of risk and uncertainty have not been given due attention. Entrepreneurship and risk were believed to exist inseparably with each other. In the book by John von Neumann (1903-1957) and Oscar Morgenstern (1902-1977) "Theory of games and economic behavior" (Neumann & Morgenstern, 1953, Tucker & Luce, 1959), which was published in Pristona in 1953, a special attention was paid to business risk. The authors of the book for the first time studied the problem of economic usefulness considering uncertainty and risk factor. According to the theory proposed by the authors, entrepreneurs prefer to choose alternatives for investments to get higher profits.

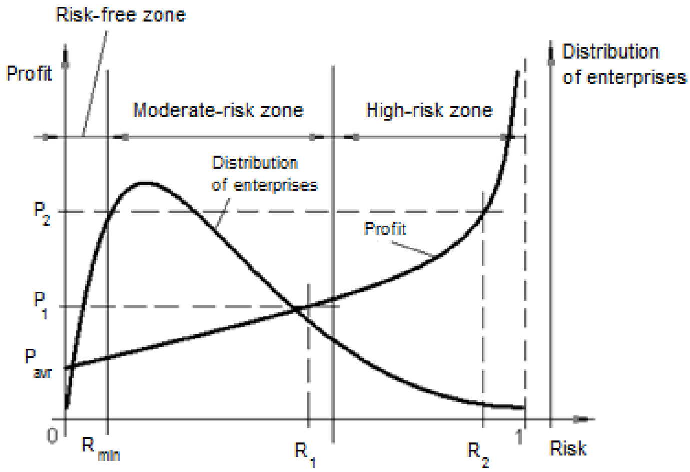

Fig.1. Risk-profit relationship
Source: Author

Fig. 1 shows the profit to depend largely on the value of the risk. The profit at the level of average profit in the industry (P_{avr}) can be obtained with minimal risk (R_{min}). With increasing risk, from R_{min} to R_1 and R_2 ($P_{avr} < P_1 < P_2$), business profits will increase, with the entrepreneurial income also increasing:

$$EI_1 = P_1 - P_{avr}\,,\; EI_2 = P_2 - P_{avr}\,,$$

where EI – entrepreneurial income.

According to (Kushlin & Folomeev, 2000), this statement can be confirmed by a survey of 50 financial firms in the United States. The survey showed that the return on risk capital is 3 times higher than when investing in securities of enterprises. However, the results of this survey are only valid for financial and venture capital firms and companies. A different picture is observed in enterprises engaged in real production, agriculture being included. In the field of real production (Fig. 1) entrepreneurs risk rather reasonably. Many agricultural enterprises and farms operate in the risk-free or moderate-risk zone (Lukyanova, 2005, Roshko, 2011, Startsev, 2000).

It is obvious that the entrepreneurship in the sphere of real production (real economy) significantly differs from the entrepreneurship in the field of financial and venture companies. In this regard, it is necessary to study the factors of development of rural entrepreneurship, considering the impact of business risks.

Economic transformations of the mid-1990s in Russia caused scientific interest in studying the impact of risks on the efficiency of business entities. Among modern Russian scholars, who have contributed to the development of the risk management theory, it is necessary to note the works by A. G. Badalova,

K. V. Baldin, P. G. Belov, A. I. Novikova and others. A significant contribution to the development of the theory and practice of risk management in the field of agricultural business (agribusiness) was made by V. Bautin, V. Kardash, V. Lazovsky, A. Zadkov and others.

Economic and climatic risks having the main impact on the development of agribusiness, the impact of economic risks is reflected in the production activities of an economic entity (a rural entrepreneur). Natural and climatic risks affect the development of plants, the yield and gross harvest of crops. Natural and climatic risks for usual entrepreneurship are external. However, they become internal risks for rural entrepreneurship. This is due to the technology and results of agricultural production (Lukyanova, 2005, Roshko, 2011, Startsev, 2000).

According to the random nature of business risk, the known methods of probability theory and mathematical statistics were used to quantify it (Emelyanov, 2014, Leonovich, 2012, Miloslavskaya **et al.**, 2014, Rykhtikova, 2012, Sarkisova, 2016, Shiryaev, 2015, Strebel, 2013, Tepman **&** Eriashvily, 2016, Vorobyov **et al.**, 2013). Gaussian distribution (normal distribution) was adopted to characterize the distribution of the results of economic activities of rural entrepreneurs. We know normal distribution to be rare in its pure form in the real economy. Therefore, the approximation to the normal distribution law was estimated by us using the coefficients of asymmetry and kurtosis.

The normal distribution law widely applicated in agribusiness can be justified by the fact that the result of activities (for example, crop yields, weight gain of animals and birds, etc.) depends on many independent factors. In addition, these factors can affect the result together and none of them has a dominant effect on the phenomenon under study. For example, the assumption that the yield of crops in different areas for a certain climatic zone (that is, the homogeneity of the sample population is observed) is subject to the normal law is widely considered in the scientific literature (Emelyanov, 2014, Miloslavskaya **et al.**, 2014, Rykhtikova, 2012, Shiryaev, 2015, Strebel, 2013, Tepman & Eriashvily, 2016, Vorobyov & Baldin, 2013), dedicated to the problems of quantitative risk assessment.

3. METHODOLOGY

Probability (frequency) of occurrence of an event depending on the size of the investigated factor is calculated by means of differential distribution function. When studying the impact of business risks on the development of agriculture, the differential function of normal distribution was interpreted as the probability of obtaining a given yield for a crop. Obviously, this definition will be valid provided that the hypothesis of normality is not rejected. In other words, the resulting distribution can be reduced to the law of normal distribution at a certain value of asymmetry and kurtosis.

We used an integral distribution function to find the probability of a normally distributed random variable falling within a specified interval. The economic meaning of the integral function of the normal distribution, in relation to our study, was formulated as follows: the value of the integral function of the normal distribution is the probability that the yield or gross yield of the studied crop will not exceed the predetermined value.

Thus, we have obtained the initial methodological base that allows assessing the value of business risks in agribusiness. With the known parameters of the integral distribution function, the risk value can be estimated as

$$R(x) = 1 - F(x). \quad (1)$$

The economic meaning of the integrated risk function is as follows: the risk that the yield or gross yield of a crop does not exceed the predetermined value is no more (1 – *F(x)*).

The authors propose to find the permissible limits of risk (the risk zone) according to the Direct Costing technique to compare the value of projected losses of products with its break-even point of production (Fig. 2)

The developed nomogram allows determining the break-even point of grain production by a farmer with the known parameters of the distribution function of a random variable (yield).

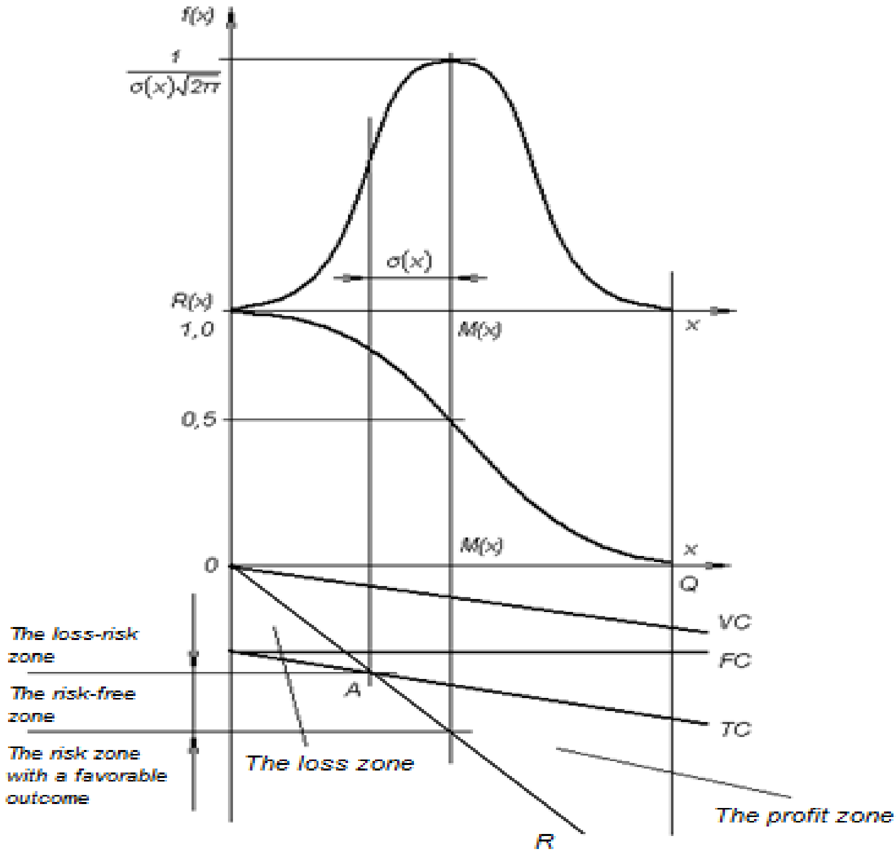

Fig. 2. The nomogram determining the zones of entrepreneurial risks in agribusiness: *FC* – fixed costs; *VC* – variable costs; *TC* – total costs (*TC*=*FC*+*VC*); *R* – revenue; *A* – the break-even point
Source: Author

In the zones of business risk farmers' entrepreneurial behavior will be different (Fig. 2):

– the loss-risk zone. In this zone, the revenue received is insufficient to cover production costs. Only variable costs are fully covered. If the farmer is not able to cover them, he will not be able to fulfil the next production cycle. Thus, in the loss-risk zone variable costs (*VC*) are fully covered, fixed costs (*FC*) – partially;

– the risk-free zone. In the risk-free zone, the farmer risks little or doesn't risk at all. His profit is equal to the average industry profit. We propose to limit this zone to the value of the standard deviation $\sigma(x)$ of the gross yield or the yield of the cultivated crop;

– the risk zone with a favorable outcome. In this zone, the farmer has the probability of obtaining additional business income. However, the probability of a favorable outcome will be lower than the probability of obtaining an average income.

4. EMPIRICAL FINDINGS

Let's use the proposed nomogram to define the limits of business risk zones when producing spring wheat grain. To do this, it is necessary to determine the basic parameters of the distribution law of the spring wheat yield as a random variable. The main parameters of the distribution law will be: the mathematical expectation $M(x)$ and the standard deviation $\sigma(x)$. The break-even volume of production of spring wheat can be defined as

$$Q(x) = S \cdot (M(x) - \sigma(x)), \tag{2}$$

S is the area occupied by the crops of spring wheat; $M(x)$ is the mathematical expectation of a random variable; $\sigma(x)$ is the standard deviation of a random variable.

Fig. 3 shows the results of the regression analysis of wheat yield in the Russian Federation.

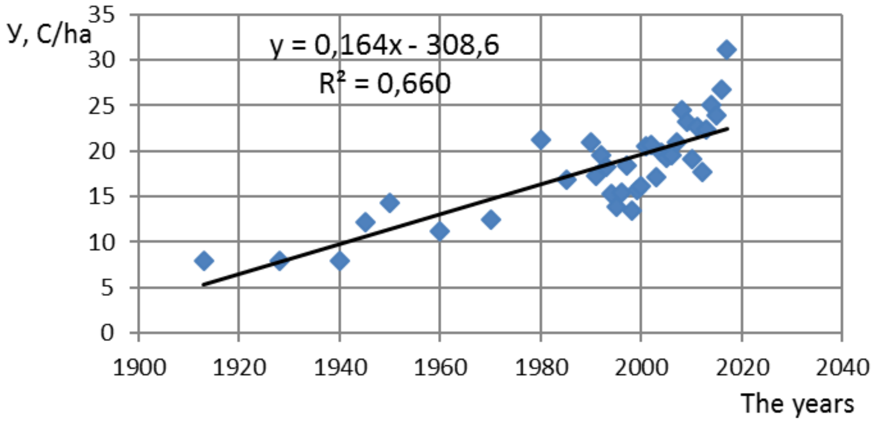

Fig. 3. Regression analysis of yield wheat in the Russian Federation

Source: Author

The analysis of the presented data shows that the wheat yield is influenced by two groups of factors. The first group (controlled factors) is the results of human activity (selection of seeds, variety improvement, etc.). The second group (uncontrolled factors) is environmental factors that are random (climate, weather, etc.).

As a result of the influence of the first group of factors there is an increase in the yield of wheat, an average increase being 16.4 kg per year, with the accuracy of the approximation $R^2 = 66.0$ %:

$$M(x) = 0.164 \cdot x - 308.6, \quad \text{C/ha} \tag{3}$$

x is the year for which wheat yield is projected.

The relatively low degree of reliability of the approximation is due to the large influence of uncontrollable environmental factors, which largely determine the value of business risks in agribusiness. The resulting equation (3) was used to normalize the variance (Table 1).

As a result of mathematical modeling, it can be predicted that the average yield of wheat in the Russian Federation in 2020 will be about 22.4...22.8 C/ha, with a standard deviation being 2.8...3.0 C/ha. Considering business risks, the planned yield can be adopted at the level of 19.4...20.0 C/ha.

On the other hand, the position of the break-even point depends on the level of costs and product prices (Fig. 4). With increasing costs, the break-even volume of production increases and with increasing prices it decreases. In this regard, when determining the boundaries of the zones of business risk, the farmer should have information about the costs and the nature of changes in market prices for products.

Table 1. The analysis of wheat yield in the Russian Federation

Years	Fact	Calculation	Deviation	Squared deviation	Years	Fact	Calculation	Deviation	Squared deviation
1913	7.97	5.13	-2.84	8.05	2000	16.1	19.40	3.30	10.89
1928	7.94	7.59	-0.35	0.12	2001	20.6	19.56	-1.04	1.07
1940	7.89	9.56	1.67	2.79	2002	20.7	19.73	-0.97	0.94
1945	12.2	10.38	-1.82	3.31	2003	17.1	19.89	2.79	7.80
1950	14.3	11.20	-3.10	9.61	2004	19.8	20.06	0.26	0.07
1960	11.2	12.84	1.64	2.69	2005	19.3	20.22	0.92	0.85
1970	12.5	14.48	1.98	3.92	2006	19.5	20.38	0.88	0.78
1980	21.2	16.12	-5.08	25.81	2007	21.0	20.55	-0.45	0.20
1985	16.9	16.94	0.04	0.00	2008	24.5	20.71	-3.79	14.35
1990	21.0	17.76	-3.24	10.50	2009	23.2	20.88	-2.32	5.40
1991	17.3	17.92	0.62	0.39	2010	19.1	21.04	1.94	3.76
1992	19.6	18.09	-1.51	2.29	2011	22.6	21.20	-1.40	1.95
1993	18.2	18.25	0.05	0.00	2012	17.7	21.37	3.67	13.45
1994	15.3	18.42	3.12	9.71	2013	22.3	21.53	-0.77	0.59
1995	13.9	18.58	4.68	21.90	2014	25.0	21.70	-3.30	10.92
1996	15.5	18.74	3.24	10.52	2015	23.9	21.86	-2.04	4.16
1997	18.4	18.91	0.51	0.26	2016	26.8	22.02	-4.78	22.81
1998	13.5	19.07	5.57	31.05	2017	31.2	22.19	-9.01	81.22
1999	15.7	19.24	3.54	12.50					
Normalized variance									9.10
Normalized standard deviation									3.02
Average coefficient of variation, %									16.82

Source: Author

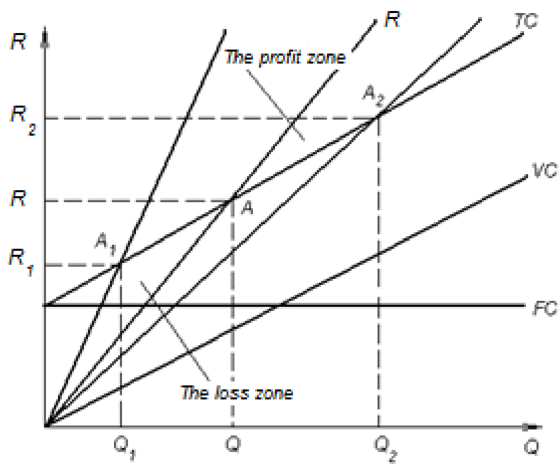

Fig. 4. Impact of prices on the position of the break-even point
Source: Author

As a result of analyzing the open data of Federal Service of State Statistics, we have determined that the share of conditionally fixed costs in the cost structure of wheat production is 29...33%, the share of conditionally variable costs being 67...71%.

The dynamics of changes in average annual market prices for wheat grain is shown in Fig. 5. According to the presented data, it can be predicted that in 2020 in the Russian Federation the average annual market price of wheat grain will be set at 9300 rub./t, with a sufficiently high degree of confidence being 91 %.

The analysis of profitability of wheat grain production in the Russian Federation did not reveal any significant trend (Fig. 6). Therefore, summarizing the obtained data, within the factor space it was assumed that the profitability is equal to the arithmetic mean 35%.

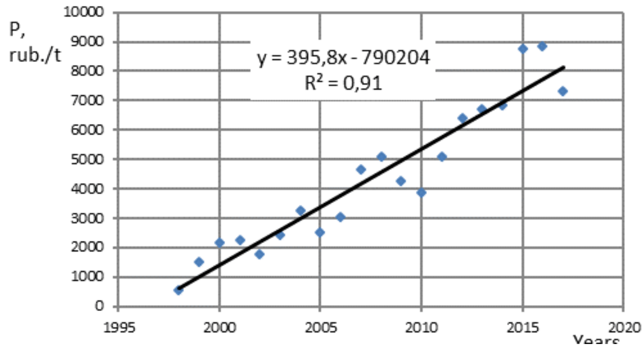

Fig. 5. The dynamics of average annual market prices for wheat
Source: Author

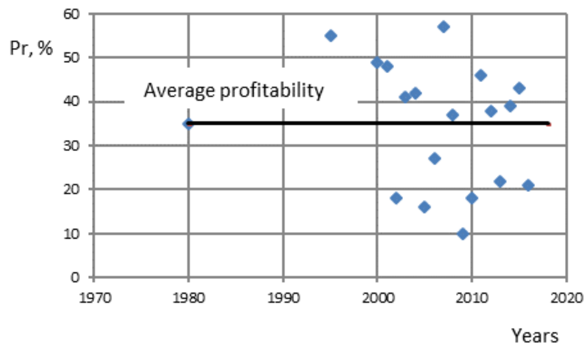

Fig. 6. The profitability of wheat grain production in the Russian Federation
Source: Author

Substituting the results of the research into the developed algorithm, the necessary size of the land plot was determined, which will ensure the profitable production of wheat in 2020. As a result, it was determined that with the existing cost structure, the price of wheat and the degree of business risk, the minimum size of land for its profitable cultivation should be at least 200...300 hectares per farm.

5. CONCLUSION

The definition of acceptable risk limits should be based on the comparison of the predicted damage with the break-even point. The definition of zones of business risk should be made considering the variance of the determining factor as a random variable. The expectation and standard deviation should be used as the desired parameters of the distribution law of a random variable.

The mathematical modeling shows that the average yield of wheat in the Russian Federation in 2020 will be about 22.4...22.8 C/ha, with a standard deviation being 2.8...3.0 C/ha. As a result, considering business risks, the planned yield can be adopted at the level of 19.4...20.0 C/ha. With the current cost structure, the price of wheat and the degree of business risk, the minimum land size for profitable wheat cultivation should be at least 200...300 hectares per farm.

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ORIGINAL RESEARCH PAPER

RATING ASSESSMENT OF A COMPANY AND COST PREDICTION OF SHARES ACCORDING TO PUBLIC REPORTING MATERIALS

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ABSTRACT

Today, rating is usually used to assess the financial condition of enterprises. Rating assessment allows determining the reliability and business activity of companies, as it is the assessment of their competitiveness on the market. Methods of financial analysis can act as basic methods for rating. In this paper, the authors proposed a rating method based on the public reporting materials of Russian joint stock companies. The authors also believe that the proposed method will make it possible to assess the investment qualities of the issuer's shares and determine its financial stability. The purpose of the study is a retrospective analysis of the algorithm for rating the financial status of joint stock companies to develop a technique for rating the company's shares based on public reporting. Objectives of the study are the following: to consider the basic methods of financial analysis for rating of companies; to determine the rating technique based on the public reporting materials of Russian joint stock companies; to determine the investment attractiveness of companies' shares (estimated demand). The hypothesis of the study: if the market history is repeated, then the current situation in the company can be determined due to rating based on public reporting materials, and stock prices can only be predicted according to deep studying of history and calculating the dynamics of their market value.

JEL classification: Q13, Q14

***Keywords**: financial analysis, financial ratios, joint stock company, securities, rating score*

1. INTRODUCTION

In the economy of the last century, the main methods of financial analysis were: technical (graphic) and fundamental.

The founders of fundamental analysis are Franco Modigliani (Neisser & Modigliani, 1953, Miller & Modigliani, 1958) and Merton Howard Miller (Miller & Modigliani, 1961, Miller & Rock, 1985, Blaug & Modigliani, 2009). The concept of Modigliani-Miller is that the securities can determine the actual performance of the issuing company. If the company's market share is large enough, it is possible to clarify the situation in the industry that it operates in. Fundamental analysis is based on the study of financial documents of joint stock companies to be published in public sources. Certain financial ratios based on the analyzed balance being calculated, the corporate share of such a joint stock company is reliable and liquid if it is within acceptable limits. The followers of another direction of financial analysis (technical or graphic) believe the price of a company share can only be determined by studying the history and calculating the exchange rate dynamics of their quotes (prices). Rating determination concerning the financial performance of a company allows determining its current position and financial stability but does not predict the future demand for its shares. Thus, the synthesis of fundamental financial analysis with the technical one is necessary to make this study quite urgent.

2. LITERATURE REVIEW

The approaches of fundamental analysis (Artyushin, 2013, Babayev & Petrov, 2014, Babayev & Petrov, 2018, Dwarf, 2006, Dybal, 2009, Efimova, 2013, Grigorieva, 2013, Grigorieva, 2016, Kazakova, 2016, Litovchenko, 2016) to predict the prices for issuing company shares are to be considered:

$$C = \frac{K}{N} \cdot \frac{1}{1 + \frac{1}{g(\frac{r}{r_n} - 1)}} \quad (1)$$

K is the capital of a joint stock company (company, corporation, etc.); N is the number of shares for issueing; r is the efficiency of alternative capital investment; r_n is the capital productivity of a joint stock company (companies, corporations, etc.); g is the profit share for paying dividends.

The formula allows combining the main factors to determine the financial situation in a company (companies, corporations, etc.). According to the presented formula, it is possible to determine the current financial situation in a company, expect its future development and determine the effectiveness of its revenue management system.

It is obvious that the factors used in the formula are presented in the most generalized form, but it is difficult to use it as there exist some problems of finding the numerical values for the factors presented in it. Today the development of the Russian market relations is of stochastic nature, this circumstance being characteristic for emerging markets.

It should be noted that Russian joint-stock companies present very limited accounting data in the public sources. As a rule, public reporting materials are presented by balance sheets, the capital being understood as the net assets of a company (a joint stock company).

Difficulties arise in assessing the capital productivity of a company (a joint stock company). As a rule, when using the formula (1) to assess the capital productivity, the company’s profitability is taken.

The next problematic indicator of the formula (1) is the indicator g. It characterizes the dividend policy of the company. Usually this indicator is taken as equal to the average value of the ratio (dividends/profit) for several reporting periods. This will require the creation of a specific database. Moreover, the more extensive the accumulated database is, the more accurate the prediction will be. If there is a enough and large database and the parameter g has a rather random nature, we recommend using the methods of mathematical statistics and probability theory when calculating its value. In this case, g will be the expectation for the resulting distribution of g as a random variable.

The indicator r for the effectiveness of alternative capital investments is of interest. In the Russian economy, the effectiveness of alternative “risk-free” capital investment is usually equated to the “key rate” (refinancing rate) of the Central Bank of the Russian Federation (Afanasievetal., 2014, Rutgayzer, 2007, Vahrushina & Melnikova, 2011). The key rate of the Central Bank of the Russian Federation is known to set the standard cost of credit resources for commercial banks in Russia. However, for joint-stock companies operating in the real economy, the “risk-free” rate can be defined as the average deposit rate of commercial banks. Considering that the size of the deposit rate for various commercial banks operating in Russia will be random, it is also advisable to apply the methods of mathematical statistics and probability theory.

At the same time, when determining the effectiveness of alternative capital investments, one cannot rely only on the “risk-free” effectiveness of investments. In addition, it is impossible to focus on the average efficiency of investments in the whole economic system of the country. In financial literature (Bakanov & Sheremet, 2001, Bakanov & Sheremet, 2009, Bakanovetal., 2005, Karpova, 1995, Startcevetal., 2005, Turmanidze, 2015, Zhilkina, 2016) the authors recommend using the average rate of return due to capital issues close to securities.

The methodological basis for fundamental financial analysis is the analysis of the coefficients obtained based on comparing the balance sheet data of a joint stock company (Babayev & Petrov, 2014, Camisascaetal., 2016, Kovalev & Kovalev, 2018, Lytnevaetal., 2012, Lytnevaetal., 2013, Savitskaya, 2002, Selezneva & Ionova, 2012).

The paying capacity of a joint stock company is characterized by the following liquidity ratios:

the absolute liquidity ratio (R_{al}). The absolute liquidity ratio is the ratio of the most liquid assets (cash + securities) to the value of the company's short-term liabilities;

the quick liquidity ratio (R_{ql}). The quick liquidity ratio allows considering the impact of receivables on the paying capacity of the company. The quick liquidity ratio is the ratio of liquid assets (cash + securities + receivables) to the value of the short-term liabilities of the joint stock company;

the total liquidity ratio (the coverage ratio) (R_c). The coverage ratio allows considering the influence of tangible current assets on the paying capacity of the company. The value of the coverage ratio is determined similarly to the Rql coefficient and differs in that the value of tangible current assets is added to the numerator.

The presented liquidity ratios characterize the ability of a joint stock company to cover its short-term liabilities with the sale of liquid assets. A joint stock company should be considered as capable of paying if the values of liquidity ratios satisfy the condition

$$R_{al} \geq 0.2;\ R_{ql} \geq 0.5;\ R_c \geq 2.0. \qquad (2)$$

If relations (2) are not fulfilled, then the joint-stock company faces the risk of loss of paying ability. Of course, this does not mean that the joint-stock company goes into the category of insolvent debtors. This means that the risk of depreciation of its share's increases.

One of the important indicators of the financial stability of a joint stock company is the equity ratio (R_e). The equity ratio is the share of the company's own funds as a result of the balance sheet. If a

$$R_e \geq 0.5 \qquad (3)$$

then the financial position of the company should be considered stable. Indeed, if the amount of borrowed funds does not exceed the number of own ones, then you can always absorb debts. In addition, if a joint stock company invests its own funds in the development of an enterprise, then it is interested in its development. The shares of such enterprises are obvious to be more reliable in the financial market.

According to the current legislation, joint-stock companies, first, are obliged to repay credit debts and interest on it, as well as to pay dividends on preferred shares. Dividend payments on ordinary shares joint stock companies may pay out of the remaining part of profits. If a joint stock company has a net profit, but does not pay dividends on preferred shares, the amount of the delayed payments should be considered as debt obligations of the company. However, such a joint stock company cannot be considered as unable to pay. First, it can pay debts. Secondly, according to the decision of the holders of preferred shares, the delayed payments can be directed to the development of the enterprise and will contribute to obtaining large future profits. This will increase the size of future dividends received and the attractiveness of the company's shares.

3. METHODOLOGY

Thus, based on the concept of fundamental analysis, if the financial ratios obtained based on analyzing the balance sheets are within the limits of acceptable values, then the shares of such joint stock companys should be considered reliable. At the same time, according to the followers of the concept of technical financial analysis, the price of a company's shares can only be determined through deep studying of the history and calculating the exchange rate dynamics of these shares. To calculate the dynamics of the share price, a statistical analysis of time series is used. This procedure allows determining not only the share price in the future, but also the amplitude of its fluctuations during the analyzed period. Excluding dividends paid, the future share price of a joint stock company can be defined as:

$$C_t = C_0(1 + R_t) \tag{4}$$

C_t is the future share price of a joint stock company; C_0 is the initial share price of a joint stock company; R_t is the mathematical expectation of the effectiveness of a joint-stock company as a random variable, for the time t.

It should be noted that in determining the future share price, the use of, for example, the concept of technical (graphical) analysis does not at all prevent from using the concept of fundamental financial analysis. Moreover, these two approaches greatly enrich each other.

In practice, a multi-stage investment management scheme is applied:

two-stage (the most common). At the first stage, an investment portfolio is formed with securities of the same type (for example, an investment portfolio is formed with shares of enterprises of the same industry). At the second stage, the price of the selected shares is predicted according to the efficiency of the chosen industry, the portfolio is optimized;

three-stage. At the first stage, portfolios are formed to place similar securities (for example, short-term loan documents or shares of enterprises of the same industry). At the next stage, the selected portfolios are mixed, and their effectiveness is assessed. At the third stage according to the practical experience of a financial manager, the composition of securities is optimized (for example, the optimal ratio between high-risk and risk-free securities is chosen).

The development of market relations requires new means to assess the financial situations in joint stock companies. When determining the reliability of a securities portfolio, the rating assessment of enterprises (joint-stock companies) is often used. Rating assessment allows evaluating not only the financial situation in a joint stock company, but also indicators of its business activity and the consumer demand for its products to determine together the competitiveness of an enterprise in the market.

In particular, the technique proposed in the early 1990s by M.I. Bakanov, A.D. Sheremet to get a comprehensive rating of Russian enterprises is well known. The components of fundamental financial analysis were its basis. According to this technique, rating is carried out in three stages: collecting the primary financial and economic information about companies; justificating a set of financial indicators sufficient for rating; ranking of enterprises.

The most important step is to justify a enough set of financial indicators to get an objective financial assessment of an enterprise. The set of financial indicators is not arbitrary. It should be minimal in the number of parameters, but enough for an objective financial assessment of an enterprise. It is necessary to consider the fact that all the necessary data should be taken from public records. Ensuring the above-mentioned conditions makes rating is quite affordable and objective. The proposed set of indicators for assessing the financial situation in a joint stock company, which can be obtained from public reporting data, is presented in Table 1.

The final rating score can be obtained by comparing the financial indicators of the company being studied with the similar indicators of the reference enterprise. An enterprise with the best performance in the industry is usually selected as a reference enterprise.

Table 1. Indicators of the financial assessing of a company, which can be obtained according to its public records

Assessment of profitability	Assessment of management efficiency	Assessment of business activity	Assessment of liquidity and financial stability
1. The overall profitability of the assets of the enterprise	1. The volume of gross profit	1. Capital productivity	1. The absolute liquidity ratio
2. The net profitability of the company's assets	2. The profitability of sales by gross profit	2. The capital intensity	2. The total liquidity ratio
3. Return on equity	3. Net profit	3. Turnover of working capital	3. Index of permanent assets*
4. The profitability of productive assets	4. The profitability of sales by net profit	4. Stored reserves	4. The equity ratio
–	–	5. Receivable turnover	5. Stocks equity with own funds

Source: Author

** Index of permanent assets is the ratio of the value of fixed assets and other non-current assets to the value of the own funds of an enterprise.*

4. EMPIRICAL FINDINGS

The above-described algorithm for rating the financial condition of a joint-stock company makes it possible to evaluate its liquidity and financial stability, but it does not answer the question of the attractiveness of its shares. In order to answer this question, the authors of this article propose a methodology based on the methods of fundamental financial analysis. The proposed method makes it possible to assess not only the financial condition of a joint stock company, but also to determine the future profitability and liquidity of its shares, if it issues them. The main indicators used by the proposed methodology for assessing the investment qualities of the issued shares are presented in Table 2.

Table 2. Rating indicators of the issuer and the investment attractiveness of its shares

Indicator name	Conditional designation	2 points	1 point	0 points
1. Depreciation of fixed assets, %	D_{fa}	$0 < D_{fa} < 25$	$25 < D_{fa} < 50$	$D_{fa} > 50$
2. The turnover ratio of working capital	R_{wc}	$R_{wc} > 2$	$1< R_{wc} < 2$	$R_{wc} < 1$
3. The profitability of productive assets, %	P_{pa}	$P_{pa} > 20$	$8 < P_{pa} < 20$	$P_{pa} < 8$
4. The financial stability ratio	R	$R < 1$	$1 < R < 1,5$	$R > 1,5$
5. The absolute liquidity ratio	R_{al}	$R_{al} > 0,25$	$0,15 < R_{al} < 0,25$	$R_{al} < 0,15$
6. Growth rate of real assets, %	G_{ra}	$G_{ra} > 15$	$5 < G_{ra} < 15$	$G_{ra} < 5$
7. Rate of profit growth, %	R_{pg}	$R_{pg} > 15$	$5 < R_{pg} <15$	$R_{pg} < 5$
8. The size of dividend payments, %	D	$D > 20$	$10 < D < 20$	$D < 10$
9. Share price	S	$S > 1,1$	$1 < S < 1,1$	$S < 1$

Indicator name	Conditional designation	2 points	1 point	0 points
10. Real asset backing of the issuer	R_a	$R_a > 1$	–	$R_a < 1$
11. Profitability of funds invested in shares, %	P_f	$P_f > 20$	$5 < P_f < 20$	$P_f < 5$

Source: Author

Based on the indicators presented in Table 2, the authors of the paper developed a scale for assessing the demand for shares of an issuing enterprise (a joint-stock company). According to the developed rating scale:

18 ... 22 points – the demand for the shares of the issuing enterprise is very high;

13 ... 17 points – the demand for the shares of the issuing enterprise is high;

6 ... 12 points – the demand for the shares of the issuing company is average;

0 ... 5 points – the demand for shares of the issuing enterprise is low.

Some of the materials presented in this paper were tested in higher institutions of the Russian Federation: at South Ural State Agrarian University, at Russian State University of Trade and Economics (Chelyabisk Institute), Chelyabinsk State University, South Ural State University, Ural State Economic University.

The main principles for rating of companies and determining the shares value formed the basis for predicting their future value at holding companies in the agro-industrial complex of the Russian Federation, and partly reported at All-Russian and international conferences and symposia (Karpova, 2014, Karpova, 2015, Karpova, 2015, Karpova, 2016). The approbation is rather declarative, more detailed data being needed. The materials presented in the paper allowed raising the interest of external and domestic investors for alternative sources of financing, which include equity financial assets, i.e. ordinary shares of companies, as well as other financial instruments.

5. CONCLUSION

Thus, the technique for rating a company based on public reporting materials allows not only assessing the financial situation in the company, but also to get an idea of the demand for its shares in the securities market. Unfortunately, this technique is not perfect, since it does not allow investigating the changes in the market value of shares in dynamics (all techniques based on the principles of fundamental analysis have this disadvantage). The development and further testing of the technique to predict the value of shares in dynamics, the authors of the paper consider it as the next task.

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ORIGINAL RESEARCH PAPER

MECHANISM OF BAKERY MARKET REGULATION EFFICIENCY IMPROVEMENT IN SOCIALLY ORIENTED ECONOMY

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ABSTRACT

Complexity of the bread market regulation in Russia is due to a special place traditionally taken by the bread in the structure of consumption and its role of the population's socio-economic well-being indicator. In this regard, on the one hand, the task of the state is to provide most of the population with cheap bread. On the other hand, tight control over the prices for this product can result in the degradation of the entire industry. The paper presents information and analytical tools to support management decisions for targeted stimulation of bakery producers contributing to the effective interaction among the state and baking business subjects. The authors determine 6 stable univocally identifiable groups of regions from 2004 to 2016 according to the results of multidimensional classification of the Russian Federation regions by 8 indicators identified by them to determine the social profile of the bakery consumers. According to the features of the considered groups of regions, possible measures are proposed to selectively support the baking industry enterprises for each of the groups considering the specificity of consumers' social profiles.

JEL classification: Q 11, Q13

Keywords: *socially important food products, bread market regulation, multidimensional classification, social profile of the bakery product consumers.*

1. INTRODUCTION: ISSUES OF THE STATE REGULATION FOR THE BAKERY MARKET

Bread and bakery products have always been special goods in Russia – the goods ensuring survival since these products account for up to 40% of the total caloric content of the population's diet in Russia the bread-producing enterprises have a special social significance, therefore the processes taking place in this subcomplex are relevant for the entire population being particularly acute today *(Ibragimova, 2012)*.

Bread traditionally takes a special place in the structure of domestic consumption. Development of the socially oriented bread and bakery production is currently hampered by the existence of several problems. On the one hand, bakery enterprises' costs are increasing due to the increase in prices for raw materials, energy tariffs and high level of equipment wear and tear. On the other hand, the task of the enterprises producing main types of bread is to provide most of the population with cheap bread. At the same time, the bakery manufacturers do not receive permanent state subsidies despite operating within the framework of the country's common agro-industrial complex (hereinafter - the AIC) and being its 3rd sphere (processing industry). The system of support for the agro-industrial complex existing in the Russian Federation is mainly aimed at stimulating the industries of the AIC's 1st sphere (producing industrial means of manufacturing) and 2nd sphere (agriculture) *(Yudina, 2005)*.

In the current situation, the bakery production is of low profitability in the Russian Federation. According to Rosstat, profitability of the bakery enterprises' assets was only 6.7% in 2017, and depreciation rate of their fixed assets reached 49.5%. The situation is aggravated by the fact that the bread and bakery production is unattractive for most investors due to its low profitability indicators *(Central database of statistical data, 2018)*.

At the same time, effective functioning of the AIC is possible only in the case of harmonious development in all spheres, economic interest of the participants and mandatory combination of state regulation and self-regulation.

Because bread and bakery products are goods of direct demand localized by the territories of population's residence, the nature of optimal stimulation in the bread and bakery market must be rational and differentiated. In this case, the incentives should consider the profile and specificity of consumers in the region since a simplified incentive system taking into account average Russian indicators may not only fail to solve the problems of the bakery production, but also give rise to problems of completely different nature.

This is proved by the experience of foreign countries. For example, in 1962, when Europe was still suffering from food shortages due to the Second World War, a common agricultural policy was adopted to support farmers' incomes. It provided the farmers with economic incentives to keep them working; this was reflected in the goals determined by the policy. As a result, the EU faced the problem of overproduction for certain types of agricultural products and the need to take measures to curb proposals including destruction of finished high-quality products *(Sokolova, 2010; Fallows, 1986)*. In this situation, we should pay attention to the experience of Korea having announced an updated plan to balance the supply and demand for rice by 2019; at the same time, they increase investment in research and development of technologies for rice processing enterprises *(OECD (2017))*.

2. ANALYSIS OF FACTORS DETERMINING THE VOLUME AND STRUCTURE OF THE BAKERY CONSUMPTION

The use of effective approaches to the development of the industry incentive strategy based on the statistical analysis of the regional consumer structure will allow the state to develop a selective regional producer incentive policy aimed at smoothing out specific imbalances in the functioning of regional bakery markets. For this, it is necessary to create multidimensional grouping of the regions in order to single out homogeneous clusters similar in social profiles considering the following trends in the consumption structure of the bread and bakery market.

Firstly, the share of bread consumption is higher among the population with low level of income. If we compare the share of bread products consumption in different households with different levels of income, we can see that the share of bread products consumption decreases with the increase in incomes. For example, in 2016, the share of expenses for the bread products in the first decile group was 9.9%, while the share of these expenses in the last (tenth) group was only 2.1% *(Household income, expenditure and consumption, 2017)*. However, this seemingly obvious conclusion requires substantial clarification. Qualitative assortment of the consumed bread products changes with the increase in incomes. Higher-income households reduce the consumption of traditional breads, because the people regard the traditional breads as low-quality products. This trend is not fixed in more expensive segments *(Perekalin, 2011)*.

Secondly, dietary preferences should be also considered. Traditionally, the most socially vulnerable bread consumers are retirees. At the same time, as researches show, this fact is not always associated with low income: elderly people cease to limit the consumption of sweets and bakery, and they eat more vegetables and fish than families with children as well. In addition, rural residents consume much more bread. However, the rural population also has no stable statistical association between the consumption of bread and the level of income. The tendency of the high consumption level is largely determined by the traditions developed in the nutrition structure of this population category. According to statistics for 2017, the share of bread products consumption in the total of food expenditures by the population living in urban areas of Russia was about 4.3%, and for the population living in rural areas it was 6.5% *(Household income, expenditure and consumption, 2017)*. Another socially vulnerable category of bread consumers are migrants. The city of Moscow is a striking example in this case due to its high rates of bread consumption because of population migrating from other regions.

The third manifested trend is an increase in the bread products consumption depending on the number of children in the family. For example, the share of expenses for the bread products in the nutrition structure for families with one child was about 4% in 2017, while for large families (3 or more children) this indicator was 6.8% *(Household income, expenditure and consumption, 2017)*.

The fourth important direction of studying the social profile in this case is the morbidity rate in the region. The main share of bakery production in the RF includes low-cost, mass-oriented bread types with low added value, while the production of dietary bakery products is insignificant. It should be noted that certain types of bread, such as coarse flour ones, are good for health due to containing dietary fiber, vitamins and minerals. The RF Government approved the Basics of State Policy in the Field of Healthy Nutrition for the period up to 2020. The objectives of the state policy in the field of healthy nutrition are preservation and strengthening of public health, prevention of diseases caused by malnutrition and unbalanced nutrition. One of the main directions of implementing the state policy in the field of healthy nutrition is increase in the share of mass-oriented foods enriched with vitamins and minerals, including mass types of bakery and dairy products up to 40–50% of the total production.

In this situation, foreign experience in the use of the bread products enriched with dietary fiber showed its efficiency. Now, bread products are produced containing not only additional vitamins, but also iodine, which is important for urban residents, and prebiotics (for example, lactulose). Absorptive properties of the fiber explain the mechanism of its effectiveness for lowering the level of cholesterol in the blood, which is important for prevention of cardiovascular diseases and reduction of the diabetes risk *(Betoret etc., 2011; Bogomolova &. Belimova, 2014; Matraeva etc., 2018)*. However, the cost of such healthy breads is high and unaffordable for most of the population. In this case, development of this area is difficult to implement without the state support. Many regions have to decide for themselves which useful sorts of bread to support and how relevant this is for the particular region.

3. RESEARCH METHODOLOGY

Considering the above trends, it is expedient to consider the following indicators within the framework of the region's social profile and selective policy of the state in the area of stimulating the bread and bakery producers:

- share of population with incomes below the subsistence minimum (z_1), %;

- value of the subsistence minimum (z_2) , rubles;

- demographic burden rate, the number of disabled people per 1000 people of working age (z_3) , persons;

- migration growth rate per 10,000 population (z_4) , persons;

- number of students in general education institutions (z_5) , persons;

- morbidity per 1000 population (z_6) , persons;

- share of expenses for bread in the structure of nutrition expenses (z_7) , %;

- share of rural population (z_8) , %.

According to the above indicators, multidimensional grouping of regions was made for the period of 2004 - 2016. The information base in this case was the data on the RF subjects for 2004 - 2016 published in the official statistical edition of the RF Federal Statistics Service "Regions of Russia". Data processing was carried out with the use of statistical package SPSS. Since the direct use of variables in the analysis could result in the grouping determination by the variables with the greatest variation of values, the indicators were standardized in the process of value grouping.

For the grouping process, a hierarchical algorithm with Euclidean distance metric – the Ward's Method – was used. The use of the Ward's Method in this case is since the task of this research stage was to find closely located clusters. Since this method involves an intragroup sum of deviation squares as the objective function, two clusters leading to its minimum increase are combined at each step, i.e. the intragroup sum of squares; this method is the most appropriate for solving such tasks *(Baker & Hubert, 1975; Hardy, 2006*).

Grouping variants of 2 to 11 clusters were considered. Frequency analysis of the clusters showed that the best option is division into 6 clusters. This assumption is confirmed by the analysis of coefficient characterizing the distance between the clusters. Its value increases significantly with a 6-cluster solution determining the choice of this grouping option. Analysis of the RF regions hierarchical grouping dendrograms for 2004 – 2016 also confirms this conclusion. Thus, by the value and statistical criteria, the best variant was the division into 6 clusters.

The 1st, 2nd and 3rd cluster groups are the most stable in terms of quantitative composition: they form a cluster core with the largest number of observations. The share of the first cluster accounts for 27 to 53 % of the regions, the share of the second class is 15-23 % (except 2013), and for the third one it is 15-21 %. The share of the 4th group accounts for 4-6 %, the share of the 5th group is 4-12 %, and the sixth one is 3-8 %.

Table 1 presents average values of the determining variables by 6 clusters for the period of 2004-2016.

Table 1. Average values of the determining variables formed by the social profile of the bread and bakery consumers in the RF for the period of 2004–2016

Cluster number	Value of determining variable	Volume of the subsistence minimum, rubles	Share of rural population, %	Demographic burden rate, persons	Migration increase rate, persons	Population with income below the subsistence minimum, %	Share of expenses for bread in the nutrition expenses, %	Morbidity per 1000 people, persons	Number of students studying in educational institutions, persons
1	Cluster average	4,935.66	30.01	673.76	-3.93	17.73	17.53	839.50	4,935.66
	Deviation from the RF average, %	84.40	98.01	104.38	47.31	92.15	102.91	110.12	84.40
2	Cluster average	5,902.45	32.28	635.02	-24.10	19.76	17.80	755.59	5,902.45
	Deviation from the RF average, %	100.93	105.44	98.38	290.39	102.72	104.52	99.11	100.93
3	Cluster average	4,818.53	38.45	685.94	2.08	18.00	16.99	641.06	4,818.53

Cluster number	Value of determining variable	Volume of the subsistence minimum, rubles	Share of rural population, %	Demographic burden rate, persons	Migration increase rate, persons	Population with income below the subsistence minimum, %	Share of expenses for bread in the nutrition expenses, %	Morbidity per 1000 people, persons	Number of students studying in educational institutions, persons
	Deviation from the RF average, %	82.39	125.59	106.27	-25.09	93.57	99.75	84.09	82.39
4	Cluster average	5,805.31	18.82	644.56	59.67	13.28	14.54	725.80	5,805.31
	Deviation from the RF average, %	99.27	61.48	99.86	-718.94	69.02	85.38	95.20	99.27
5	Cluster average	7,836.66	17.74	553.72	-50.57	16.52	15.40	885.55	7,836.66
	Deviation from the RF average, %	134.00	57.93	85.78	609.34	85.88	90.44	116.16	134.00
6	Cluster average	5,790.52	46.40	679.94	-32.95	30.14	19.93	726.65	5,790.52
	Deviation from the RF average, %	99.01	151.55	105.34	396.99	156.66	117.01	95.32	99.01

Source: Author

The use of stimulating or targeted selective regional policy in the market of bread and bakery products is not advisable for this group.

Cluster 1 includes regions of the Russian Federation, the average values of the determining variables in which are close to the average Russian values. These are typical representatives of the regions for the considered profile of social indicators, deviations from the average values for most of the indicators is about 15%. The exception is the “Migration Inflow Rate” indicators (the outflow of the population for this group is almost twice as high as the average Russian indicators) and “Number of students enrolled in general education institutions” this indicator is more than 20% lower than the average Russian one.

The structure of this cluster steadily included (more than half of the years under consideration) 22 regions: Bryansk, Vladimir, Vologda, Ivanovo, Irkutsk, Kirov, Kostroma, Kurgan, Novgorod, Omsk, Orenburg, Oryol, Penza; Perm region; Samara, Smolensk, Tver, Ulyanovsk, Yaroslavl regions, the Republic of Khakassia, Udmurtia and Chuvash.

Cluster 2. The regions of this cluster are characterized by lower values of the demographic burden rate and lower number of students compared with the average Russian values (20-45 % lower than the average Russian values), as well as significant outflow of the migrating population, which steadily exceeds the average Russian values for different years by 2-5 times. This group has a fairly small stable core - only 5 regions (although the size of this group ranged from 8 to 26 regions), which have been assigned to this group for more than a half of the years under study: Amur region, Jewish autonomous region, Zabaykalsky and Primorsky Krai, the Republic of Buryatia.

These are regions with a large social burden and average standard of living; it is expedient to use targeted bread subsidies for socially vulnerable groups of population or government support to produce mass types of “social” bread in them.

Cluster 3. is most clearly distinguished from other groups by a rather high share of the rural population and higher demographic burden rate, though these regions are also characterized by a lower morbidity rate (it is 20-40 % lower than the average Russian values). Also, the regions included in this cluster have slightly higher population’s standard of living than the average Russian one. Primarily, these are agrarian regions with good ecological situation; their sustainable representatives are Voronezh and Leningrad regions, the Republics of Kabardino-Balkaria, Karachay-Cherkessia, Adygea and Stavropol Krai.

Thus, the most socially vulnerable group of the population consuming bread and bakery products in these regions are retirees; the targeted policy aimed at the stimulation of the bakery production should be primarily oriented to them.

Cluster 4. Most of the regions included in this cluster have the lowest share of the rural population, higher subsistence minimum, high growth rates due to the migration and very big number of students in educational institutions - more than 2 times above the average Russian one. The core of this cluster steadily consists of Moscow, St. Petersburg and Moscow region. However, in general, the regional composition of this cluster was rather unstable throughout the period under study.

As for this group, it is advisable to develop the production of therapeutic and prophylactic breads targeted at the urban residents, especially children; for example, these are iodized and whole grain flour breads (Bogomolova & Belimova, 2014).

Cluster 5. Regions of this cluster are primarily the regions of Northern Russia: Kamchatka Krai, Magadan, Sakhalin and Murmansk regions, the Republics of Komi and Sakha (Yakutia). In this group, there are the highest morbidity and subsistence minimum, low number of students in general education institutions and low share of the rural population.

For this group, the production of both “social” bread and its prophylactic types should be stimulated simultaneously.

Cluster 6. It is one of the smallest clusters. Its structure steadily includes only 3 regions: The Republics of Altai, Kalmykia and Tyva.

For these regions, government stimulation of the bread and bakery market is the most needed since almost all socially vulnerable segments of population are represented there: high share of rural population, high demographic burden rate and high share of the population with incomes below the subsistence minimum.

4. CONCLUSION

The task of studying the distribution of regions by the social profile of bread and bakery consumers necessitated the inclusion of the following indicators in the range determining the social profile of the bread and bakery consumers: the share of population with incomes below the subsistence minimum; the value of the subsistence minimum; the demographic burden rate; the migration growth rate; the number of students in general education institutions; morbidity; the share of expenditures for bread in the structure of the nutrition expenditures; the share of the rural population in the region. The performed multidimensional grouping allowed determining the direction of bakery production development and stimulation within profile groups.

Such an approach will allow reaching a certain compromise between the market efficiency and social orientation of the bread market due to the following:

- provision of the neediest Federation subjects with funding and subsidies;

- provision of certain population categories or social groups in these subjects with the “bread subsidies”;

- state subsidizing for specific regions’ priority areas within the framework of development programs for small and medium businesses in the sphere of bakery production.

The proposed research algorithm can be used as an information basis for supporting the management decision-making by executive authorities of the RF subjects during the process of development and adjustment of the programs for the bread and bakery production support in the regions; it can also be used by the RF Government for the development of targeted policies to stimulate the manufacturers of the bread and bakery products.

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ORIGINAL RESEARCH PAPER

ECONOMIC ANALISIS OF FACTORS CAUSING THE EFFICIENCY OF INTRODUCING INNOVATIVE METHODS AND MEANS IN INDUSTRIAL POULTRY

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ABSTRACT

In modern poultry enterprises at different stages of production, innovative methods and means are introduced to reduce the level of veterinary risks and improve product quality. The lack of objective economic evaluation algorithms for their implementation makes it difficult to make management decisions. To establish the factors determining the economic efficiency of introducing new veterinary methods and means into industrial poultry farming and scientific substantiation of the methodology for assessing the economic efficiency of veterinary measures using the example of anti-stress therapy in growing broiler chickens, various economic assessment aspects were analyzed. The studies were carried out in broiler poultry farms of Tyumen and Chelyabinsk regions, the chickens were given anti-stress pharmacological complexes during the early and final stages of fattening. The basic data for the economic analysis were the main technological indicators (poultry population, safety, live poultry weight, amount of meat), the cost of preparations. The economic efficiency of veterinary measures was determined by the generally accepted method, the economic result was estimated by the increase in live weight or by the meat yield per one production section, per 1000 heads per production cycle and for the period of using the preparations. Evaluation of the qualitative changes that occur as a result of biotransformation or the collection of products was carried out according to the safety of the chickens, the amount of live weight, the average daily increase in live weight, the meat output. Due to anti-stress treatment, despite its limited period, an increase in these indicators is observed. For an objective and reliable quantitative, or monetary evaluation of economic results, firstly, the equality of conditions for economic evaluation is necessary, which is achieved through equal starting indicators of biological assets at the beginning of using the innovative methods and means; secondly, it is necessary to take into account quantitative indicators of productivity according to target performance indicators, i.e. the volume of meat obtained by broiler chickens during the full cycle of production, avoiding approximation. The updated methodology for assessing economic efficiency will allow objective decision making.

JEL classification: Q13, Q19

Keywords: *veterinary measures, innovative methods and means, anti-stress therapy, economic effect, economic result, cost of production, veterinary costs, poultry farming, broiler chickens, biological asset*

1. INTRODUCTION

A poultry enterprise, carrying out agricultural activities, creates conditions for using of biological characteristics of poultry as a production asset, including physiological processes – birth, growth and development, production, reproduction (Alekseeva, N.A., Shamsutdinov, R.F., Alexandrova, E.V. et al., 2018), which the production technology is based on (Alekseeva, N.A., Schamsutdinov R.F., 2015). Poultry farming almost immediately gets regained (Alekseeva, N.A., Konovalova, Yu.A., 2011). The industrial type of production is believed to eliminate a number of unfavorable conditions for production intensification, increases the degree of predictability when achieving the planned financial and economic results due to used integration effects (Alekseeva, N.A., Konovalova, Yu.A., 2011), however, poultry production volume and production efficiency is determined not only by the quality and quantity of labor involved, but also by the actual conditions of agricultural production associated with a higher degree of production risks, the risk of violating veterinary and sanitary requirements, leading to high exposure of birds to various diseases being the most significant (Halimbekova, 2009). To prevent the occurrence of these risks, several veterinary and sanitary measures are carried out; new veterinary methods and tools are introduced into the production technology. In connection with the above stated, there is a need for a reliable, apodictic methodological approach to the economic assessment and economic forecast of the results when introducing new methods and means in veterinary medicine, which corresponds to the concept of effectuation (Sarasvathy, S.D., 2001), especially in situations with a enough degree of uncertainty (Karpez, OV, Yurchenko ES, E.S., 2017). The key concepts for the poultry industry development for today and for the future are efficiency and biosafety. To get high rates of productivity and product quality is possible only from healthy poultry; therefore, for the modern large-scale poultry farming, innovations in veterinary science are of great impotance (Fisinin, 2015).

2. LITERATURE REVIEW

At poultry enterprises at different stages of production, effective methods and means are introduced to reduce the level of veterinary risks and improve product quality. Thus, the efficiency of using the nanosecond electron beam irradiation method for sterilizing eggs in industrial poultry farming, which reduces the level of bacterial contamination of eggs and improve product quality, was described (Donnik, I.M., Sokovnin, S.Yu., Krivonogova, A.S. et al., 2017). A number of studies substantiated the effectiveness of using biologically active substances from the extract of Quercus cortex (Fisinin, V.I., Ushakov, A.S., Duskaev, G.K., Kazachkova, N.M., Nurzhanov, B.S., Rakhmatullin,Sh.G., Levakhin, G.I., 2018), Quercus castaneifolia (Rezaie & Semnaninejad, 2016), irradiated flaxseed in broilers' diet (Beheshti Moghadam, Rezaei, Behgar, & Kermanshahi, 2017), fennel extract (Hadavi, Kermanshahi, Nassiri Moghaddam, & Golian, 2017), hemp seeds and hemp oil (Bazdidi, Afzali, Hosseini-Vashan, Ghiasi, & Malekaneh, 2016) in laying hens' diet.

These substances introduced in the poultry's diet help to enhance the immunomodulating state of the body, maintaining the required level of productivity and increasing product quality.

It is necessary to consider that changes in chickens' bodies, aimed at enhancing productivity, are closely interrelated with increased sensitivity to negative environmental factors (Miftahutdinov, A.V., Kuznetsov, A.I., 2012). Among the four main types of stress, a special attention should be given to food stress, which adversely affects the productive and reproductive performance of birds (Surai, P.F., Fisinin, V.I., 2016). Mycotoxins being inevitable contaminants of poultry food (Surai, P.F., Fisinin, V.I., 2016) at the molecular level (Fisinin, V.I., Miftahutdinov, A.V., Amineva E.M., 2017) cause oxidative stress in the body (Surai, P.F., Fisinin, V.I., 2016). In this connection, an important task of breeding remains the reinforcement of resistance to technological stresses (Cheng, H.W., Dillworth, G., Singleton, P., Chen, Y., Muir, W.M., 2001) at the genetic level (Soleimani, A.F., Zulkifli, I., Omar, A.R., Raha, A.R., 2011).

Internal stresses, including the peak of egg production and vaccination, are also of great importance for the poultry industry (Surai, P.F., Fisinin, V.I., 2016). Because of them, the genetic potential of industrial crosses is not always realized (Fisinin, V.I., Papazjan T., Suray P., 2009). Therefore, the problem of enhancing adaptogenic reactions when using pharmacological agents (Fisinin, 2015), the introduction of effective antioxidant solutions to reduce the negative effects of food and internal stress is relevant (Surai, P.F., Fisinin, V.I., 2016). Studies have been conducted on the positive effect of selenium preparations on the productivity of broiler chickens and the quality of slaughter products (Ahmadi, M.; Ahmadian, A.; Seidavi, A.R., 2018). Studies on the productivity, nutritional value of meat and the composition of the intestinal microbiocenosis of broilers treated with mixed feed, when replacing the feed antibiotic with a probiotic based on cellulosolytic and lactic acid microorganisms, the product quality due to the absence of antibiotics in it, increasing the protein level in the poultry muscle, reducing leg fat levels is improved (Fisinin, V.I., Egorov, I.A., Laptev, G.Yu., Lenkova, T.N., Nikonov, I.N., Ilyina, L.A., Manukyan, V.A.,Grozina, A.A., Egorova, T.A., Novikova, N.I., Yildyrym, E.A., 2017). Poultry farming is looking for the most effective sources of organic selenium for industrial use, with further directions for developing of new Se sources having already been identified (Surai, P.F., Kochish, I.I., Fisinin, V.I., Velichko, O.A., 2018).

The analysis of the sources described above showed that a quantitative or monetary assessment, which allows objectively assessing the effectiveness of new methods and means for veterinary use, is practically absent, which may impede their use. In the process of developing methodological principles for determining the economic efficiency of introducing research concerning the application of new veterinary methods and means in poultry farms, we proved that, despite the high cost of new methods and means, an increase in productivity allows achieving significant economic results (Zhuravel, N.A., Miftahutdinov, A.V., Zhuravel, V.V., 2018). An important condition affecting the level of achieved economic effects is the objectivity of determining target performance indicators.

In connection with the above stated, the purpose of the research was to analyze the factors determining the economic efficiency of introducing new veterinary methods and means into the poultry industry and the scientific substantiation of the methodology for assessing the economic efficiency of veterinary activities in poultry farms for broilers.

3. METHODOLOGY

Studies on the economic analysis of used anti-stress preparations at different stages of poultry breeding were carried out in broiler poultry farms of Tyumen and Chelyabinsk regions, where poultry breeding technology involves slaughter of chickens being 38-40 day old. In ZAO Uralbroiler, Chelyabinsk Region, the Hubbard F15 cross-breeding chickens (cellular content) were given the CM-complex from the first day of life for 7 days with water at a dose of 150 mg per 1 kg of body weight. The total stock in the control group included 338977 heads and 337439 heads were in the experimental group. In AO Tyumensky Broiler, Tyumen Region, the Arbor Acres cross-breeding chickens (floor keeping) were given the SPAO-complex at a dose of 185 mg per 1 kg of body weight during 4 days before slaughter. The experiment was carried out on the initial stock during sitting, 6000 chickens being in each group.

The initial data were basic technological indicators (poultry population, safety, live poultry weight, amount of meat), the cost of veterinary preparations. The economic efficiency of veterinary measures was determined by the formula $E_r = E_e : C_v$ (1), where: E_e is the economic effect, rub., C_v are the veterinary costs, rub. The economic effect was calculated according to the formula $E_e = D_c – C_v$ (2), where: D_c is the cost of the products obtained additionally by increasing its quantity or quality, rub., C_v are the veterinary costs, rub. The value of veterinary costs was determined according to the formula $C_v = C_m + C_l + O_{ec}$ (3), where: C_m is the material costs, rub., C_l is the labor costs, rub., O_{ec} is the earnings contributions, rub. The time spent by chickens on using anti-stress preparations was found based on timing. The established time commitment was multiplied by the wages per unit of time in accordance with the “Recommendations on the labor rationing for veterinary specialists” (2014). Charge on payroll was carried out according to the accepted value, i.e. 30.2%. The cost of products obtained additionally due to the anti-stress therapy was established by the formula $D_c = (B_n – B_b)xP_sxM$ (4), where: B_n, B_b is the output amount obtained due to using the new and basic technology, respectively, per head, kg; P_s is the selling price per unit of output, rub., M is the number of birds, heads.

A comparative analysis of the economic evaluation for the results was carried out, based on considering body weight for the period of using the preparations and taking into account the meat output per production cycle, as applied to the actual production conditions – the stock in the section, and according to 1000 heads, ensuring the equality of conditions for economic analysis.

4. EMPIRICAL FINDINGS

Poultry should be treated as biological assets, the life cycle of which involves the collection of products, i.e. the separation of products from the biological asset (increase in live weight) or the termination vital activity of the biological asset (slaughter). In the biotransformation process broiler chickens are subject to growth and production processes, as a result of which positive qualitative or quantitative changes occur in the biological asset while creating favorable conditions for raising poultry. Evaluation of changes means analyzing of quantitative and qualitative changes occurring as a result of biotransformation or collection of products: the safety of chickens, the amount of live weight, the average daily increase in live weight, meat output (Table 1).

Table 1. Production figures due to used anti-stress preparations for broiler chickens in ZAO Uralbroiler

Indicator	Control	Experiment
Number of birds when sitting	337439.00	338977.00
Body weight when sitting, g	36.24	36.45
Body weight at the age of 7 days, g	150.17	154.17
Average daily live weight gain of chickens during the final fattening period, g	60.16	88.16
Live weight before slaughter,	1728.00	1821.00
Safety in the first 7-10 days, %	98.82	99.13
Safety at the final stage of fattening (since the 36^{th} day)	99.64	99.36
Safety during the period of growth, %	94.85	96.28
Average daily weight gain, g	46.18	48.10
Meat yield, %	72.40	72.45

Source: Author

Table 2. Production figures due to used anti-stress preparations for broiler chickens in AO Tyumensky Broiler

Indicator	Control	Experiment
Number of birds when sitting	6000.00	6000.00
Body weight when sitting, g	38.67	38.70
Body weight at the age of 7 days, g	178.00	182.00
Average daily live weight gain of chickens during the final fattening period, g	87.30	93.80
Live weight before slaughter,	2338.00	2381.00
Safety in the first 7-10 days, %	99.80	99.70
Safety at the final stage of fattening (since the 36^{th} day)	98.80	99.40
Safety during the period of growth, %	96.10	94.80
Average daily weight gain, g	60.50	61.60
Meat yield, %	74.50	74.30

Source: Author

The data from the tables show an improvement in production performance at different stages of broiler chickens' growth: due to used anti-stress preparations, their live weight increases by 1.80-5.48%, the safety of chickens – by 0.31-0.61%, which indicates a higher level of the total production volume for one cycle. Each of these changes in physical characteristics is directly related to future economic benefits. Even though due to the anti-stress therapy an increase in production indicators is observed, a quantitative assessment of the expected economic results is difficult.

Thus, the increase in live weight is the result of the biotransformation process of broiler chickens in the form of separation of products from the biological asset. During the period of using the anti-stress preparations, an increase in the production of this type is noted (Table 1), the quantitative assessment of which is given in Table 2.

Table 3. Economic effect of used anti-stress preparations during the period of their use

Indicator, rub.	The quantity of products			
	ZAO Uralbroiler		AO Tyumensky Broiler	
	1000 heads	section stock	1000 heads	section stock
Veterinary costs	304.56	2507.92	2292.62	12204.59
Cost of products obtaine additionally	379.83	144549.70	2486.59	11748.66
Economic effect	75.27	142041.79	193.97	- 455.93
Economic effect per 1 rub.	0.25	56.64	0.08	-

Source: Author

As Table 3 shows a quantitative assessment of the effect of used anti-stress preparations for chickens during the period of their use depends on such a factor as the equality of the economic evaluation conditions. When finding the economic effect by calculating the total number of poultries, the principle of equality of conditions was not observed, since the stock in different groups was different (Table 1).

The cost of additional products is determined by the difference between the number of products from poultry according to the basic and new production technology. When conducting research at the early stage of fattening, initially there were more birds in the experimental group, which initially resulted in higher productivity in the group. When using anti-stress preparations at the final stage of fattening, the number of poultries in the control group by the end of the fattening period was higher than in the experimental one, which resulted in lower productivity in the group, and, as a result, a negative economic effect was observed. If the conditions are equal, i.e. the same number of poultries at the beginning of the experiment, the economic effect was positive at different stages of the application of pharmacological complexes, which, accordingly, affected the profit from 8 to 25%.

The value of profit indicators to compare in this analysis does not seem appropriate, since the cost of used preparations is different.

The use of preparations has a positive effect on the increase in live weight, but the production technology in the conditions of the poultry farms of the meat industry provides as the cessation of production the termination of the biological activity (poultry slaughter) and is aimed at obtaining the final product (poultry meat). Therefore, we should not take into account the increase in live weight, but the amount of meat. Therefore, we should not evaluate the period of preparations, but the entire production cycle, with the target production indicator being poultry meat (Table 4).

The data in Table 3 also indicate that the products obtained due to the termination of vital activity of a biological asset (meat output) as the most appropriate production technology is more informative than in the form of separating products from a biological asset (increase in live weight). Approximation, or replacement of some objects of economic analysis by other similar ones (in this case, the replacing of the indicator for the level of meat output to the level of increase in live weight), reduces the accuracy and reliability of economic analysis. However, in this case, the economic conditions also affect the objectivity of economic evaluation.

When calculating the economic effect of anti-stress therapy at the early stage of chick fattening, the unrealistically high economic effect is achieved due to the different number of birds in the control and experimental groups, the comparative assessment of which and the control data is not objective. If the equality of conditions is observed, i.e. equal stock number at the beginning of the period of using the anti-stress preparations, the results of the economic analysis are consistent with positive changes in bird productivity.

The amount of profit, or economic efficiency per ruble of costs, is determined by both the economic result, i.e. the cost of production, and the cost of preparations; therefore, it varies from 1.79 to 194.26 rub. per 1 ruble of cost.

Table 4. Economic effect of used anti-stress preparations during the growth period

Indicator, rub.	The quantity of products			
	ZAO Uralbroiler		AO Tyumensky Broiler	
	1000 heads	section stock	1000 heads	section stock
Veterinary costs	304.56	2507.92	2292.62	12204.59
Cost of products obtaine additionally	59467.71	20366443.46	6398.42	7367.38
Economic effect	59163.16	20363935.54	4105.80	-4837.21
Economic effect per 1 rub.	194.26	8119.86	1.79	-

Source: Author

5. CONCLUSION

Broiler chickens are a well consumed biological asset; therefore, product accounting as an object of economic evaluation should be carried out upon their reaching the state of maturity to determine the output. Therefore, despite the limited period of application of anti-stress pharmacological complexes for the period of broiler chickens' growth, the quantitative indicators of productivity should be considered according to the target production indicators, i.e. the volume of poultry meat output. With the introduction of new veterinary methods and means the economic effect is determined by the cost of production additionally obtained and the amount of the veterinary costs due to the used of methods and means. Obtaining objective results of economic analysis is achieved by considering the poultry productivity during the entire cycle of its economic use and equal starting indicators at the beginning of the use of new methods and means. The target when introducing innovative methods and means should be the level of changing performance indicators due to their use. Refined criteria for assessing economic efficiency contribute to an increase in finding its accuracy and reliability, but they do not require changes in finding the productivity, but they allow making objective management decisions.

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ORIGINAL RESEARCH PAPER

DESIGN SOLUTIONS FOR BUSINESS PROCESS REENGINEERING OF AN AGRICULTURAL ENTERPRISE

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ABSTRACT

The article is devoted to the improvement of business processes of a state unitary agricultural enterprise according to economic growth strategy. As part of the work, the current state of agricultural enterprises of the Russian Federation and the Republic of Bashkortostan are studied, the business processes of a state unitary agricultural enterprise are being solved. The structure and content of the concept of "reengineering of business processes", the study of the mechanisms and means for its implementation are analyzed. The models and regulations for reengineering of business processes of agricultural enterprises are developed. The practical significance of the work is that the main findings and methodological developments can be used both in further theoretical studies and in the real activity of enterprises to form effective management systems.

JEL classification: Q13, Q19

Keywords: *agricultural enterprise, competitiveness, agro-industrial complex, systematic reengineering, regulations*

1. INTRODUCTION

The relevance of the research is determined by several items. Firstly, the enterprises of the agro-industrial complex of Russia due to the difficult economic situation are in conditions of necessary transformations of their internal environment, improvement of management technologies based on scientific approaches to management. Secondly, the accumulated experience of applying process-oriented management makes it possible to use its principles for agricultural enterprises, considering their specificity (production dependence on environmental conditions, import substitution policy of technical and technological bases of production). Thirdly, the application of such an approach to management requires the restructuring of business processes, which determines the significance of theoretical studies and the development of practical recommendations for the reengineering of business processes of a agricultural enterprise in order to further positive experience.

The object of the research is the state unitary agricultural enterprise.

The subject of the research is the business processes of the state unitary agricultural enterprise.

The purpose of the research is to improve the business processes of the state unitary agricultural enterprise in the context of an economic growth strategy.

The research objectives: 1) the statistical study of the current state of agricultural enterprises of the Russian Federation and the Republic of Bashkortostan (RB); 2) the research of business processes of the modern state unitary agricultural enterprise; 3) the analysis of the structure and content of the concept of “reengineering of business processes”, the study of the mechanisms and means for its implementation; 4) the development of a model and regulations for reengineering of business processes of the RB agricultural enterprise.

The practical significance of the research carried out is that the main conclusions and methodological developments can be used in further theoretical studies, in the activities of a real enterprise to form an effective management system.

2. LITERATURE REVIEW

Studying the actual state of the agro-industrial complex (AIC) of Russia and the regions (the Republic of Bashkortostan) made it possible to identify the main groups of problems. Firstly, the problems connected with the quality of production results. Secondly, “the problems of managing the AIC, namely: the extremely low level of unification of accounting policies and the organization of internal document management; the lack of qualified specialists in all business processes; the defeciency of regulated accounting procedures; the need for labor-intensive manual accounting; poor connection of the central office with remote subdivisions”. (Babich, 2012, Gracheva, 2016, Guseva & Nazarova, 2016, Pasport APK, 2017, Postanovlenie Pravitel’stva RF, 2012, Repin, 2014, Sviridov, 2016, Ganieva &Nurova, 2017, Slepneva, 2014, Syusyura &Pustotin, 2016, Yaroshevich, 2015, Muñoz Dueñas, 2015) The results of the analysis of the current situation in the development of the agro-industrial complex of the Russian Federation presents a cause-effect diagram (Fig. 1). The goal at this diagram is competitiveness improvement of agricultural enterprises as being “the engine of economic progress, prompting commodity producers to increase production efficiency”. (Kiseleva&Tramova, 2014)

The specific nature of the activities of agricultural enterprises implies the need for fast-acting data transfer concerning production activities per day, integration and consolidation of data, as well as rapid analyzing of information on production indicators and inventory movements to the management company. All this make investors and management of enterprises change the methods and approaches to managing the modern agricultural complex, which is a large and complex production organism. (Babich, 2012, Gracheva, 2016, Zyukin, 2014, Kiseleva &Tramova, 2014, Kurbanov, 2016, Leont’eva, 2014).

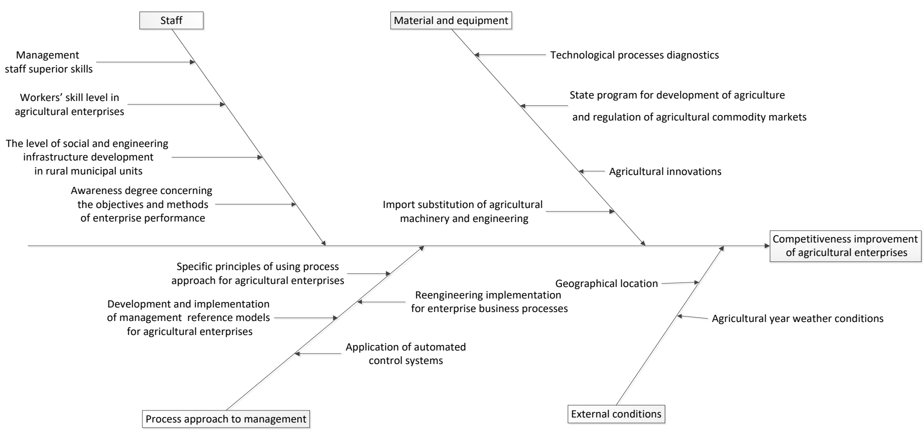

Figure 1. A cause-effect diagram determining competitiveness improvement of agricultural enterprises
Source: Author

In this regard, due to new investments, managers and investors take a growing interest in integrated management automation, its usage for managing agricultural enterprises being possible only along with the fundamental redesigning of existing business processes. This will increase their competitiveness. Business process reengineering (BPR) is aimed at improving the key performance indicators of enterprises through analyzing and restructuring of business processes (Sviridov, 2016, Ganieva &Nurova, 2017, Slepneva, 2014, Syusyura &Pustotin, 2016, Sheykhova, 2016, Park, 2018).

3. METHODOLOGY

BPR organization of agricultural enterprises is based methodologically on: general theoretical issues of management in the agro-industrial complex (the researches by R.Kh.Adukov, P.F.Askerova, G.A.Baklazhenko, N.V.Bannikova, B.B.Basayeva, P.E.Gasieva, A.M.Gataulina, V.A.Dobrynina, A.P.Zinchenko, Yu.B.Koroleva, V.D.Korotneva, Yu.L.Lomidze, V.Z.Mazloeva, N.M.Svetlova, I.G.Ushacheva and others); theory and practice of process-oriented management (the researches by B.Andersen, I.Ansoff, T.Davenport, E.Deming, P.Drucker, M.Porter, M.Robson, A.Smith, F.Taylor, A.Fayol, J.Champi, A.-V.Sheer, G.Emerson); applied studies of using the process approach in Russian enterprises (the researches by S.A.Borodulina, A.I.Gromova, V.G.Eliferova, V.V.Efimova, G.N.Kalyanova, V.V.Kondratyeva, M.N.Kuznetsova, K.V.Loginova, Yu.V.Lyandau, D.O.Mikhaylina, V.V.Repina, G.Yu.Sokolova, M.V.Taradina, O.B.Nazarova, L.Z.Davletkireeva and others); works by S.Ye.Matyushchenko, K.A.Petrov, A.V.Sibiryakova, V.V.Nevzgodova, by scientists G.V.Sapogova, I.A.Volkova, A.V.Nemchenko, dedicated to justifying the benefits of process management in the agrarian sphere, as well as concerning the peculiarities of using the theory of process management for controlling the technological processes of agriculture (Karabanova, 2012, Nazarova, 2015, Nechaev &Kolos, 2011, Gosudarstvennoy programme razvitiya, 2014, Zyukin, 2012, Yaroshevich, 2015, Marin, 2004). The source of economic information were official statistics, publications in periodicals, and actual data concerning agricultural enterprises.

According to (Ganieva &Nurova, 2017, Yunusova, 2016), the following phases can be distinguished in the procedure for BPR implementation: 1) planning: the BPR project is determined, the project team is formed and project goals are shaped; 2) reverse engineering: a model of some existing business is developed; 3) transformation (direct engineering): a new process is developed according to the existing one, as well as existing investments, level of training, etc.; 4) implementation: the solutions made and approved in two previous phases are implemented, the process changes.

The main tasks solved in the planning phase are: 1) selecting a process for improvement with the help of BPR and determining its scale; 2) assessing the potential for achieving improvements and setting goals; 3) forming a team to work in the project; 4) developing a preliminary plan for the BPR project.

IT technologies play a significant role for effective conducting of the re-engineering of business processes of enterprises, the BPM system. BPM (Business Process Management) is “the concept of the process management of an organization, considering business processes as special resources of an enterprise that are continuously adapted to constant changes. The key principles of such systems are: clearness and visibility of business processes in an organization by modeling business processes using formal notations, software for modeling, simulating, monitoring and analyzing business processes, the ability to dynamically rebuild business process models with the help of participants and the means of software systems”. (Nechaev, 2011)

BPMN (Business Process Modeling Notation) is intended to describe business processes according to the single standard that is understandable to every participant of the business area – from developers and technical specialists to managers who monitor processes. Creating a BPMN scheme is an integral part of a business process development and implementation project.

4. EMPIRICAL FINDINGS

4.1 THE RESULTS OF THE PLANNING OF A BPR AGRICULTURAL ENTERPRISE

A model of enterprise activity has been developed with the help of BPMN notation. Figure 2 shows only the network model of top-level processes. In the course of the work, a business processes register was compiled, its assessment being based on the process quality management technology (PQM technology) made it possible to determine the BPR appropriateness and select business processes to be changed. The entire sequence of work is reflected in the regulations for the reengineering of business processes of agricultural enterprises.

4.2 RESULTS OF EVALUATING THE BUSINESS PROCESSES FROM THE REGISTRY WITH THE HELP OF THE PQM TECHNOLOGY

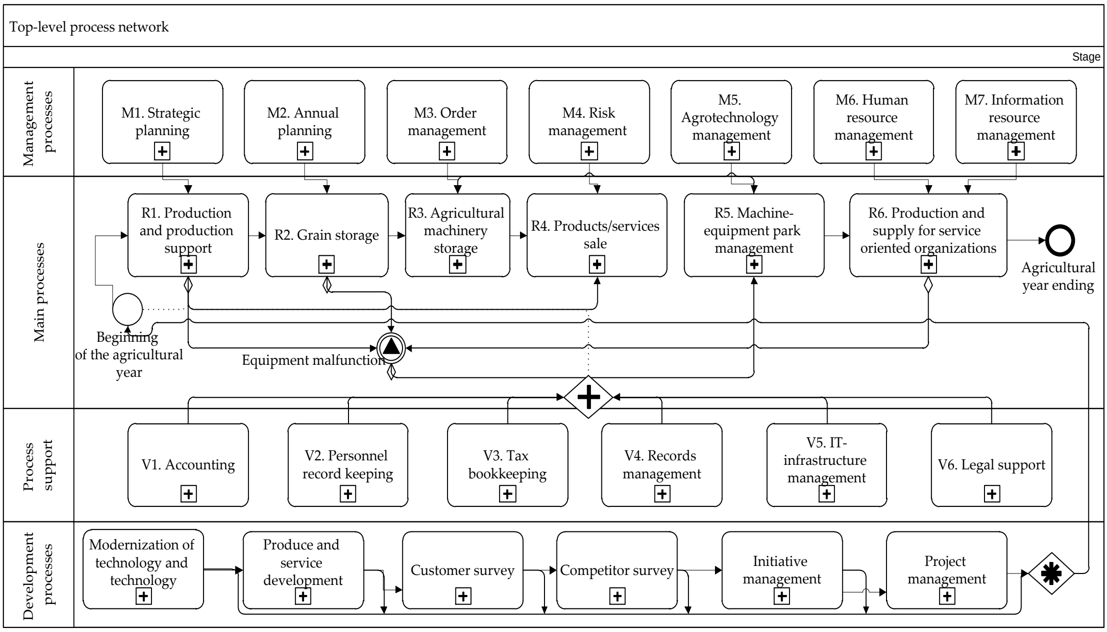

Figure 2. Network of top-level business processes
Source: Author

The mission of the organization: the company was established in order to effectively use the state property of the Republic of Bashkortostan and to meet the needs of agricultural producers of the Bashkir Trans-Urals concerning the services of machine-technological stations, the production of agricultural products and their processing for profit.

The list of main business processes: production and production support (P1); grain storage (P2); agricultural machinery storage (P3); products/services sale (P4); machine-equipment park management (P5); production and supply for service-oriented organizations (P6).

The list of critical success factors (CSFs), as well as the results of their comparison with key business processes are presented in Table 1.

Table 1. Comparison of CSFs and key business processes

P \ CSF	CSF 1 Lowest shipping costs on the market	CSF 2 High-level customer satisfaction	CSF 3 On-time produce delivery to customers	CSF 4 Highly-qualified machine-equipment engineers	CSF 5 Industry-leading produce quality	CSF 6 Highly-motivated employees	CSF 7 Launching processes to meet market requirements	CSF 8 Formation of opportunities to develop new business	CSF number	Rating (A, B, C, D, E)
1	2	3	4	5	6	7	8	9	10	11
P1		×		×	×	×	×	×	6	B
P2		×			×				2	B
P3		×			×				2	C
P4		×					×	×	3	C
P5	×	×	×	×				×	5	E
P6		×	×						2	D

Source: Author

Process ranking (columns 10 and 11): counting the number of CSFs that are affected by the business process and using one of the following agreed marks: A = excellent work, B = good work, C = satisfactory work, D = inadequate work, E = bad work.

The list of main business processes: production and production support (P1); grain storage (P2); agricultural machinery storage (P3); products/services sale (P4); machine-equipment park management (P5); production and supply for service-oriented organizations (P6).

Evaluation of business processes according to criteria and distribution for areas of reengineering suitability showed that the P5 process (machine-equipment park management) occured in Zone 1, i.e. in the zone of strategically most important processes that are not working well enough today. These processes and their components should be selected for reengineering, if the goal is to achieve a large, rapid, positive effect in the organization’s work (empty cell). The following business processes: P3 – agricultural machinery storage, P4 – products/services sale, and P6 – production and supply for service-oriented organizations occured in Zone 2, that is, in the zone where the processes, less affecting the work of the organization in overall, but favor achieving the mission are located. The processes: P1 – production and production support, P2 – grain storage occurred in Zone 3. These processes have a minimal impact on the performance of the organization, work well today and need least improvement. These processes should be controled so that they continue to work efficiently.

After identifying the main business processes, they were analyzed and ranked according to their importance and effectiveness, with the main stages of reengineering being analyzed and then classified into the following categories: value-adding business processes as stages directly related to customers' satisfaction, including internal (production, installation, service); business processes adding value to the enterprise as a whole as stages that the enterprise needs, but do not add real value from the client's point of view (information storage, reporting system); business processes not adding value (controlling the progress of work, storage, transportation delays, etc.).

Thus, reengineering affects the stages of the last group, and for the first two groups optimal solutions are to be found. In our case, these are the business processes comprising the main process "Machine-equipment park management".

5. CONCLUSION

As a result of solving the research tasks, the state of the agro-industrial complex (AIC) of the country and the region was determined. The balanced development of all parts of the AIC is a necessary condition for solving the problem of providing the country with agricultural raw materials and food. Currently, insuffisient development of the AIC processing industries, the industrial infrastructure of the complex leads to large losses of agricultural products. The study of the current state of the Russian AIC made it possible to identify its main problems, namely: the significant reduction in production volumes, acreage, livestock population, which occurred as a result of disrupting production and economic ties, increased inflationary processes, increased costs of credit resources, reduced state financing, declined consumer purchasing power of agricultural products, disparity of prices for industrial and agricultural products; the poor state of agricultural land.

As a result of solving the next task, it was established that reengineering is one of the ways to prevent crisis phenomena at agricultural enterprises. Reengineering of business processes of enterprises is used in cases when it is necessary to decide on reorganizing activities: business restructuring, replacement of existing management structures with new ones. An enterprise aiming to survive or improve its position must continually improve the ways of organizing business processes and production. The critical state of agricultural enterprises during the economic crisis leaves no time for a long search for ways out of difficult economic situations. Reengineering of business processes allows, through analyzing and rethinking of business processes, dramatically improving the main modern indicators of the enterprise. The main goal of business process reengineering is a dramatic acceleration of the company's response to changes in customers' requirements with a multiple decrease in costs of all kinds.

The methodological basis for reengineering of business processes was determined to be the works by M. Hammer, J. Champi, J. Becker, L. Vilkova, V. Taratukhina, M. Kugeler, M. Rosemann, A.S. Kochnev, V.V. Repin, B. Anderson and others. The key positions that will be put in recommendations for reengineering of business processes of agricultural enterprises and the rules for carrying out the necessary work at a particular agricultural enterprise of the Republic of Bashkortostan are identified: the enterprise's adaptability to market conditions benchmarking; the introduction of integrative strategies; the process management and process approach to the organization of the enterprise; the creation of a business process management system based on it; the implementation of a process control system; the measurement and monitoring of business processes; the application of BPM technology and related systems and notations (BPMN).

The following results of reengineering planning for business processes of agricultural enterprises were obtained: a model for enterprise activity with the help of BPMN, a register of business processes, selected business processes for reengineering based on the PQM technology; regulations for reengineering of business processes of agricultural enterprises.

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ORIGINAL RESEARCH PAPER

DIRECT ENGINEERING OF AGRICULTURAL ENTERPRISE BUSINESS PROCESSES

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ABSTRACT

The article is devoted to work technologies in direct engineering of agricultural enterprise business processes in conditions of economic growth strategies. In this work the tasks of Russian Federation and Republic of Bashkortostan agricultural enterprise current state ststistic research and business processes of a unitary agricultural enterprise are solved. Direct engineering procedures according to ESIA rules are realized, the network model of agricultural enterprise main business processes with changes after engineering procedures is built. The practical importance of the done work is the following. The main done results and methodic works may be used in the future theoretical researches and in a real activity of a research enterprise for forming effective management system.

JEL classification: Q1, Q13

***Keywords** business processes re-enginerring, an agricultural enterprise, system re-enginnering, information system introduction, direct engineering*

1. INTRODUCTION

The actuality of the work determines by the following positions. First, because of the economic situation Russian agricultural enterprises are in the conditions of needed transformation of the internal environment, managent technologies improvement based on the scientific approaches to the management. Secondly, the practice of the such an approach to management demands business processes reconstruction, that determines the significancy of theoretical researches and practical recommendations output on concreat agricultural enterprise business processes for the purpose of the positive experience future expantion.

Study object – a state unitary agricultural enterprise.

Research question – state unitary agricultural enterprise business processes.

The purpose of the work is developing the direct engineering of agricultural enterprise business processes in the conditions of an economic growth strategy.

The problems of the research: 1) a statistic research of a modern state of agricultural enterprises of the Russian Federation and the Republic of Bashkortostan (RB); 2) conducting works on the direct engineering of agricultural enterprise business processes of the Republic of Bashkortostan.

The practical relevance of the done research is the following. The main results and methodiz works may be used in future theoretical researches, in the activity of a real enterprise for forming an effective management system.

2. LITERATURE REVIEW

The specification of agricultural enterprises activity supposes the necessity of the operational data transmission about productive activity for a day, data integration and consolidation, and operational data analisis about process performance and commercial material flows into a management company. All this apposes investors and enterprises management the necessity of changes in methods and approaches to managing a modern agricultural complex which is a big difficult production entity. (AgroArchive of agricultural materials; Babich (2012); Gracheva (2016); Guseva, Nazarova (2016); Kiseleva,Tramova (2014); Kiseleva, Simonovich (2014); Kiseleva,Simonovich (2016); Passport of the agro-industrial complex of the Republic of Bashkortostan at the end of 2017; Resolution of the Russian Federation Government (2012); Repin (2014); Sviridov (2016); Ganiev, Nurov (2017); Syusyura, Pustotin (2016); Yunusova (2015,2016). In the conditions of new investments leaders and investors take growing interest in complex managent automation. The use of such an agricultural enterprise managent instrument may be only under fundamental restructuring existed business processes. This allows to increase their competivity. Business processes reengineering (BPR) allows to improve key characteristics of enterprise activities by means of business processes analysis and rethinking. Sviridov (2016); Ganiev, Nurov (2017); Slepneva (2014); Syusyura, Pustotin (2016); Sheikhova (2016); Yunusova (2016); Yaroshevich (2015).

3. METHODOLOGY

The methodological basis of BPR organization of an agricultural enterprise are general purpose questions of management in agro-industrial complex (AIC) (researches of Adukov R.H., Askerov P.F., Baklazhenko G.A., Bannikova N.V., Basaev B.B., Gasiev P.E., Gataulin A.M., Dobrynin V.A., Zinchenko A.P., Korolev Yu.B., Korotnev V.D., Lomidze Yu.L., Mazloev V.Z.,Radovic -Markovic,M. Svetlov N.M., Ushachev I.G., etc.); theory and practice of process based management (researches of Andersen B., Ansoff i., Robson M., Champy G., Sheer A.-B., Amerson G.); applied researches of using process approach at Russian enterprises (researches of Repin V.V., Sokolov G.Yu., Taradina M.V., Nazarova O.B., Davletgireeva L.Z., etc.); works of Matyustchenko S.E., Petrov K.A., Sibiryakov A.V., Nevzgodov V.V., scientists: Sanogova G.V., Volkova I.A., Nemchenko A.V., devoted to proving advantages of process management in an agricultural sphere. [1-4, 6-8,14-18, 21-27,29,30-32]. As for economic information sources official statistic materials, puplication in periodics, facts on an agricultural enterprise were used.

Accordig to (Robson, Ullakh) (Telnov) in a procedure of realization of BPR the followin phases may be marked: 1) planning: a BPR project is determined, a project team and project purposes are formed; 2) back engineering: a model of existed business is developed; 3) transformation (direct engineering): a new process is developing with the help of existed things, and present invesnments, an educational level, etc.; 4) implementation: solutions are introduced thar are worked and confirmed on the two previous phases, the process is changing.

The main steps of this direct reenginerring stage are documentation of this existed process; process reengineering; output of recommendations on improvement.

According to Anderson B. two methods of using BPR are emphasized: systematic reengineering – current process is understood, documented and analysed for system creation of new and better processes; reengineering with clean sheet of paper – an existed process is fully destroyed and utilized. A new process is created from clean sheet of paper by fundamentally rethinking of the existed one. For conducting works during this research, the first from the indicated methods was used. This method relates to simplifying enterprise business processes and leading to the usage of ESIA rule (Exclude, Simplify, Integrate, Automation). The sequence of using these rules are the following: 1) excluding all the operations, that were not connected with adding value; 2) performing activity “simplify” is conducted at very difficult sections (document forms, processes, technologies, etc.); 3) performing activity “combine” (a combination may be performed at several stages: tasks, work groups, enterprises); 4) performing activity "automate" (processes, recommended for automation: difficult stages of work, data transmission, data analysis).

4. EMPIRICAL FINDINGS

In previous researches on this topic, it was determined that firstly business processes of the main process "Management of machine-technological park" will be subjected. The application of ESIA rules to this process allowed to perform the transformations presented below and in Figure 1.

The transformation of the processes is from the register of agricultural enterprise business processes.

By process group 5.1. Ensuring the work of equipment in the subsidiary processes are excluded, 5.1.1. Providing methodical assistance to machine operators, 5.1.2. Preparing harvesting equipment for operation and ensuring its efficiency during the operation, 5.1.3. Organizing commission work for checking the readiness of grain-harvesting machinery for work.

The following processes have been eliminated (included in the Development processes group and removed due to duplication - 5.1.2): 5.1.4. Drawing up acts of checking the readiness of grain-harvesting machinery for work (automated in 1C: Management of an agricultural enterprise. Calculation of the planned need for spare parts and fuel and lubricant materials); 5.1.5. Maintaining technical documentation, filling out a passport (automated in 1C: Management of an agricultural enterprise. Detailed accounting of the work of trucks and cars); 5.1.6. Accounting of fuel and lubricant materials consumption, spare parts, maintenance, breakdowns, troubles and their causes for each harvester (automated in 1C: Management of an agricultural enterprise. Detailed accounting of the work of trucks and cars); 5.1.7; Scheduling monthly technical and periodic services (implemented in 1C: Management of an agricultural enterprise. Management of repairs and maintenance of the equipment); 5.1.8. Compilation of damage claims on identified faults (implemented in 1C: Management of an agricultural enterprise).

Group processes 5.2. Performance of the mechanized works are united. Accounting by processes is carried out in process "Customer Relationship Management" and "Production Accounting of Agricultural Work and Services Rendered" in 1C: Management of an agricultural enterprise.

Group processes 5.3. Operation, repair and technical maintenance of agricultural machinery (5.3.3. Ensuring the replacement of failed parts and assemblies, 5.3.5. Drawing up an application for the purchase of fuel and lubricant materials, spare parts and other repair materials, 5.3.6. Control during the operation of fuel and lubricant materials consumption, operating modes, performance) implemented in 1C: Management of an agricultural enterprise. Detailed accounting of trucks and cars' work. Calculation of the planned demand for spare parts and fuel and lubricant materials. The remaining processes of the group are left unchanged.

Group processes 5.4. Technical maintenance and repair of motor vehicles (5.4.2. Ensuring uninterrupted and technically correct operation of transport; 5.4.3. Calculation of the consumption of operating fluids, lubricants and rubber products, 5.4.4. Monitoring the rational use of operating fluids, lubricants and rubber products) implemented in 1C: Management of an agricultural enterprise. Detailed accounting of the work of trucks and cars. Calculation of the planned demand for spare parts, fuel and lubricant materials.

When making recommendations for improving business processes, a selection of automation tools for an agricultural enterprise was made.

As for the selection criteria the following factors were such as: an IT solution should provide "coating" of all required management processes (Accounting for land share rent calculations, Vehicle operation accounting, Accounting and tax accounting, Cattle Planning, Warehouse Management, Customer Relationship Management, Equipment Management, Human resource management and payroll preparation) - processes (K1); the methodology for implementing an IT solution should exist and

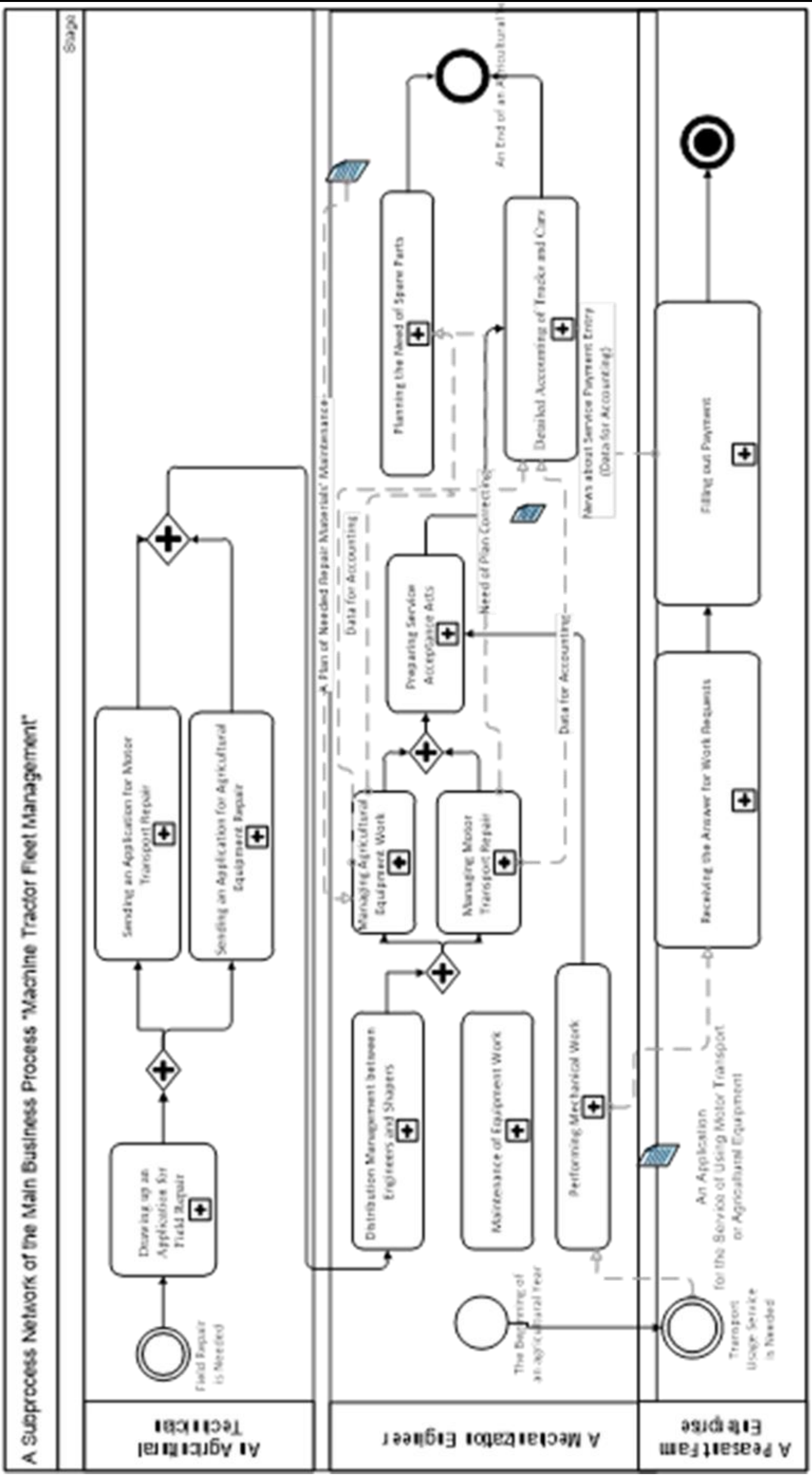

Figure 1 – A Subprocess Network of the Main Business Process “Machine Tractor Fleet Management” after Reengineering

Source: Author

ensure its implementation by the customer at the appointed time - the period of implementation (К2); IT solution should provide the minimum monetary costs - monetary costs (К3); an IT solution should ensure minimum labor costs when introducing new business processes - labor costs' implementation (К4); an IT solution should be provided with the necessary documentation package (all types of instructions, methodological and technological recommendations for implementation and maintenance) - documentation (К5); an IT solution should provide integration with GPS monitoring systems - integration (К6); the IT solution implementation methodology should maximally reflect the high-quality implementation of introducing all life cycle stages (life cycle) – the stages of life cycle introduction (К7).

The alternatives were chosen such automated systems as: "COMPASS: Marketing and Management" (E1); "AdeptIS: Agrocomplex" (E2); "Parus-APK" (E3); "1C: Management of an Agricultural Enterprise" (E4).

The results of the calculations are presented in tables 1-3.

If we evaluate the obtained results, then a significant advantage of "1C: Management of an agricultural enterprise" was received due to the high assessment of the implementation of such criteria as: "coating" of all the required management processes (К1), minimum cost expenses (К3), integration with GPS monitoring systems (К6).

Table 1 – A Matrix of Criteria' Paired Comparisons

	К1	**К2**	**К3**	**К4**	**К5**	**К6**	**К7**	**Criterion Weight (CW)**
К1	1,00	5,00	7,00	7,00	3,00	1,00	3,00	0,39
К2	0,20	1,00	1,00	1,00	0,33	0,33	0,20	0,07
К3	0,14	1,00	1,00	1,00	0,33	0,20	0,33	0,06
К4	0,14	1,00	1,00	1,00	0,20	0,20	0,33	0,05
К5	0,33	3,00	3,00	5,00	1,00	1,00	1,00	0,21
К6	1,00	3,00	5,00	1,00	1,00	1,00	1,00	0,22
К7	0,33	5,00	3,00	1,00	1,00	1,00	1,00	0,18

Source: Author

Table 2 – A Matrix of Alternatives' Pairwise Comparisons by Criteria

	E1	**E2**	**E3**	**E4**
К1	0,12	0,12	0,19	0,64
К2	0,05	0,29	0,13	0,47
К3	0,05	0,29	0,10	0,56
К4	0,06	0,33	0,21	0,22
К5	0,42	0,07	0,36	0,06

	E1	E2	E3	E4
К6	0,08	0,20	0,29	1,05
К7	0,45	0,09	0,16	0,35

Source: Author

Table 3 - Combined Criterion Weight

IT solutions that are estimated	Combined Criterion Weight
“COMPASS: Marketing and Management”	0,16
“AdeptIS: Agrocomplex”	0,16
“Parus-APK”	0,24
“1C: Management of an Agricultural Enterprise”	0,57

Source: Author

Thus, the result of this work stage on business processes reengineering for the discussed enterprise are: a model of a new state of agricultural enterprise business processes; recommendations on the business processes’ reengineering (in the form of regulations); the choice of automation means for managing an agricultural enterprise (according to the made calculations, an ERP solution from 1C "1C: Agricultural Enterprise Management" with a combined weight of 0.57 according to T.Saati method has a notable advantage.

5. CONCLUSION

It can be assumed that the implementation of an appropriate IT solution will be the basis (driving force, mechanism) for business processes reengineering of a specific agricultural enterprise of the Republic of Bashkortostan. The goal of the project of introducing an automated enterprise management system "1C: Agricultural Enterprise Management" can be considered as the increase of enterprise competitiveness and customer service quality. The choice of such a solution was carried out by T. Saati method of pairwise comparisons.

The combined weight in the calculations obtained by this ERP system was 0.57 compared with the other systems (table 3).

The implementation of this system will provide the management of the enterprise and managers responsible for business development with the analysis, planning and flexible management of the company's resources; heads of departments, managers and employees who are directly involved in production, sales, supply and other activities to ensure the production process, with tools that allow to increase the efficiency of daily work in their areas; employees of the accounting services of an enterprise by means of automated accounting in full compliance with the requirements of the law and corporate standards of the enterprise.

Based on the results of the assessment of the business processes of the registry using the PQM (Process Quality Management) methodology, it was decided that the business processes of the main process “Management of the machine-technological park” would be subjected to reengineering. These business processes are presented in section 5 of an agricultural enterprise business processes register. The most part of transformations were associated with the processes’ realization in the proposed ERP system. The recommended changes are also reflected in the new business process model of an agricultural enterprise.

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ORIGINAL RESEARCH PAPER

IMPROVING COMPETITIVENESS OF DAIRY FARMING OF THE REGION IN THE CONTEXT OF FOOD SECURITY

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ABSTRACT

Food security of the country is one of the priorities of the state in modern conditions. In order to achieve this goal, it is necessary to solve a range of problems of agricultural development due to the restoration and sustainable development of animal production which is characterized by a decline in production and reduced efficiency. The article is devoted to the study of topical problems of formation of competitive dairy farming in the Chelyabinsk region. The paper presents a scientific analysis of the current level and economic efficiency of dairy farming in the light of the emerging diversified economy, as well as the impact of certain factors on the growth of milk production efficiency. Considering the experience and best practices of economically developed foreign countries and the peculiarities of the development of domestic dairy farming, the most effective ways to intensify forage production are substantiated. Elements of selection work as one of the priority factors influencing dairy productivity of cows are proved. A model of improving competitiveness of dairy farming as the basis of food security in the region is worked out. Recommendations on dairy farming recovery in a market economy are given. The production factors determining the level of competitiveness of milk production in the Chelyabinsk region are given. The correlation and regression model of increase of dairy farming efficiency is constructed. The quantitative relations of production and economic indicators established in it allow to reveal the regularity of their changes, to plan and predict the volume of milk production based on improvement of forage base. The model considers the peculiarities of dairy farming development and the possibility of choosing options to improve its efficiency, allows not only to show the quantitative impact of each of the factors included in the model, but also to predict the value of the function and, consequently, to manage the analyzed indicator. The priority guidelines for the management of dairy breeding that provide economic efficiency of agriculture are considered.

JEL classification: Q10, Q21

Keywords: *Milk, Cattle breeding, Production efficiency, Food security, Growth stability.*

1. INTRODUCTION

The socio-economic target at the present stage of development is to provide the population of Russia with food and agricultural raw materials. And first of all, it concerns milk and dairy products. Milk and dairy products occupy one of the leading places in the nutrient budget of the population of our country and are extremely important for a balanced human diet. The share of dairy products in the structure of the consumer basket (cost estimate) ranges from 20 to 30% in different regions. (Vukovic, Markovic, &Hanic, 2016). Changes in the development of dairy breeding are characterized by the fact that during the years of reforms in this industry there was a destruction of production capacity, decline of production and decrease of efficiency. A relatively long period will be required to carry out import substitution successfully rather than redistribution of the main import flows of agricultural products, resources and food.

2. LITERATURE REVIEW

Increasing of competitive advantages of domestic agricultural products, milk, can be achieved only by ensuring a high level of quality with simultaneous reducing forage costs. (Sarkar & Costa, 2008) One of the main advantages of cows as ruminants is the ability to digest cheap rough and juicy forage. This fact should allow to reduce the cost of milk by increasing productivity of cows and reducing share of fixed costs per unit of production. Under rapid growth of grain prices in the world and domestic markets, respectively, and feed-stuff, intensive technology in forage production are becoming a determining factor in improving competitiveness of dairy farming.

3. METHODOLOGY

The success of the development of dairy breeding depends on the level and usefulness of animal nutririon (Shaheb, Nazrul, & Ataur Rahman, 2014), optimal housing conditions, rate of increase of their genetic potential, use of high-performance technologies. In this connection researches to determine the ways of effective management of dairy farming will be relevant. The purpose of this study is to analyze the development of dairy farming in the region and the foundation for improving the efficiency of the industry at the present stage of reforming of the agro-industrial complex. The analysis of publications on the studied aspects of the development of dairy farming, comparative analysis of the values of indicators, economic and mathematical modeling are the main research methods used in the study. Statistical data on indicators of functioning of the dairy subcomplex in the region are sources of information. By using methods of analysis, forecasting (EHS, Anjum, Ashraf, Anjum, Khan, & Ghaffar, 2015), evaluation, planning, the main directions of the development of dairy farming in the Chelyabinsk region as one of the factors to improve the efficiency of agriculture given regional characteristics are substantiated. The methods of logical and statistical analysis were used in the process of studying the problem of increasing competitiveness of dairy farming as the basis of food security in the region.

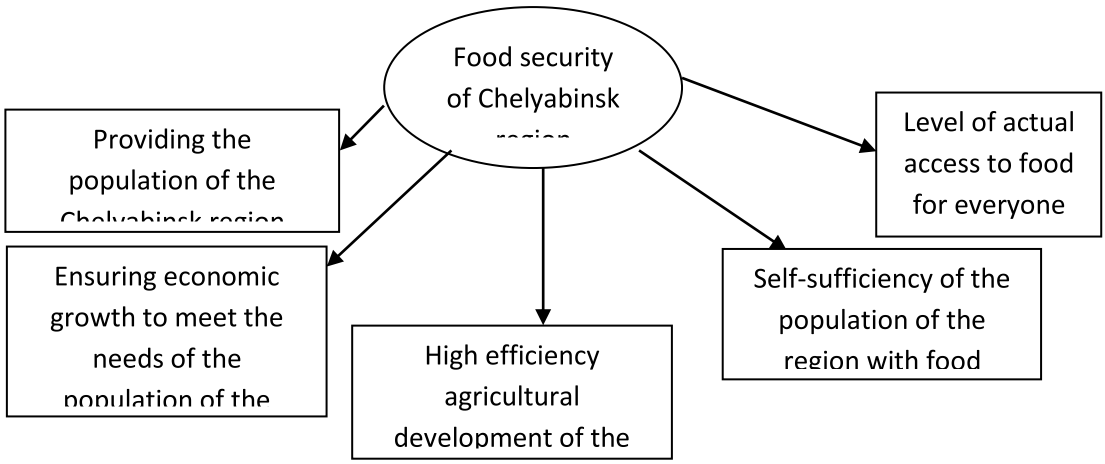

Figure 1 – Model of food security in the region
Source: Author

In order to achieve the main goals, it is necessary to solve a set of problems of agricultural development connected with the restoration and sustainable development of dairy farming, which is characterized by a decline of production and a decrease of efficiency.

The study is a case study that was conducted in the Chelyabinsk region. The aim of the study was to study objectively existing links between the level of dairy herd feeding and animal productivity. In the course of the statistical study of these relations we have identified cause-and-effect relationships between the indicators, i.e., how much the change of some indicators depends on the change of other indicators and determined the closeness and direction of the relationship between the studied phenomena. In order to establish a quantitative assessment of the impact of various factors on the resulting indicator – milk yield – a correlation and regression model was built. The indicators of activity of 108 agricultural enterprises of the Chelyabinsk region for 2016 were used for the calculation.

Milk yield per 1 cow (y), kg was considered as the resulting indicator in the construction of the regression model.

4. EMPIRICAL FINDINGS

The obtained equation of dependence of milk yield per 1 cow on production factors has the form:

$$y = 16{,}88 + 1{,}09x_2 \,,$$

- where y – milk yield per 1 cow, kg;
- x_2 – feed costs per 1 cow, RUB;
- Interpretation of the obtained equation is that the increase in forage costs to 1 thousand rbl. will lead to an increase in milk yield 1.09 kg per 1 cow.

The Chelyabinsk region occupies a total area of 88.5 thousand square kilometers and is one of the richest regions of Russia in natural and climatic resources. In a region with a predominantly industrial economy, milk and dairy products occupy a special place in the diet of the population. On the one hand, this is since the region is favorable for the development of dairy breeding. On the other hand, milk and dairy products are biologically valuable elements and products that are more affordable for the least protected segments of the population. (Grabner, Posch, 2018) The Key point is that during the years of reforms, the industry has experienced destructive processes in production and reduced efficiency. While there is a growth of milk production all over the world - cow's milk is 83% of the total milk. (Altukhov, Drokin, & Zhuravlev, 2015)

The efficiency of dairy breeding is a natural basis for solving the problem of providing the population of the Chelyabinsk region with dairy products, and consequently, the revival of sustainable socio-economic development.

The potential milk productivity of cows in the region is currently used by no more than 50%. And if you create the necessary conditions for its implementation, you can increase the productivity of cows in 1.5-2 times. The analysis of the development of the dairy subcomplex up to date, the results of scientific research, as well as the experience of the best domestic and foreign agricultural farms determine the following areas of achieving the goals for the near future: increasing the number of livestock, along with the growth of its productivity, improving the quality of forage, reducing the cost of milk production.

The solution to the problem of increasing the efficiency of the dairy subcomplex of Russia will reveal the reserves of increasing food production, improve its balance and, therefore, it will be possible to improve the economic mechanism. (Demidova, Marelli, &Signorelli, 2015) There is an important role of the dairy subcomplex of the Chelyabinsk region. Consumption of milk and dairy products in the region compared to the early 90-ies in 2016 decreased by 49%. It was revealed that the average per capita consumption of milk in the region is lower than the recommended medical standards. The Chelyabinsk region is forced to buy food products in other regions of the Russian Federation. Thus, in 2016 the level of self-sufficiency in milk in the region amounted to 67.5%. Analysis of the volume and structure of milk production for 1990-2016 years in the region showed a significant change. Thus, gross yield for all categories of farms decreased by 2 times to the level of 1990, including in agricultural enterprises - by 5 times. We note that in 2012-2016 the volume of milk production in households increased by 20.5%. These data show that the transformation in property relations, not only did not lead to positive results, but also led to a significant drop in production. We justified the constraints on the development of factors:

- partial absence of breeding animals in farms;

- non-compliance with the technology of growing animals;

- lack of manpower;

- worn material and technical base;

- lack of information base on the market for products;

- insufficiently effective mechanism of state regulation of market processes, etc.

The analysis of the current state of dairy breeding in the region shows that over the past 5 years the number of dairy cows in agricultural organizations decreased by 23.8 thousand heads and amounted to 40.5 thousand heads in 2016. At the same time, there is a dynamic growth in the number of cows in peasant farms. During the five-year period, the number of cows in peasant farms increased by 62.7% and amounted to 12.2 thousand heads.

As for the intensity of dairy breeding, it has a positive trend. So over the past 5 years, milk yield per cow in agricultural organizations reached 5 thousand kg, which is 1244 kg or 32.8% higher compared to 2012. However, the pace of intensification in feed production is significantly lagging. For 2012-2016 on 1 conditional head no more than 20 TS forage were prepared. The predominance of concentrates in the diet leads to an increase in feed costs, an increase in the cost of dairy products, adversely affects the health of animals and indicators of herd reproduction. (Chesbrough & Crowther, 2006)

The conditions of stable economic growth are important to change the socio-economic potential (Wittayakun, Innaree, &Pranamornkith, 2017).

Livestock breeding is the main subsector of agriculture. (Khan, Ijaz, Saeed, &Amjad, 2014) Forage crops in the agricultural enterprises of the Chelyabinsk region occupy 25% of the cultivated area, with most perennial grasses. The most important factors of increasing the yield and quality of harvested voluminous feed is the selection of different in precocity herbs and mixtures, timely re-ripening, optimal harvesting time, the use of modern technologies of silage.(Ehsanullah, Ashraf, Anjum, &Ghaffar, 2015) Increasing quality and nutritional content of harvested forage to the required level allows to increase the proportion of bulk feed in the diet to 55-60%, despite some increase in their cost, provides a reduction in total feed costs by 10-15% and reduces the cost of milk by 5-7%.

Progress in improving productivity and reducing the cost of livestock products by about 35% is due to feeding and maintenance, 25% to the genetic characteristics of cows (Farooq, Naeem, Zahur, Khan, Sidique, & Qureshi, 2017) and 25% is due to the health status of cows and 15% is due to the age of the animal and season of the year.

The question of improvement of quality of forages in connection with delivery to the Chelyabinsk region of cattle of the European selection (R. S. Shepitko, 2015) of the dairy direction of the productivity characterized by the raised requirements to conditions of feeding is topical. Science and practice have proved that improving quality of all types of feed is a large and real reserve to create a solid food base of domestic livestock, providing a sharp increase in its productivity. The decrease in the quality class of feed worsens its digestibility, especially the digestibility of protein substances falls sharply, between the first class of quality of corn silage and it decreased 2.4 times, the digestibility of crude protein decreased by 35% (Khan, Jo, & Tariq, 2015).

Milk production is a promising area of agricultural business in the Chelyabinsk region. At present, it is economically feasible to increase production volumes both by increasing productivity and increasing the number of cows.

5. CONCLUSION

Thus, those farms, where the issues of ensuring the competitiveness of dairy breeding become a priority, can effectively function, develop steadily and increase competitive advantages in the modern market economy. The economic growth regime is important to change the socio-economic potential. It occurs with a reduction, increase in the level of national wealth, or this level does not change. (Sukharev, 2016)

Our analysis revealed the need to improve the strategy of development of dairy farming in the region, which should include:

- emphasis on the new stage of development of the dairy subcomplex as one of the leading sectors of the agricultural economy of the Chelyabinsk region;

- output of the level of profitability of enterprises, population and budget to higher levels;

- carrying out technical and technological re-equipment of enterprises, improving the quality of products.

Solution of other urgent social and economic problems of the region, ensuring stable sustainable development of the village.

The factors of increasing the competitiveness of dairy farming in the Chelyabinsk region include integration processes, sustainable markets, forage base, breeding work, energy and the use of innovative technologies. Improving the efficiency of dairy farming in the region is determined by the following factors:

- state support;

- formation of regional markets;

- adaptation of production to rapidly changing market conditions.

Taking these factors into account in the regional agricultural policy, in our opinion, will greatly contribute to improving the efficiency of dairy farming, and hence the solution of socio-economic problems.

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ORIGINAL RESEARCH PAPER

THE DUAL SYSTEM EFFICIENCY OF HUMAN CAPITAL FORMATION OF THE REPUBLIC OF KAZAKHSTAN AGROINDUSTRIAL COMPLEX

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ABSTRACT

The article considers the factors of human capital formation.The purpose of the study is todevelop and test of a methodology for evaluating the effectiveness of human capital formation in an enterprise based on dual system of specialist training.The object of research is the enterprises of the processing industry of the Kostanay region of the Republic of Kazakhstan.The subject of the research is economic relations on the formation and development of the human capital in an agricultural enterprise.Hypothesis: the use of the dual training system will increase the productivity of processing enterprises and provide the Agrarian-Industrial Complex of Kazakhstan with a high-quality human capital.As a result of theoretical and experimental studies, an analysis of existing methods for assessing the human capital in an enterprise has been done, and their main disadvantages have been identified.In terms of EBITDA a methodology for assessing the investments effectiveness in human capital based on a dual system of education has been developed.The methodology on the example of a specific enterprise has been tested.The analysis of the obtained results allowed to confirm the stated hypothesis and proved the effectiveness of the dual training system as a development factor of agro-industrial complex.The dual system of personnel training implemented in JSC "Bayan Sulu" allowed, firstly, to increase labor productivity in the enterprise, secondly, to increase production and market share, and thirdly, to form a high-quality competitive human capital of the enterprise.

JEL classification: Q13, J5

***Keywords** Human capital, vocational education, dual training system, motivation, personnel management system, Agrarian-industrial complex, processing enterprises, assessment methods, economic efficiency.*

1. INTRODUCTION

Human capital is an important component of any enterprise, since it determines the peculiarities of its functioning and therefore the problem of formation and development of human capital becomes relevant for scientific research (Jordao, RVD., Novas, JC., 2017).

The purpose of the study is to develop and test of a methodology for evaluating the effectiveness of human capital formation in an enterprise based on dual system of specialist training.

The object of research is the enterprises of the processing industry of the Kostanay region of the Republic of Kazakhstan.

The subject of the research is economic relations on the formation and development of the human capital in an agricultural enterprise.

Hypothesis: the use of the dual training system will increase the productivity of processing enterprises and provide the Agrarian-Industrial Complex of Kazakhstan with a high-quality human capital.

The main problem that modern enterprises face is the evaluation of the effectiveness of investments in human capital. (Ermolina, LV., Golikov, VV., Kozenko, ZN., Ponosova, EV., 2018). The difficulties arising from this, to a certain extent, are explained by the fact that investments in human capital have several features that distinguish them from other types of investments (Sakamoto, T., 2018). Therefore, the issue of evaluating the effectiveness of the human capital formation in an enterprise is very relevant.

2. LITERATURE REVIEW

The issues of formation and development of human capital of organizations are of particular importance in modern conditions of economic development (Kato, Masatoshi; Honjo, Yuji, 2015), (Manuti, A., Impedovo, MA., De Palma, PD., 2017), (Passaro, R., Quinto, I., Thomas, A., 2018), (Pineda-Herrero, P., Fernandez-de-Alava, M., Espona-Bracons, B.,Grollman, PC., 2018), (Prusak, R., 2016), (Roy, I., 2018), (Schick, A., Steckel, R.H., 2015), etc.

Socio-economic development at the beginning of the new millennium is characterized by the increasing role of the human factor (Che, Y., Zhang, L., 2018). Human capital is the main factor in improving the competitiveness of the company (Che, Y., Zhang, L., 2018). In this regard, investment in human capital is an integral part of the successful development of the enterprise.

The main factors for the formation and development of human capital include: the education system, the personnel management system, communications and motivation that have a synergetic effect on the activities of the enterprise (Saidov. A.M. , 2017).

Like ordinary capital, the ability, knowledge, skills of a person tend to accumulate. At the same time, their formation and development require from the individual as well as from society a rather significant investment of time, labor, material and financial resources, that is, investment. These include all types of costs that can be estimated in monetary or other form. (Sabirova, RK., Baimukhasheva, MK., Utepkalieva, KM., Dingaziyeva, MD., Sanaliyeva, LK., Tsatkhlanova, TT., 2018). Investments in human capital are justified if they have a sufficiently high level of payback and profitability.

Vocational training is of primary importance for firms and organizations. It occupies a central place and is characterized as the most important component of the production process in investment in human capital (Kapelyushnikov. R., 2009).

The lack of connection between the university and production training does not allow to achieve high rates of production activity. That is why it is necessary to bring the training system closer to the present working process, basing the real problems of production. This can be achieved through the dual education system (Kuzembayev S.B., Alzhanov M.K., 2013).

In all organizations that have implemented a dual system, staff costs will certainly increase. However, if these costs will be considered by companies as long-term investments in the development of human resources, in the future they will be reimbursed by an increase in the income, due to an increase in labor productivity (Belkin. V.N., Vinogradova V.Yu., 2009).

The implementation of this training system will allow: to prepare highly qualified personnel for enterprises, to achieve compliance with the needs of the labor market, to shorten the adaptation period and to get an experienced worker ready to work in production, to restore prestige of working professions (Saidov A., 2016).

3. METHODOLOGY

As far as it is known, a technical efficiency is calculated by the ratio of the result to the costs. Applying this methodical technique, we will try to establish the effectiveness of the dual training system. For this purpose, we will use the ratio of the economic indicators of the organization to the costs of human capital of the enterprise.

The most important human capital costs are as follows:

- payroll - the cost of labor.

- social package - this is a compensation, which is provided to an employee of the company in addition to wages (Vladykina. L.B., 2010).

Each organization offers its own list of rewards, the most common of which include: sick leave, holidays, medical insurance, travel expenses, trips, soft loans, etc. (Zhytchenko, G., Kovalenko, M., Shvorob, G., 2017).

Thus, the costs of human capital contain a payroll, a unified social tax and the cost of a social package, which are calculated according to the formula (1)

$$C_{hc.}=P_{w.}+UST+Soc.p. \qquad (1)$$

For the analysis of the effectiveness of human capital, there are two well-known methods of evaluation, based on the performance of firms and investments in personnel (Vladykina. L.B., 2009).

In the first case, the efficiency of human capital is calculated based on sales of products (formula 2):

QUOTE $$\mathbf{E}_{hc.sp.}=\mathbf{V}_{sp.}/\mathbf{C}_{hc} \qquad (2)$$

where $\mathbf{E}_{hc.sp}$ - the efficiency of human capital in sales; V $_{sp}$. - the volume of sales products; $\mathbf{C}_{hc}$ - the cost of human capital of the enterprise

In order to evaluate the efficiency of the firm's formed human capital, the labor cost efficiency indicator for the sales of products is compared with the same industry on average.

In the second case, the efficiency of human capital is calculated by profit (formula 3):

$$\mathbf{E}_{hc.sp.}=\mathbf{P}/\mathbf{C}_{hc.} \qquad (3)$$

where $\mathbf{E}_{hc.sp}$ - the efficiency of human capital in sales; P - the total profit of the company; $\mathbf{C}_{hc}$ - the cost of human capital of the enterprise.

As in the previous version, the obtained efficiency indicator is compared with the similar industry on average.

The presented indicator reflects the direct connection of net profit with the cost of human capital of the company. However, due to the diversity of operating principles, the net income of companies with different tax structures, different amounts of loans, and different schemes for calculating depreciation will not be comparable.

In this regard, EBITDA is the most objective indicator for assessing the company effectiveness, the profitability of its investments and its comparison with other companies.

EBITDA stands for Earnings Before Interest, Dividend, Tax and Amortization. This is the profit of the company before deductions of all the payments that the company must make. It shows not the profitability of the company itself, but the profitability of the business.

EBITDA allows to evaluate the effectiveness of human capital by eliminating the effect on the capital structure of various percent, the burden of taxes and the depreciation component of the company.

Thus, it is necessary to raise the question on evaluation the human capital effectiveness of the company in terms of EBITDA.

The effectiveness of the human capital of the company for this indicator is proposed to be calculated by the next formula (4).

$$\mathbf{E}_{hc.EBITDA}=\mathbf{EBIDTA} \ / \ \mathbf{C}_{hc.} \quad (4)$$

where $\mathbf{E}_{hc.EBITDA}$— the human capital effectiveness of the company in terms of EBITDA; **EBITDA** - profit before taxation, deduction of accrued interest on loans and borrowings and depreciation on fixed assets and intangible assets.; $\mathbf{C}_{hc.}$ - the cost of human capital of the enterprise.

The calculation of EBITDA is presented in formula 5:

$$\boldsymbol{EBITDA} = P_{sp}+D \quad (5)$$

where: **EBITDA** - profit before taxation, deduction of accrued interest and depreciation; $\mathbf{P}_{sp}$ **-** profit from sales of products; **D** -depreciation.

The efficiency of human capital in terms of EBITDA will also need to be compared with the average industry.

The proposed method of evaluating the effectiveness of investment in human capital is simple and convenient; it can link the effectiveness of the organization and costs of human capital.

The considered method requires practical testing and evaluation of the effectiveness of a enterprise. The confirmation of the theoretical result by practical approbation will make it possible to assess the significance of dual education.

JSC "Bayan Sulu", which is one of the largest confectionery production enterprises of the Republic of Kazakhstan, was selected as an enterprise for testing. The company has a high personnel potential and takes an active part in the pilot program for the introduction of the dual education in the Republic of Kazakhstan.

To assess the human capital, we analyzed the dynamics of staff costs over the past 5 years. (Table 1)

Table 1: Dynamics of staff costs, thousand rubles

The name of indicators	2012	2013	2014	2015	2016
Payroll, thousand rubles	62 759	79 455	176 265	193 068	200 859
Unified social tax, thousand rubles	16 945	21 453	47 592	52 128	54 232
Social expenditure on staff, thousand rubles	4 654	7 823	17 040	24 736	23 269
Total, thousand rubles	84 358	108 731	240 897	269 932	278 360

Source: Author

4. EMPIRICAL FINDINGS

The dynamics of staff costs leads to the following conclusions:

- over the last 5 years, the Payroll has increased from 62,759 to 200,859 million rubles, that is, 3.2 times;

- the unified social tax (UST in JSC "Bayan Sulu"is 27% of the payroll) increased from 16,945 to 54,232 million rubles, also 3.2 times;

- social expenditures for personnel increased from 4,654 to 23,269 million rubles, that is, 5 times.

The dynamics of cost growth is presented in Figure1.

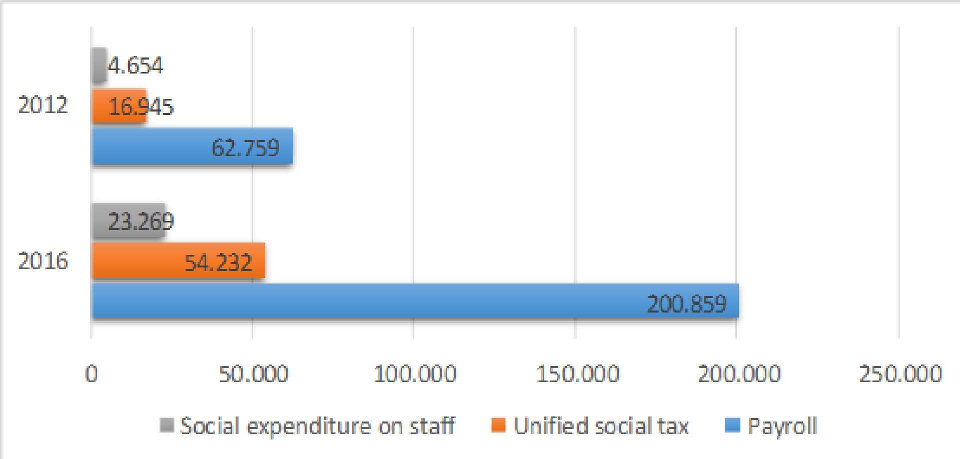
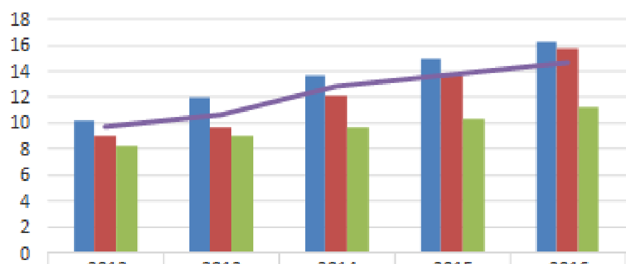


Figure 1. The dynamics of personnel costs in JSC "Bayan Sulu", millionRubles

Source: Author

The increase in costs is due to the opening of several branches of the company and the introduction of a dual system of training of future employees.

Using EBITDA, we estimated the effectiveness of all the costs for human capital of JSC "Bayan Sulu" (Figure 2).



	2012	2013	2014	2015	2016
JSC "Bayan Sulu",	10,15	11,96	13,68	14,92	16,24
LLP "Confectionery Factory Pioneer",	8,97	9,64	12,18	13,67	15,81
JSC "Konfety Karagandy"	8,23	8,96	9,61	10,34	11,2
the industry average	9,74	10,67	12,89	13,76	14,6

Figure 2. Indicators of the efficiency of human capital of agricultural enterprises in terms of EBITDA

Source: Author

The presented calculations allow us to conclude that enterprises LLP "Confectionery Factory Pioneer", JSC "KonfetyKaragandy", are characterized by low levels of competitiveness of human capital in terms of EBITDA compared to JSC "Bayan Sulu". Thus, we can conclude that the competitiveness of the human capital of JSC "Bayan Sulu"is higher than the industry average.

5. CONCLUSION

The purpose of the research was to evaluate the effectiveness of the dual system of education in human capital formation of the agro-industrial complex and its approbation in a enterprise.

As a result of theoretical and experimental research: a methodology for assessing the human capital effectiveness of an enterprise has been developed, and the effectiveness of the dual training system using the example of a specific enterprise has been assessed.

The analysis of the obtained results made it possible to confirm the hypothesis that the formation of the human capital of an enterprise, based on the dual system of education, is economically efficient, resulting in an increase in the value and income of the company.

The dual system of personnel training implemented in JSC “Bayan Sulu” allowed, firstly, to increase labor productivity in the enterprise, secondly, to increase production and market share, and thirdly, to form a high-quality competitive human capital of the enterprise.

Thus, the formation of the human capital of an organization based on the dual system of personnel training has proven itself on the positive side, demonstrating its effectiveness.

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Part III - Food safety, Health and Ecology Protection

ORIGINAL RESEARCH PAPER

THE GREENING OF AGRICULTURE AND FOOD QUALITY

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ABSTRACT

Scientific and technological progress in agriculture makes cardinal changes in the fully formed technologies. The aim of getting new knowledge and bringing the obtained results of investigation to practical use is the raise of efficiency, i.e. the reduction of social labor expense and other elements per production unit, growth of productivity of the earth and cattle, provision of production independency, creation of product funds for export, provision of favorable condition for labor and living condition, the raise of total span of life and active working age and so on. The article gives data characterizing ecological, organizational – economic and social aspects of the quality of agricultural raw materials and food products. The investigation results showed that the social responsibility in the sphere of agro industrial complex (AIC) and agriculture is one of the important directions of market economy and it has a great influence on the quality of food stuff. In article are shown the questions of improvement of quality of food raw materials and end products. Position with a food quality in many positions does not meet the requirements.

JEL classification: Q10, Q18, Q57

Keywords: *environment, economical, quality of food, social environment, farming, food product, natural environment, human, animal, agriculture.*

1. INTRODUCTION

Quality as a combination of food, technological and other characteristics is of great importance. A human being with his addictions and tastes always preferred individual products. Animals and plants in the process of evolution adapted to one or another areal of their habitation. A human being using roots, leaves and plant seeds, meat of animals also adapted to one or another areal. Over generations he gained the skills of picking plants and hunting, he learnt to prepare food from picked plants and hunted animals. Naturally while getting new knowledge, improving means of hunting and processing raw materials the ration became more diverse.

Due to scientific and technological progress productive activity of a man increased, it became easier for him to provide his family with food, to keep house (Krasnoperova, et al., 2015) (Reymers, 2005) (Sotnikova, 2013) (Nagy, et al., 2017)).

Till certain time when anthropogenic activity didn't have any serious influence on nature, problems of ecology as a science didn't exist, there was no need in it. We don't consider separate cataclysms (such as floods, volcanic eruptions, etc).

2. THEORY (A REVIEW OF MODERN INTERNATIONAL LITERATURE FOR THE LAST 5 YEARS)

Cardinal changes happened in the 20th century. Tractors and agricultural machines replaced draft animals. Productive power of agricultural labor increased greatly increased greatly. There began a rapid growth of industry, the cities and population in them grew significantly. The influence on natural objects (soils, forests, water reservoirs) and even on the air pool is accompanied with several negative consequences.

Environmental problems gained paramount importance, became the subject of discussion of science and general public so there appeared anthropogenic situation when development of ecology as a science became vital need. Suffice it to say that according to the records of several ecologists the energy expenses on the production of the food unit increased 1000 times during the 20th century. At first look it seems incredible but if we think it over more attentively, we should agree with such an opinion. In fact, the raise of labor efficiency in agriculture due to the using machines increased 10 and even 100 times.

Achievements in genetics and animal and plant breeding provided it. But in order to produce a tractor with a set of machines at first it is necessary to mine the iron ore, to smelt it into metal, to carry out metal processing and to make machines. The machines need power supply – petrol, diesel fuel, etc. All this requires great losses of energy, productivity of plants and animals increased many times, but the growth rates were much lower. Hence the problem of saving resources throughout the economy becomes clear.

Along with an increase in number of machines used in agricultural sector their great impact on natural objects is observed. Let’s recollect that the K-700 tractor in one pass across the field compacts the soil structure to the depth of one metre. Go out into the field in the late autumn and stare at how the tractor furrowed the ground (Galatov, et al., 2013).

But this is only one side of the technological progress in agriculture which is called in literature as “a grey revolution”. There is also another direction in agricultural intensification connected with genetics and selection.

As a result of new developments in genetics there appeared a possibility on the gene level to control the formation of certain signs which previously were not characteristic of the plants. Genetically modified organisms (GMO) – tomatoes, corn, soya and others gain such signs as drought and frost resistance, immunity to several diseases. It was a progress. What impact the GMO have on plants, animals and men through using them in the food is unknown. There are sometimes the statements that the use of GMO in our food has no harmful effect on a human being. This statement is incorrect and inappropriate. The formation of a man as an object of nature lasted for millennia. To judge even by the results of short-term use of such products is at least disputable. By the way an export of genetically modified products from the USA and other countries is only increasing. Protecting from it several countries from the Western Europe stopped this less regulated flow by law.

In Russia there is a formal prohibition on usage of modified products. However, nobody denies the delivering of soya, corn and vegetables from the USA and Turkey.

Scientific-technological progress for the last centuries had such cardinal consequences in all aspects of human life that had not happened in previous millennia. In agriculture it relates to the introduction of complex mechanization and electrification, breeding new varieties of grain and fodder crops, breeding new species of more productive animals. As a result, the productivity of living labour has multiplied. Changes concerned not only productive sphere but also all aspects of life (Krasnoperova, 2016, 2017) (Kulikov, 2016) (Zhang, et al., 2001)).

The way of living in the village changed completely. Tractors, agricultural machines, automobiles and other equipment replaced draft animals (horses, oxen, donkeys). The expenses of manual labour were dramatically reduced both in public and household. Now it seems like some kind of archaism when grass was mowed with a scythe, cereals were cut with a sickle. Hunger and malnutrition gradually disappeared from the lives of Russians, food products became more available. Character of nutrition changed. Consumption of sugar, confectionary and canned products significantly increased, consumption of meat and dairy products per capita increased gradually too. Simultaneously there was a reduction of the volume and range of vegetables, potato and bakery products. For the last 30-40 years the import of food increased though even at the beginning of the last century Russia was one of the leading countries in the food market (Ivanova, et al, 2016) (Krasnoperova, 2016) (Acemoglu, , et al (2015) (Giorgi, et al., (2018)).

The increase of food consumption, the substitution of heavy physical labor with easier and mental one led to the obesity of the greater part of the population. So, such changes had not only positive but also a negative effect. The same situation is characteristic for many citizens of Europe and North America where a "golden billion" lives.

3. DATA AND METHODS

The objects of investigation are organizational-economic processes which characterize ecological and social aspects of quality of agricultural raw materials and food products. Economic-statistic, abstract-logical and other methods were used during the investigation.

4. METHODOLOGY OF INVESTIGATION

In connection with the stated above the significance of good nutrition increases. The consumption of ecologically safe food products, the formation of culture of nutrition and environmental improvement are the main tendencies in sanitation of population, increase of life span and capacity for work. From our point of view nowadays the priority tasks are not as much as the growth of the volume of consumption per head but also the expanding of the range of food products mainly vegetables, berries and fruit, improvement of the quality of food products. As for expanding of production and consumption of vegetables and fruit an enormous work has been done during the last years the results of which are appearing just now. In many regions' greenhouses were commissioned to cover the demand for vegetables throughout the year. In Chelyabinsk region a greenhouse "Churilovo" was put into operation which became a worthy competitor on the market. Garden companies play a great role in providing people with berries, fruit and vegetables.

In Chelyabinsk region there are about 370-390 thousand owners of allotments that means that about 1 million people (owners and their families) provide themselves with the garden production. In our region the share of rural population is 17 per cent, most of which grow one or another product by themselves. We consider that production safety is a state task. Rural citizens and town-dwellers-gardeners help to solve this problem and it means that the state should help them. It is a question of reasonable prices for country trips for the town-dwellers to their plots, ensuring regularity of traffic, etc. It's about giving them trading places for realization of fresh products in the cities, availability of seed prices, fertilizers and so on. One should admit that the problem is wide of the settlement especially in relation to local transport.

Now let's pay attention to the quality of food products on regional markets in our country. It is usually considered that the quality of food products is a combination of characteristics demanded by the consumer to these products. The most important characteristics are safety, composition of raw materials, freshness (sell-by date), organoleptic characteristics (color, smell, flavor, presence of other tastes) and food edibility.

During the pre-reform period in mass media there was an unfounded criticism of home-produced products. Quite often one stated of the low quality of home-produced products, of their non-competitiveness in comparison with imported ones. The presence of well-thought-out advertisement, colored package formed notification about high quality of imported products. Enormous shop-windows with goods, new forms of organization of trade (self-service, not selling the good behind the counter), trade-mark sellers' clothes, polite service were at first identified with high quality characteristics of the products. There was a price dumping when a task was set up to drive the home commodity producers back. However, it turned out that it was not so easy.

Disappointment from premature expectations came quickly. Soon the consumer understood that under the bright package on the shop-window there is not the product he wanted to buy. It’s enough to remember chicken legs from the USA (Bush legs). Which have won our market quickly and which could just as quickly be driven out of it. The latter didn’t happen only thanks to the USA government pressure. The same can be said about canned meat which had been kept in foreign refrigerators for 6-8 or ever more years, as strategic supply of provisions.

Agriculture was destroyed very much for the first decade of the economic reforms. A quarter of the century have passed but the consequences of it are felt even now. Willingly or unwittingly most of the agricultural enterprises were destroyed, whole industries disappeared. For example, in Chelyabinsk region the trade sheep-breeding stopped to functionate because its main product – wool was unclaimed. Cattle livestock decreased by 2 to 3 times, trade pig farms disappeared in many agricultural enterprises because of the violation of economic interests of producers of raw materials, difficulties with the sale of meat products. It was difficult to get on the counters of trade networks due to small production, due to the impossibility of its planned vision and so on. This was the reason of constant growth of food import (Nikitina, 2008) ((Krasnoperova, et al., 2017) (Kubyshko, et al., 2016)).

Gradually the interest to the development of early maturing industries began to appear in Russia. Large holding companies focused on feed growing, egg, poultry and pork production, raw material processing and they supplied market with finished production. In addition, many of them began to develop brand trade where 25-40 per cent of product volume was realized. This determined success in the market of these powerful companies. For example, the cereal company “Uvelskaya krupyanaya”, macaroni “Makfa”, milling “Sitno”, “Uralbroiler”, “Ravis” (poultry meat), “Ariant” (pig products) gained fame in Chelyabinsk region and beyond. There is a tough competition in the region, every holding company tries to interest and retain the consumers.

However, in the price sector competition in weak. The fact is that largely these companies were created on credit funds which was time to return. It means that companies are not ready to reduce the price of the finished product. They still can complete in the product quality sector. But here it is also not everything ordinary and simple.

At present the technologies of industrial poultry and pig-breeding don’t differ much from foreign ones. The main feed is balanced combined feed, growth stimulators, vitamins, supplements are used (Bautin, 2016) (Nikitina,2008) (Barcena-Martin, & Silber, (2017) (Frewen, et al., (2006) (Ogwang, (2016)). Industrial technology of poultry and pig-breeding deprives poultry and animals of movement, they are kept in the conditions of regulated microclimate in artificially created conditions. All that, of course, influences on the quality of meat production and not for the better (Rosental, 2006) (Teixido-Figueras, et al 2014)).

It should be noted that in connection with Russia’s announcement of retaliatory economic sanctions, interest in the purchase of imported raw materials and products fell and it strengthened the competitive positions of the enterprises of agro-industrial complex.

We set out to conduct a comparative assessment of food quality through the eyes of buyers on the market in Troitsk (Chelyabinsk region), the results are presented in table 1.

Market research was conducted by us within the period of 2016-2017.

Elderly and old age people who remembered the former pre-reform situation well-acted as respondents. As for middle-aged people (up to 40-45) and especially young people they couldn’t evaluate the quality of products of 20 and more years ago. In general, the buyers shared information willingly. Perhaps in large markets of regional and industrial centres the situation won’t coincide with our results, but these mismatches will have private character.

Table 1. Consumer assessment of food products in the regions market

Type of goods	Number of respondents	Evaluation of Soviet products								Evaluation of modern products								Relation to imported products Positiv (+) Negative (-)
		excellent		good		satisfactory		unsatisfactory		excellent		good		satisfactory		unsatisfactory		
		quantity	%	quantity	%	quantity	%	quantity	%	quantity	%	quantity	%	quantity	%	quantity	%	
Bakery products	127	38	30	40	31	28	22	21	17	26	20	28	22	43	33	30	19	-
Pasta	84	14	17	16	19	30	36	24	28	22	26	24	28	20	24	18	22	-
Cereals	73	9	12	12	16	16	22	36	50	17	23	21	29	28	38	17	10	Positiv
Cucumbers (fresh)	109	22	20	34	31	33	30	20	19	31	28	35	32	28	26	15	14	Negative
Tomatoes	94	16	17	23	24	35	37	20	22	21	22	28	30	19	20	16	28	Neutral
Gabbage	121	32	26	34	28	40	33	25	15	35	29	41	34	32	26	13	11	Neutral
Fruit	124	16	13	41	33	57	46	10	8	20	16	49	39	36	29	19	16	Neutral
Chicken edds	132	49	37	52	39	18	14	13	12	30	23	44	33	23	17	45	27	Positiv
Meat	76	11	14	21	28	34	44	10	14	18	24	24	31	24	31	10	14	Negative
Sausages	68	10	15	18	26	23	34	17	25	6	9	11	16	21	39	30	36	Positiv
Canned meat	57	27	47	30	53	-	-	-	-	5	9	18	31	18	31	16	29	Negative
Drinking milk and dairy products	138	23	17	39	28	40	29	36	30	18	13	23	17	56	40	35	30	Positiv
Butter	103	29	28	37	36	22	21	15	15	10	10	22	21	40	39	31	30	Positiv
Hard cheese	88	20	23	28	32	24	27	16	18	8	9	16	18	35	40	29	33	Positiv
Canned milk	64	27	42	30	46	10	12	-	-	5	8	29	45	20	31	10	16	Positiv

Source: Author

5. RESULTS

The materials from the table allow to make several conclusions, the main of them are the following.

First, in general the quality of food products in comparison with the Soviet period improved little or not at all. Let's take bread as one of the main food products. Approximately one third of the population notes deterioration in taste, low preservation due to poor quality of raw materials. Bread dries quickly, grows stale and even molds. The reason lies in the use of poor-quality flour. The situation has reached the point that the mill's owners are taking the initiative to recognize the flour from third-grade wheat as baking flour. But as a matter of fact, it is a feed grain. Different supplements (baking powder, flavor enhances) are widely used now. In this market there are many new players, as a rule, representatives of small business. They have outdated equipment, low qualifications of personnel. Competition is mostly not on the price level but at the expense of cheap raw materials.

An example of improvement is the situation with pasta and cereals. Many factories are equipped with up-to-date equipment and produce a wide range of products and of good quality. All this has been confirmed in the behavior of customers and their preference for domestic products. They willingly purchase products of famous trends. In Chelyabinsk region they are OJSC Makfa - Chelyabinsk Pasta Factory, the Uvelsky grain Company, Magnitigorsk OJSC Sitno. Their production is well-known not only in the Russian Federation but also abroad (Kazakhstan).

In the vegetable market the situation is just the same – the quality of own-produced vegetables is noticeably improving, competition is increasing and there is a constant replacement of imported vegetables. In 2015 in Chelyabinsk region the largest greenhouse complex was put into operation, it almost completely covers the region’s demand for green vegetables (bow, dill, salad etc.).

An ambiguous situation is observed with meat and its products. Poultry farmers and pig producers have mastered new technologies, the main principles of which are keeping animals without motion and uniform feeding.

Lack of exercise when cattle and poultry are kept in cages form the special type of metabolism. Animals grow rapidly but their production is less valuable and accumulate fat and their muscular tissue contains much moisture. The main thing for manufacturers is to reach slaughter conditions as quickly as possible. To achieve this goal, they use not only complete feed but also growth stimulators which the meat producers try to hide from the consumers (Zharinov, et al, 2016) (Rosental, et al, 2016) (Hercher, et al, 2009) (Zhang, et al, 2009)).

What is said above doesn’t mean that this production must leave the market. It found its consumers among people with average and low per capita income. However, it’s no coincidence that products from farmsteads and farms are in demand on the market. In terms of food flavor their production is full value as animals and poultry move and are kept in natural conditions. It goes without saying that their production is more expensive, but it ought to be present on the market, it has its consumer; who is ready additionally to pay for the product; the price of which is 1,5 – 2 times higher, where the product is of the superior quality. And from the social point of view the realization of surpluses of the grown production allows to support the incomes of rural people.

Many consumers are disposed to the import of beef and pork negatively as it is unknown where, when and at what circumstances this production was reared. The production was very often subjected to the deep-freeze, it was kept on the strategic stores of exporters. It is unreal for them to sell this production within the country because there is much fresh meat on the market. But our importers buy it willingly for dumping prices as if for the industrial processing (cans, sausage). It very often happened, but some part of the production gets to the market without any processing.

Everywhere consumers complain of the low quality of sausage products. Cheaper ingredients – soya, fat, tendons, skin and cartilages are used now for the manufacture of sausages. At present there is a concept of meat-containing product where meat content is from 5 percent and more. It’s clear that it is absolutely another product containing food colors, flavor enhances, collagen protein and etc. Why in other European countries there are no such products? What are the consequences of long use of such products? There is no answer.

6. CONCLUSIONS

Returning to what was said earlier such conclusions can be made:

The quality of products in several products in a number of industries of the Russian Federation is not improving.

We suggest returning to the standardization of food products because the health and welfare of our nation depend on it. If we want to complete on the world food market we should think of the reputation of our country, to produce competitive production of a good quality. We speak much about the competition of consumer goods and industrial goods. To reach a success in competitiveness of food products at the home and world market is not a simple task, but it can’t be postponed.

We consider it is time to put a question about the quality of the production on the poultry and farm complexes. It can be solved at the expense of the introduction of corresponding GOSTs on the complete feed and on the control for this process. At present a producer himself is responsible for the quality of complete feed and therefore he enriches them with all possible supplements and growth stimulators.

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ORIGINAL RESEARCH PAPER

NUTRITION ECOLOGY: ENSURING PLANT PRODUCTS QUALITY

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ABSTRACT

The health of the nation largely depends on the socio-economic and living conditions of a person, including the ecology of nutrition. In modern conditions, the environmental purity of food is becoming an increasingly important global problem, which not only concerns people's health, but also has a significant impact on the economies of countries. Vegetables play an important role in human nutrition. They are natural medicinal and prophylactic agents and contain physiologically active substances, vitamins, minerals, organic acids, fiber. When organizing greenhouse plant production, which can give products throughout a year, it is necessary to consider the conception of a modern policy in the field of healthy nutrition of the population which provides for obtaining crop products in environmentally optimal conditions. The purpose of the research was the development of innovative technical solutions aimed at ensuring the quality of greenhouse crop products. The object of the research is agro-technologies of hydroponic vegetable cultivation; the subject of the research is the impact of agricultural practices associated with biological plant protection and plant diagnostics on crop yield and product quality. The working hypothesis is formulated as follows: the use of promising methods of plant protection and plant diagnostics can increase crop yields and ensure the quality of crop products. As a result of theoretical and experimental studies, the technology of A. colemani mass production for the biological protection of cucumber plants has been improved; a technique for identifying the stress state of plants, that does not require sample preparation and based on the evaluation of the leaf apparatus absorption spectra, has been developed. The analysis of the obtained results showed the economic and energy efficiency of the presented technical solutions. The use of biological methods for plant protection and plant diagnostics helped to increase crop yields and to ensure the quality of crop products

JEL classification: Q13, Q18

***Keywords:** nutrition ecology, ecological purity of products, food quality, food safety, greenhouse plant cultivation, agricultural technologies, ecologized plant protection, phytomonitoring, plant diagnostics, crop yield*

1. INTRODUCTION

The health of a nation is known to depend on the socio-economic and living conditions of a person, including the nutrition ecology, by 52 ... 55% (Food safety and main criteria for its assessment, 2018), (Blednykh, 2003), (About fundamental principles of the Russian Federation state policy in the sphere of healthy nutrition of the population for the period up to 2020, 2010). Nutrition, as a social criterion, is one of the most important factors determining the health of the population: high-quality, balanced diets help to prevent diseases and to increase working efficiency, to ensure child’s appropriate growth and development. In this regard, the ecological purity of food is becoming an increasingly important global problem which not only concerns people's health, but also has a significant impact on the economies of countries. (Food safety and main criteria for its assessment, 2018), (Blednykh, 2003), (About fundamental principles of the Russian Federation state policy in the sphere of healthy nutrition of the population for the period up to 2020, 2010).

The article deals with the issues related to nutrition ecology; the research purpose is the development of innovative technical solutions aimed at ensuring the quality of greenhouse crop products.

The object of the research is agro-technologies of hydroponic vegetable cultivation; the subject of the research is the impact of agricultural practices associated with biological plant protection and plant diagnostics on crop yield and product quality. The working hypothesis is formulated as follows: the use of promising methods of plant protection and plant diagnostics can increase crop yields and ensure the quality of crop products.

2. LITERATURE REVIEW

The ecological purity of food is of particular importance in the current conditions of increasing anthropogenic pressure on the environment (Bantis, et al., 2018), (Kraska, Kleinschmidt, Weinand, & Pude, 2018), (Rouphael, Kyriacou, Petropoulos, De Pascale, & Colla, 2018), (Ku, et al., 2018), (Nay-Htoon, et al., 2018), (Saha, Mandal, & Dutta, 2018), (Bianciotto, Victorino, Scariot, & Berruti, 2018) , (Lisetskii, 2018), (Belachew, Nagel, Fiorani, & Stoddard, 2018), (Wang, et al., 2018), (Kumar, Singh, & Adholeya, 2017), (Gautam & Fomsgaard, 2017), (Salazar-Moreno, et al., 2017), (Miranda, Lara, Rocksch, Dannehl, & Schmidt, 2017), (Prasad, Bhattacharyya, & Nguyen, 2017), (Zhang, Wijesundara, Abbey, & Rupasinghe, 2017), (Yi, et al., 2017). Continuous pollution of nature creates a source of dangerous eco-toxicants that get into food raw materials and then into food products which have the ability to accumulate some of them. Therefore, 40 ... 50% of substances-pollutants enter the human body with food from the environment, 20 ... 40% of them enter with water (Food safety and main criteria for its assessment, 2018), (Blednykh, 2003), (About fundamental principles of the Russian Federation state policy in the sphere of healthy nutrition of the population for the period up to 2020, 2010).

A contemporary conception in the field of healthy nutrition provides for the expansion of domestic manufacturing the main types of food raw materials that meet the requirements of safety and quality (Blednykh, 2003). Food products should satisfy the physiological needs of human body in vital substances, as well as perform therapeutic and environmental preventive tasks (Belogubova, Vasiliev, & Gil, 2007).

Vegetables play an important role in human nutrition because they contain a number of physiologically active substances, which take part in all metabolic processes, serve as a source of vitamins, contained a balanced complex of mineral substances, organic acids and fiber. In the conditions of intensified impact of adverse factors on human body, vegetables contribute to good health promotion; they are natural medicinal and prophylactic agents. Fresh vegetables are of great value, since a number of biologically active substances lose their properties during heat treatment (Belogubova, Vasiliev, & Gil, 2007).

The possibility of consuming fresh vegetables is limited to the season of the year. Therefore, a year-round manufacturing crop products under greenhouses conditions is one of the possible ways to solve this problem (Belogubova, Vasiliev, & Gil, 2007), (Autko, Ganush, & Dolbik, 2006).

When organizing greenhouses, it is necessary to take into account that vegetable products grown without effective plant protection and plant diagnostics are not competitive in the world market. In addition, food quality requirements are constantly rising; and the absence of residues belonging to chemical protection means as well as the content of other ecotoxicants conformed to standards (Belogubova, Vasiliev, & Gil, 2007) (Shpaar, Bakkhauz, Baton, Belyakova, & Burt, 2005) are of paramount importance.

3. METHODOLOGY

Experimental studies were carried out in the Limited Liability Company Agrocomplex "Churilovo", Chelyabinsk city. The cultivation method is a photoculture (low-volume aggregate-ponics); the cultivated crop is a medium sized cucumber *F1 "Meva"*. The chemical composition of cucumber fruit was determined in Federal Budgetary Institution of Health Care "Center for Hygiene and Epidemiology in the Chelyabinsk Region". Plant diagnostics involved the analysis of leaf apparatus absorption spectra using photometric equipment: *UV 1800 Shimadzu* spectrophotometer, a *LASA AGRO 2800* laboratory. The variational statistics methods were used to evaluate the results obtained.

Plant protection was carried out using a biological method, the advantages of which include cumulative effect, reduction or rejection of using the chemical means for plant protection, sparing environmental impact, protection of plants cultivated for child nutrition, etc. (Shpaar, Backhouse, Baton, Belyakova, & Burt, 2005). An energy- and resource-saving technology involving the use of an organic-mineral substrate was developed for aphidophidus entomophage (*A. colemani*) mass cultivation in the LLC Agrocomplex "Churilovo".

A technique developed at the Federal State Budgetary Educational Institution of Higher Education "South Ural State Agrarian University" was used to diagnose the plants state. It is intended for the production conditions of greenhouse farms; it does not require sample preparation and can detect stress states based on leaf apparatus absorption spectra before carrying out the corresponding chemical analysis (Belogubova, Vasiliev, & Gil, 2007).

4. EMPIRICAL FINDINGS

As a result of theoretical and experimental studies, the technology of *Aphidius colemani* mass production for the biological protection of cucumber plants has been improved. According to this technology the number of basic operations related to the preparation of the substrate has been reduced; and the number of components included in its composition has been decreased. The main difference of this technology is the use of ultrasonic processing of the substrate organic part which activates the interaction of the chain links “substrate - fodder plant - phytophage - entomophage” (Basarygina, Putilova, & Panova, Eco-module: biological plant protection, 2015). The use of the proposed organic-mineral substrate consisting of peat and mineral wool helps not only to increase the number of entomophages during the cultivation period, but also to ensure their guaranteed departure at the application stage (by attaching mobile lawns with entomophages to the irrigation system of protected plants). Such technological technique is not possible to use for all other known substrates, since there is no mineral wool foundation in their composition. This leads to deteriorating the properties of vegetable root environment.

The calculation results of economic and energy efficiency when using agrotechnologies for greenhouse vegetable cultivation are given in Table 1.

Table 1: Economic and energy efficiency of agrotechnologies for greenhouse vegetable cultivation

№	Indicator	Control	Experiment
1	Bioproduct yield, % to the control	100.0	150.0
2	Yield capacity, % to the control	100.0	110.3
3	Cost reduction level, %	-	9.8
4	Production profitability, %	2.3	7.4
5	Labor costs per 1 ton of products, man/hour	569.0	492.0
6	Labor productivity, % to the control	100.0	113.5
7	Energy intensity of bioproduct production, % to the control	100.0	67.7

№	Indicator	Control	Experiment
8	Energy intensity of vegetable production, % to the control	100.0	89.7

Source: Author

The analysis of presented results shows that the improved method of *Aphidius colemani* mass production for biological protection of cucumber plants proved to be profitable in terms of energy and economy. In the experimental variant the bioproduct yield increases by 50%, and the cucumber yield increases by 10.3%. We may observe growing production profitability and labor productivity and decreasing cost of production. The energy intensity of vegetable production is reduced by 10.3%, the energy intensity of *Aphidius colemani* production is reduced by 33.3%.

The developed technique for diagnosing the plant state included:

- determining the absorption spectra of leaf apparatus of vegetable plants,

- comparing the obtained absorption spectra with the recommended ones;

- correcting the nutrition regimen of vegetable plants.

The nutrition regimen was corrected in the case, when significant differences between the obtained absorption spectra and those recommended were detected in accordance with the scheme (Fig. 1). The main maxima and pigment absorption areas were taken from the data of known publications (Basarygina, Gorshkova, & Putilova, 2016).

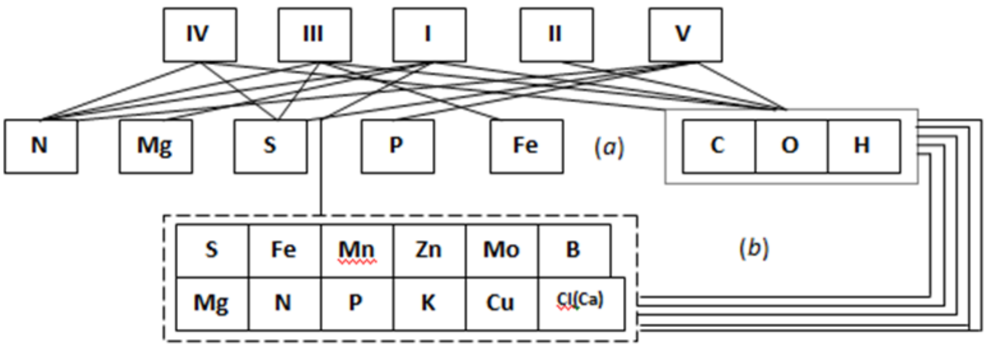

Fig. 1. Chemical elements included in composition (a) and affecting the synthesis (b) of leaf apparatus pigments: I - chlorophyll, II - carotenoids, III - cytochrome, IV - phytochrome, V - cryptochrome

Source: Author

Particularly, when identifying significant differences in the values of chlorophyll absorption according to the results of processing experimental data (using Student's criterion), special attention was paid to such nutrients as magnesium and iron, as well as sulfur, manganese, molybdenum, zinc and boron (Fig. 1). The supply of leaf apparatus by nutritious elements and the composition of root environment were determined by means of chemical analysis.

The research results of cucumber fruits quality (% by wet weight) are shown in table 2. The nitrate content was 100 mg/kg; pesticides were not found.

Table 2: The content of chemical elements in cucumber

№	Element	Designation	Content, %
1	Potassium	K	0.150
2	Calcium	Ca	0.016
3	Phosphorus	P	0.024

№	Element	Designation	Content, %
4	Magnesium	Mg	0.014
5	Iron	Fe	0.028
6	Manganese	Mn	0.073
7	Zinc	Zn	$0.080 \cdot 10^{-3}$
8	Copper	Cu	$0.039 \cdot 10^{-3}$
9	Cadmium	Cd	$0.002 \cdot 10^{-3}$
10	Mercury	Hg	$0.001 \cdot 10^{-3}$
11	Lead	Pb	$0.040 \cdot 10^{-3}$
12	Arsenic	As	$0.010 \cdot 10^{-3}$

Source: Author

The analysis of these data reveals that the content of Eco toxicants in cucumber fruits is below the maximum permissible concentrations; the content of nutritional elements is in accordance with the established standards.

Thus, the use of biological methods of plant protection and plant diagnostics can increase the yields and ensure the quality of crop products.

The presented technical solutions are recommended for usage in greenhouse vegetable cultivation technologies. The field of further research relates to the improvement of Phyto monitoring methods which can (due to the timely detection of plants stress states) ensure the high quality of crop products.

5. CONCLUSION

Ecological purity of food products is of importance in modern conditions, since the pollution of the environment results in the formation of a source of hazardous Eco toxicants that get into food. Vegetables play an important role in human nutrition; they contain physiologically active substances, vitamins, mineral substances, organic acids, fiber; they are natural medicinal and prophylactic agents. The most valuable are fresh, raw vegetables, but the possibility of consuming fresh vegetables is limited to the season of the year.

When organizing a greenhouse crop production, which makes it possible to receive vegetable products throughout a year, it is necessary to consider the conception of a contemporary policy in the field of healthy nutrition of the population which provides for obtaining crop products in environmentally optimal conditions. In this regard, the urgent task is to ensure the quality of crop products.

The purpose of the conducted research was the development of innovative technical solutions aimed at ensuring the quality of greenhouse vegetable products.

As a result of theoretical and experimental studies the technology of *A. Coleman* mass production for the biological protection of cucumber plants has been improved; a technique for identifying the stress state of plants has been developed. It does not require sample preparation, and it is based on the evaluation of leaf apparatus absorption spectra.

The analysis of the obtained results confirmed the stated hypothesis and showed the economy and energy efficiency of the presented technical solutions. The use of biological methods for plant protection and plant diagnostics contributes to increasing yields and ensuring the quality of crop products.

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ORIGINAL RESEARCH PAPER

HEALTH EFFECTS OF SOIL CONTAMINATION FOR THE MOSCOW POPULATION

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ABSTRACT

The paper presents results of analyzing sanitary and hygienic status of soils in the city of Moscow, and its effects on health of the city population. Summary value of soil contamination with Zc for all administrative districts of Moscow does not exceed 16, which allows classification of soil pollution in Moscow as "acceptable". Highest values of Zc contamination were registered in Central (Zc = 10.2) and South-Eastern (Zc = 8.9) administrative districts of Moscow. The authors determined average degree of interrelation between soil contamination with petroleum products and general primary morbidity of Moscow population (r=0.65; p=0.04; R^2=51%), and average degree of interrelation between soil contamination with petroleum products and malignant neoplasm morbidity in Moscow (r=0.68; p=0.02; R^2=55%).

JEL classification: I10, Q52, Q57

Keywords: *soil pollution, social and hygienic soil monitoring, popular health, heavy metals, petroleum products, Moscow.*

1. INTRODUCTION

Moscow is an actively developing metropolis with characteristic ecological issues of atmospheric air pollution, industrial and household waste. Soils of the city of Moscow do also bear anthropogenic stress that damages their ecological functions of processing organic residues, cleaning atmosphere and surface waters, forming the microclimate, protecting the earth surface, and providing conditions for biological and geological cycles of matter. Disruption of ecological balance affects soils before other elements since soils absorb and accumulate toxic elements.

Soil contamination with heavy metals is a global issue for industrial centers and urban areas all over the world (Yang et al., 2018; Cai et al., 2019; Stepanova et al., 2018; Kaur et al., 2018; Peng et al., 2017; Belozubova et al., 2014). Industrialization and urbanization in recent decades did have an enormous impact on the properties of urban soils, and that inevitably affects public health (Li et al., 2018; Trujillo-González et al., 2016).

Contaminated soils affect health of city inhabitants both directly and indirectly. Indirect effects are caused by secondary pollution of the contacting media, effects of inhaling particles of contaminated soil dust are also possible (Chernyaeva, 2011; Jafari et al., 2018).

Research by Gabarrón that included analysis of city soil and road dust from three cities with different population densities and defining contents of Pb, Zn, Cu, Cd, Cr, Co, and Ni demonstrated that these metals were mainly related to PM10 fractions in both soil, and road dust, increasing overall risks of adverse health effects by affecting the respiratory tract. Risk assessment demonstrates that the most dangerous way of exposure is swallowing followed by skip absorption and inhaling (Gabarrón et al., 2017).

Child population that has greatest probability of contract with contaminated soil is under direct epidemiological exposure. For example, research by Tepanosyan G. Included assessment of soil contamination with heavy metals on kindergarten grounds in Yerevan. Multidimensional geostatistical analysis demonstrated that concentrations of Ag, As, Ba, Cd, Cu, Hg, Mo, Pb, and Zn, observed in upper level of kindergarten soils usually have anthropogenic origins, while Co, Cr, Fe, Mn, Ni, Ti , and V generally come from natural sources. According to the overall pollution index (Zc), for 102 kindergartens to level of pollution was low, for 7 in was moderate, and for 2 - high. Cr and multi-element cancerogenic risk (RI) values exceed safe levels for all kindergartens and demonstrated that there is a certain potential for cancer development, though it is small (Tepanosyan et al., 2017).

Demographic analysis for Moscow demonstrates that primary neoplasm morbidity within 10 years demonstrated a 13% increase and demonstrated the value of 39769 cases per 100 000 people in 2016.

Therefore, analysis of a system for social and hygienic monitoring of soils in Moscow remains relevant. The goal of the work was to analyze the sanitary and hygienic state of soils in Moscow and estimate its effect on public health.

2. RESEARCH METHOD

Monitoring of soil quality and its effects on public health is performed in Moscow as part of a Socio-Hygienic Monitoring (SHM) system. SHM system is based upon the principles of complex and complete data, efficiency, timeliness, and continuous expansion of monitoring network (Buzinov, 2014).

At the same time SHM system is a system for risk (exposure assessment) management, and a monitoring system that tracks the amounts of pollutants in soil. Due to that, in it is important to select primary soil contaminants, and choose control periodicity and methods used within the system. In order to perform objective soil contamination analysis, monitoring network shall cover 20% of each functional zone within the territory, while covering the whole urban area. In order to receive the required volume of data, it is important to perform regular soil research.

Within the SHM system the soils are controlled using the following set of parameters – sanitary chemical, sanitary bacteriological, sanitary parasitological, sanitary entomological, soil biological activity, and chemical pollution.

It is necessary to note that there are sanitary norms stating the maximum permissible concentrations (PDC), and tentative permissible concentrations (TPC) for soil pollutants (heavy metals, arsenic, and petroleum products). There is a problem related with the lack of specific normative for urban soils, and differentiation of this normative in terms of climate and natural conditions, limiting chances for quality assessment of urban soils.

Compared to other environment components, soil is hard to analyze due to its complex and multi-component composition. Element analysis of the soils requires use of complex analytical methods with high validity of results, and low thresholds of pollutant recognition. For the moment, three methods of atomic spectrometry are most widely used for analysis of soil contaminants (Table 1) (Ladonin, 2016).

Table 1 – Comparison of soil pollution laboratory analysis methods

Method	Advantages	Disadvantages
Atomic absorption spectrometry	Low cost of equipment, high speed of analysis, high resistance to interference	Low sensibility, slow performance of multi-element analysis

Method	Advantages	Disadvantages
Optical emission spectrometry	Fast performance of multi-element analysis	Low resistance to interference
Inductively coupled plasma mass spectrometry	Fast performance of multi-element analysis High sensitivity	Expensive equipment, high quality reagents and clean room requirements

Source: Author

Inductively coupled plasma mass spectrometry can be the most promising method for element analysis of the soils.

3. RESULTS AND DISCUSSION

Social and hygienic monitoring of Moscow soils is performed by the Federal budget healthcare organization “Center for hygiene and epidemiology of the city of Moscow”.

In 2016 soil samples were taken on 145 monitoring sites which is 6% more than in 2015 (On the status… report, 2017). Sampling sites are in all functional areas of the city. Samples were taken twice a year – in spring and autumn.

Samples were examined in accredited labs of the Federal budget healthcare organization “Center for hygiene and epidemiology of the city of Moscow” in order to determine key soil contamination parameters. Considering the results of laboratory control for soil chemical pollutants using SHM data, it is possible to conclude that key pollutants of Moscow soils in 2016 were lead, zinc, cadmium, chrome, and cobalt (Table 2).

Table 2 – Key soil quality parameters for the city of Moscow

Chemical	Bacteriological	Parasitological
Pb, Cd, Zn, Cu, Cr, As	Coliform bacteria, enterococci	Toxocara, whipworm (Trichuris trichiura)

Source: Author

Total amount of examined soil samples in 2016 was equal to 2241; compared with 2015 the largest amount of samples was examined for parasites (Figure 1) (On the status… report, 2017).

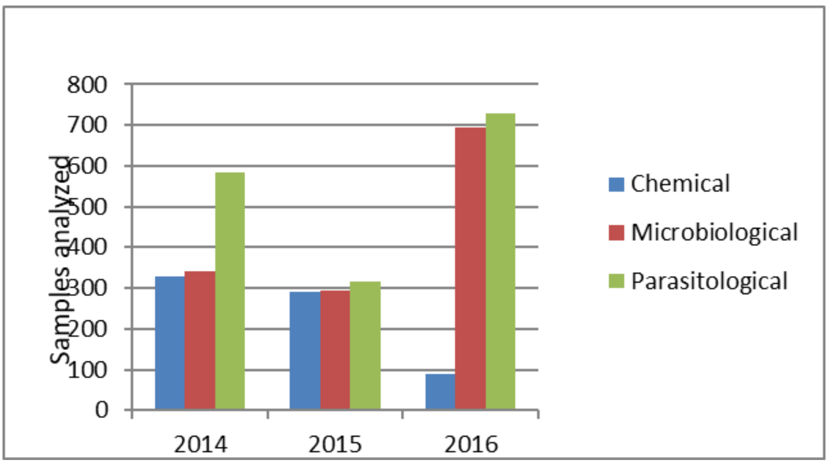

Figure 1 – Number of soil samples analyzed in the SHM system of Moscow
Source: Author

In 2016 total number of specimens that did not comply with sanitary normative was 158, 20.2% less than in 2015 (198 specimens).

In 2016 chemical and bacteriological pollution decreased, while there was a certain growth in parasitological contamination of the soil (Table 3).

Table 3 – Soil contamination dynamics for Moscow based on 2012-2016 SHM system data

Parameters	Share of inadequate samples, %				
	2012	2013	2014	2015	2016
Chemical	47.6	38.7	26.9	38.3	37.9
Bacteriological	19.9	31.6	24.9	24	19.3
Parasitological	4.4	1.9	1.4	1.2	2.2

Source: Author

Summary parameter of soil contamination Zc allows estimating effects of soil pollution on public health. This parameter is calculated using data from ecological monitoring of Moscow soils.

In 2016 summary contamination parameter for the soil of Moscow for all administrative districts was Zc < 16, which allowed defining Moscow soils contamination level as “acceptable”. Highest values of Zc were recorded in Central (Zc = 10.2) and South-Eastern (Zc = 8.9) districts (On the status… report, 2017).

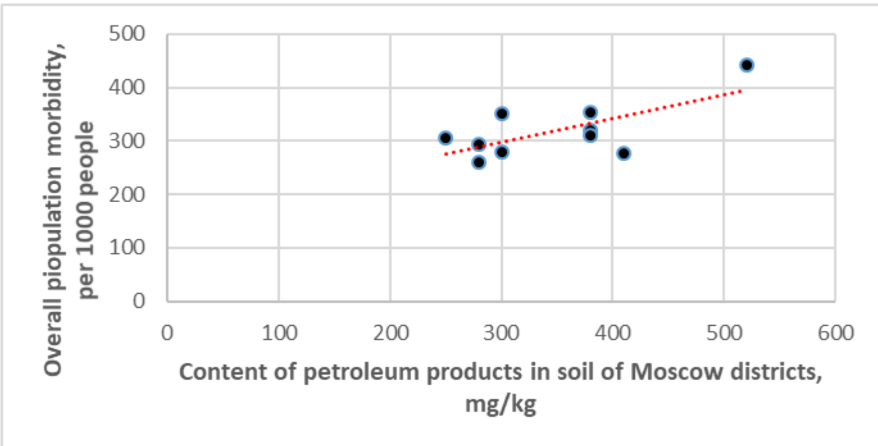

Figure 2 – Overall primary morbidity of Moscow population related to soil contamination with petroleum products in 2016
Source: Author

Soil contamination data analysis demonstrates that most chemically polluted soils in Moscow are in the Northern, Western, Central, and Southern districts of Moscow (On the status… report, 2017).

Soil is a deposit environment for pollutants. Soil pollution in the cities is one of the reasons for appearance of the so-called technogeneous bio-and geochemical provinces, where additional population morbidity is possible. Therefore, soils can act as integral indicator of an ecological status for a territory.

In 2016 the share of Moscow population covered by SHM system in terms of assessing effects of urban soil sanitary and epidemiological safety was equal to 70.5%. Increase of overall morbidity for children and adults was observed in 2014-2016 rin the Central, Easters, Northern, and Southern districts of Moscow, along with increased and high levels of morbidity related to endocrine diseases (On the status… report, 2017).

Petroleum products are among the most common soil pollutants; in high concentrations they suppress activities of soil microbiota, affecting soil self0purification capabilities.

Correlation analysis was used to establish relationship between soil contamination with petroleum products in 2016 (On the status… report, 2017) and malignant neoplasm morbidity in Moscow in the same year (r=0.68; p=0.02; R2=55%) (Figure 3).

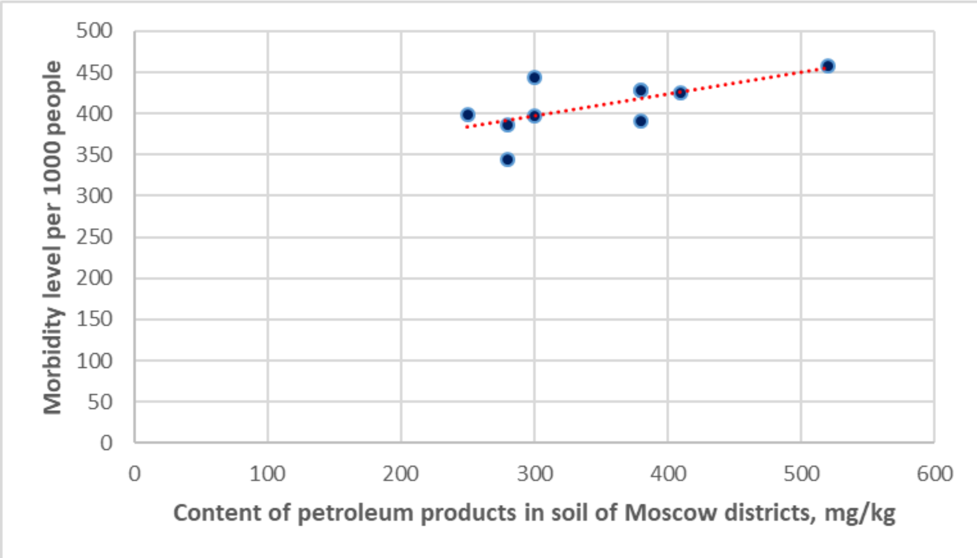

Figure 3 – Moscow population malignant neoplasm morbidity related to soil contamination with petroleum products in 2016

Source: Author

Territory of Moscow is an area with light iodine deficit, i.e. it is a natural biogeochemical province with low iodine content in soils, water, and food.

In 2016 the incidence rate for toxocariasis in Moscow demonstrated a 13% growth. Share of children morbidity about geohelminths and bacterial infections related to soil conditions remained at high levels.

Therefore, in 2016 the decrease in total number of soil specimens inadequate to sanitary and hygienic requirements was observed, along with increase in parasitological contamination of Moscow soils.

Average relationships among the Moscow soil contamination with petroleum products, and general morbidity and malignant neoplasm morbidity of Moscow city population were established for the year 2016.

Irregular research of soil parameters (two times a year) and variations in number of annually examined specimens complicates viable assessment of threats for public health since risk assessment requires application of mathematical and statistical methods for data processing.

General measures required to improve sanitary and hygienic conditions of Moscow soils include greening of residential areas, organization of dog walking areas, and quality control of the used soils.

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ORIGINAL RESEARCH PAPER

THE SOCIAL ASPECT OF RISK FACTORS OF OCCUPATIONAL INJURIES AND HEALTH PROBLEMS AMONG FARMERS FROM KALMYKIA

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ABSTRACT

On the example of a peasant farm, there were carried out analysis of the state of labor protection in the modern farms of Kalmykia, one of the southern steppe regions of Russia. There were considered the risk factors of occupational injuries and health problems of production personnel as well as the questions of regulation of social and labor relations. It was concluded that now the only means of security is the employment contract. There have not been created any Trade Union or committees on this peasant farm. The employees here like at most other farms, do not show any activity, any interest in the creation of a public body which will be regulating labor relations in the enterprise. The employees do not participate either directly in the management of the organization or through their representative bodies, and the collective agreement in the small agricultural enterprises is often not concluded. Presently, with the strengthening of the economic situation of farms, there is a tendency to increase attention to the issues of labor protection. In the peasant farm Bair, this was manifested in the appearance among the staff a new employee and occupational safety specialist. Since that moment, measures have been taken to organize safety trainings in accordance with GOST 12.0.004-90, the study of sanitary and hygienic factors of the working environment, the severity and intensity of the work process. This made it possible to make recommendations for improving working conditions, which the employer has partially started to follow, and he is planning to fulfill the rest of them soon.

JEL classification: I10, Q59

Keywords: *risk factors, occupational injuries, agricultural farm, the conditions of agricultural labor, occupational safety and health in agriculture, measures to improve working conditions, monitoring of working conditions, harmful and dangerous working conditions, temporary disability*

1. INTRODUCTION

In modern conditions of the development of a market economy in Russia new requirements to the organization of work at the enterprise are imposed. In this regard, an important issue is the creation of effective working conditions. Many conventions and recommendations of the International Labor Organization indicate that the work and life of people coincide in time and space, or, in other words, the main active life of a person takes place at work. Being at work, a person spends a complex of vital forces not only to achieve certain results of work, but also to the reaction of the body associated with working conditions.

The working conditions depend on: the result of work, the total life expectancy, the state of working capacity, physical health, the period of social activity.

The aim of the work is to analyze working conditions and develop measures to improve them in the livestock farming complex «Bair».

2. THEORY

According to ILO estimates, the world's agricultural production employs about 1.3 billion workers, representing almost half of the world's workforce. Technological development has reduced the share of agricultural labor in the world's economically active population, so almost 60 percent of employees are in developing countries and only 9 percent of employees are in industrialized countries. The vast majority of agricultural workers are concentrated in Asia, including more than 40% in China and more than 20% in India. The share of the agricultural sector has been declining in recent decades, but it continues to make a significant contribution to the EU economies. The number of employed people in the EU-15 agriculture decreased from 22% to 4% of the working population (5983 thousand people) between 1995 and 2005.

In the context of occupational safety and health, the term "agriculture" is generally used in a broad sense. According to article 7b of the Convention on safety and health at work in agriculture of the International Labor Organization, the term "agriculture" covers agricultural and forestry activities carried out in agricultural enterprises, including crop production, forestry, animal husbandry, beekeeping, primary processing of plant and animal products by or on behalf of the owner of the enterprise, as well as the use and maintenance of machinery, equipment, tools and agricultural units, including any processes, storage and storage of agricultural product, operations or transportation in an agricultural enterprise that are directly related to agricultural production.

In EU, US and other legislation, the term "farm" is defined as an agricultural enterprise producing at least one of the following products for sale:

1) crops (hay, field crops, fruit, berries, grapes, vegetables, etc.);

2) farm animals (cattle, pigs, sheep, horses, other Pets);

3) poultry (hens, chickens, turkeys, etc.);

4) animal products (milk or cream, eggs, wool, fur, meat);

5) other agricultural products (nursery products, mushrooms, honey, etc.).

For comparison, we present the level of agricultural injuries in Finland, which in 2016-2017 amounted to 5.8 per 100 000 people for women and 9.1 for men. The highest rates occurred among workers in pig breeding and workers associated with maintenance of cattle (of 9.7 and 8.7 per 100,000, respectively). Compared to production as a whole, the number of non-fatal accidents is much higher, with injuries in agriculture being more severe than in all other industries. The number of days of disability associated with accidents exceeds the average twice.

3. DATA AND METHODS

Peasant farm "Bair" is a well-known enterprise in the Oktyabrsky district of the Republic of Kalmykia. Initially, before the formation of the farm, here was a personal part-time farm belonging to Kovaev family. Kovaevs were engaged in animal husbandry. In the farm there were present horses, camels, cattle, sheep, goats. In 1960 on this place the collective farm "Tsagan-Nur"was formed. In 1995 the farm "Tsagan–Nur " "collapsed" and the territory was leased to Kovaev M. E. In the same year the farm Bair was founded.

Employees of this employer are not United in any primary trade Union organizations; collective bargaining is not carried out. This is typical for most farms. There is also no Commission with the necessary powers of representatives of the parties to ensure the regulation of social and labor relations, collective bargaining and preparation of drafts of the collective contracts, agreements; conclusion of collective contracts, agreements, as well as monitoring their implementation at all levels on equal basis.

The collective agreement at the enterprise wasn't signed. Employees do not participate either in the management of the organization directly or through their representative bodies. The main instrument of regulation of activities at enterprises of this type, including the Bair farm, is an employment contract - the agreement between the Employer and the Employee according to which the Employer undertakes to provide the Employee with the work according to the agreed labor functions, to provide the working conditions following the labor legislation and other regulatory legal acts containing regulations of the labor law, local regulations, to pay the Employee's salary fully and in due time.

The Employee undertakes personally to perform the labor function defined by this agreement, to follow the rules of the internal labor regulations applicable to this Employer.

Considering that the employees are working in shifts, the shift schedules are approved and communicated to employees in advance by their direct supervisors. Shift schedules are an Annex to the Rules of internal labor regulations.

The Employer does not allow the Employee to work on the working day (shift) in case the Employee appears at work in a state of alcoholic, narcotic or toxic intoxication. Any absence of an Employee in the workplace, except for cases of force majeure, is allowed only with the prior written permission of the Employer or his representative.

The duration of annual paid leave for all employees, according to the current legislation, is not less than 28 calendar days.

Employees working in the cold season in the open air or in closed not heated rooms are provided with special breaks for heating and rest, which are included in the working time. However, the Employer does not provide allocation and equipped premises for heating and rest of workers.

The employer provides:

- safety of Employees in the operation of buildings, structures, equipment, in the implementation of technological processes, as well as in tools, raw materials and materials; used in the production

- application of the means of individual and collective protection of Employees which passed mandatory certification or Declaration of conformity in the order established by the legislation of the Russian Federation about technical regulation;

- acquisition and issue at the expense of own means special clothes, special footwear and other means of individual protection, the washing-off and neutralizing means {which passed the obligatory certification or Declaration of compliance in the order established by the legislation of the Russian Federation about technical regulation, according to the established norms}for the workers occupied at works with harmful and (or) dangerous working conditions as well as for the works performed in special temperature conditions or connected with pollution.

Employees must:

- comply with the requirements of labor protection;

- use correctly personal and collective protection;

- undergo training of studying the safe methods and tricks of fulfilling the works and first aid to victims at work, safety instructions, training on a workplace, verification of knowledge of occupational safety requirements;

- immediately inform his direct or superior Manager about any situation that threatens the life and health of people, about every accident that occurred at work, or about the deterioration of his own health;

- undergo mandatory preliminary (on admission to work) and periodic (during employment) medical examinations (checkups) as well as undergo extraordinary medical examinations (checkups) on Employer's referral.

3.1. METHODS

A comprehensive assessment of working conditions on the basis of special studies of the factors of the working environment is carried out during the certification of workplaces. The results of this work are used to carry out measures to improve working conditions.

The air temperature in summer is 3°C above the permissible level, in winter the deviation reaches a much greater value (-5; -7°C), which leads to the increase in the level of acute respiratory diseases, therefore this factor should be paid special attention to, since in the cold season the level of ARI can be much higher. The main means of preventing catarrhal diseases are improving the sanitary and hygienic conditions of industrial premises. Air humidity is 30%, which corresponds to the permissible level.

Parameters of natural light in the workplace meet the requirements of SNiP 23-05-95 " Natural and artificial lighting."

According to the normative documentation, certification of workplaces on working conditions is carried out once in 5 years by a special Commission, which includes the general specialists of the enterprise, employees from Human

Resources, from labor protection department, medical workers. Studies of sanitary and hygienic factors of the working environment, the severity and intensity of the labor process are carried out at specific workplaces through laboratory studies, instrumental measurements and calculations. Results of instrumental measurements of parameters of harmful and dangerous production factors are made out by protocols and are entered in cards of certification of working conditions in the workplace.

Further analysis and comparison will be carried out based on maps of working conditions in the workplace. Based on the results of the certification, let’s consider the actual state of working conditions in the workplace.

4. RESULTS

Many factors of working conditions are not below the permissible level. There are no mechanic-repairmen in the enterprise. It’s the Drivers who oversee repair and maintenance of equipment in the enterprise and to whom certain unit of equipment is assigned.

Over the past 3 years, in the enterprise 4 cases of injury were recorded. One of which was not recognized as a work injury. An employee was injured on the way to work. The other case was investigated by the Prosecutor's office of Oktyabrsky district: during the working process between the warehouseman and the loader arose disagreements that escalated into a fight, one of them received a severe maxillofacial injury. Cases of injuries with a fatal outcome at the enterprise were not recorded.

However, in the enterprise KFH "Bair" there is no system of control over the state of working conditions and over the compliance with the rules of labor protection by the administration. The control by the Director of the enterprise is not made, the control log is not maintained, therefore, administrative control over the state of working conditions at the enterprise is absent and does not work.

Instruction of the employees is carried out during the employment in accordance with GOST 12.0.004-90 "Organization of safety training."

Induction training is conducted with all employed personnel, as well as with the seconded employees and employees of third-party organizations performing works on a dedicated site, students undergoing internship in the organization, and other persons involved in production activities. Instructing is carried out by Occupational safety specialist to whom these duties are assigned by the order of the employer. The results of instructing are entered in the register of introductory instruction as well as in the documents of employment (personal card). The program of induction training is developed by Occupational safety specialist considering requirements of standards of SSBT, rules, norms, instructions on labor protection and features of the enterprise. The results are entered in the register of briefings in the workplace, as well as in the documents of employment (personal card).

Inspection of working conditions, sanitary conditions, fire extinguishers is carried out one time per month. For violation of techniques and rules of labor protection, the company provides reprimands and disciplinary penalties.

Table 1. The incidence rate of employees KFH Bair with temporary disability for 2015 - 2017.

Indicators	2015	2016	2017
Number of employees	65	64	66
Number of diseases with temporary disability	31	41	34
Number of days of temporary disability	170	220	150
The average duration of one case of incapacity	4 days	6 days	4 days

Source: Author

The table 2 shows that the number of cases of temporary disability and the number of days of temporary disability in 2016 is higher than in the other years. This is due to the long cold winter of 2016.

Table 2Structure of diseases of employees of KFH "Bair" for the period 2015-2017

Type of disease	2015	2016	2017
Diseases of the respiratory system	2	3	1
Diseases of the circulatory system	2	3	2
Diseases of the nervous system	0	1	0
Diseases of the digestive system	3	6	3
Injuries, poisoning	15	24	14
Catarrhal diseases	17	34	16
Others	13	17	10

Source: Author

About half of all cases of diseases with temporary disability are due to catarrhal diseases and ARI, this is due to the low temperatures of the industrial premises of the enterprise, and as a consequence, a high level of morbidity.

It is possible to allocate the following jobs with harmful factors:

Warehouses are poorly heated, on the two main access roads for heavy trucks there is no unloading vestibule, on the gates of which there are thermal curtains, but either because of the old age or low power they cannot cope with the flow of cold air, as a result, when working through these gates of the warehouse (receipt of goods or shipment of large goods), the temperature in the warehouse drops sharply. There are 16 shipping Windows of size 1,5x1,5 m, not equipped with thermal curtains, which are closed by shields. When goods are unloaded through these windows, the temperature in the warehouse also drops. Because of the low temperature, all warehouse employees work in warm clothes and shoes. Insufficient lighting of the warehouse leads to rapid fatigue, fatigue of the eyes of workers, and as a consequence causes discomfort. If the dimensions of the truck allow loading and unloading operations are carried out mainly through shipping windows. If the dimensions of the cars do not allow, the loading and unloading operations are carried out in the street with the use of mainly manual

At work with harmful and dangerous working conditions, as well as at work carried out in special temperature conditions or related to pollution, workers are given free of charge special clothing, special shoes and other personal protective equipment that have passed mandatory certification of conformity, as well as washing off and (or) neutralizing agents in accordance with standard norms.

Provision of sanitary services for employees in accordance with the requirements of labor protection is the responsibility of the employer. For this purpose, the employer equips sanitary premises, premises for eating, first-aid kits, completed with the set of medicines for first aid and they are kept in the Brigadier's room.

There are no rooms to rest in during working hours and there is no psychological relief.

4.1. RECOMMENDATIONS TO IMPROVE THE CONDITIONS OF WORK

The creation of favorable working conditions and further facilitation of work contribute, on the one hand, to the preservation of Employees ‘health, to the improvement of their labor skills, and, on the other hand, to the improvement of labor efficiency and productivity, to the reduction of staff turnover and to the improvement of discipline in the workplace.

Based on the analysis, it is advisable to propose the following activities:

- Anti-noise measures (installation of silencers), which will reduce noise from 90 – 98 dB to 65 – 70 dB. Silencers are designed to reduce the level of aerodynamic noise that occurs during the operation of fans, air conditioners, air control devices, as well as noise from the movement of air flows in the duct system. This element of the ventilation system has a large surface area, covered with sound-absorbing material.

- The increase of illumination in the workplace from 65 to 350 Lux (the replacement of incandescent lamps with luminescent ones). The entire control unit is in the lamp base, that is why it has a small size, operates silently and without flicker. In addition, the luminescent lamps emit a very small amount of heat, which allows to use them in plastic lighting devices. In addition to all the described advantages related to energy saving, luminescent lamps also have a beneficial or neutral effect on vision and health. Even if the lamp is damaged and destroyed, a negligible amount of mercury vapor is released into the atmosphere, so simple ventilation is enough to remove it.

- Improvement of ventilation systems. Now the company has old ventilation systems, which often fail, and the repair is delayed for a few days. It is necessary to purchase a new ventilation unit. A good ventilation system will be more suitable, reliable and economical. Suitability means that the system corresponds to the design features of the building in which it is installed, as well as to all the requirements for the system. Reliability means that the system can operate properly for the planned long period, provided that regular maintenance is carried out. Cost-effectiveness means that energy losses in the system are minimized. Consequently, the system should provide savings in all respects.

- The elimination of the flow of cold air drafts in the winter. It is recommended to install the thermal curtain Ballu BHC-9 TR. Air heat curtain - a fan suspension type, designed to supply heated (or cold) air. Being located above the doorway or on the side of it, the curtain creates a powerful air flow that serves as an invisible barrier between the room and the street, so that the cold air practically does not penetrate inside. The massive air barrier of thermal curtains reliably keeps heat, cold and clean air even with open doors of any rooms. In addition, the room is protected from dust, odors, flying insects. Therefore, the veil will not remain idle in the summer, keeping inside the invigorating coolness. Air thermal curtains represent an energy-saving equipment and provide comfortable conditions in the room with minimal cost.

- It is necessary to allocate a special room for rest of the personnel of the enterprise. Employees will be able to relieve stress and thereby maintain efficiency. Also, the recreation room will help to improve the microclimate in the team.

- Installation of new ventilation systems in cowsheds. The current ventilation system often fails. Ventilation of the barn should be constant regardless of weather conditions and season, only air exchange rates change. So, for example, in the winter period the ventilation should be carried out at least with four times change of air in all volume of the room. And in summer the required air exchange rate increases sharply, the air in the barn should completely change 60-100 times per hour.

5. CONCLUSION

Thus, analyzing the state of labor protection in modern farms of Russia, it can be concluded that currently the only means to ensure the regulation of social and labor relations is an employment contract. Employees do not participate in the management of the organization either directly or through their representative bodies, and the collective agreement in the enterprise is often not concluded. Therefore, subjective factors play an important role, such as the foresight and consciousness of the employer, his attitude to the workforce. At the same time, with the strengthening of the economic situation of farms, there is a tendency to increase attention to the issues of labor protection. In the Bair farm, this was manifested in the appearance of an employee and occupational safety specialist. Since then, measures have been taken to organize safety training in accordance with GOST 12.0.004-90, the study of sanitary and hygienic factors of the working environment and of the severity and intensity of the labor process. This made it possible to draw up the above-mentioned recommendations for improving working conditions, which the employer has partially begun to implement, and the rest of them is planning to execute soon.

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ORIGINAL RESEARCH PAPER

DYNAMICS OF MEDICAL AND DEMOGRAPHIC INDICATORS OF POPULATION HEALTH IN CONDITIONS OF A TECHNOGENIC LOAD IN STERLITAMAK DISTRICT OF THE REPUBLIC OF BASHKORTOSTAN

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ABSTRACT

The work was carried out on the basis of information and statistical database of the Republic of Bashkortostan and its own experimental studies of soil and plant systems, conducted in Sterlitamak district; the subject of the study was the parameters of soil cover, reflecting the long-term characteristics of air pollution, vegetable plants, as well as indicators of public health; the theme of the research-"the Dynamics of medical and demographic indicators of public health in the conditions of a technogenic load in the Sterlitamak district of the Republic of Bashkortostan"; the purpose of the research – the assessment of the potential risk associated with soil contamination with heavy metals, the risk of consumption of vegetables grown in conditions of the Republic of Bashkortostan. technogenic load, and health status. –research hypothesis-is environmental pollution, including heavy metals forms a load on the environment and is a risk factor for chronic exposure. The work is based on the methodology of ecological-geochemical and socio-hygienic monitoring of territories taking into account regional factors, the methodology of integrated assessment of the risk of soil pollution, considered from a two-pronged position: the risk of negative consequences for the soil as a basic component of the ecosystem as a result of violation of its stability and for public health and the methodology of demographic foresight, based on the positions of food, environmental safety and quality of life of the population The result of the work was an ecological and hygienic assessment of soil and safety of vegetable products, assessment of medical and demographic indicators and the level of morbidity, predictive risk assessment of chemical contaminants of vegetables, collection and analysis of information about the natural movement of the population in the Sterlitamak district and the main causes of death in the Republic of Bashkortostan; - a hygienic situation caused by heavy metal contamination of soil, vegetable products groundwater and surface water is studied, and the study revealed a micro element imbalance in vegetable products, characterized by an increased concentration of lead, cadmium and chromium. The obtained results can be used to develop hygienic recommendations to reduce the risk of exposure to heavy metals on public health, to determine the areas suitable for growing vegetables, to determine plants resistant to pollution, biological measures, including soil purification with the help of plants-heavy metals hyperaccumulators, followed by processing of the green mass for metal extraction. The direction of future research may be the introduction into the system of existing monitoring of biological monitoring, the inclusion of indicators of pollution of snow cover to assess and predict the anthropogenic impact of heavy metals on the environment and humans.

JEL classification: I 10, Q59

Keywords: *technogenic load, environmental monitoring, socio-hygienic monitoring, heavy metals, pollution risk, contaminants, fertility, mortality, natural growth, neoplasms*

1. INTRODUCTION

The state and development of society is largely determined by the number and composition of the population, its life and labor potential. Demographic processes are under the complex influence of economic, social, technological, environmental, political and many other factors and, in turn, have an impact on all aspects of public life without exception. The problem of environmental pollution is particularly relevant for industrialized regions, one of them is the Republic of Bashkortostan (RB), whose cities and districts are divided into 4 groups: developed, relatively prosperous, lagging and depressed (Daukaev, 2010), (On the state, 2017). Ufa, Sterlitamak, Salavat, Neftekamsk, Oktyabrsky are referred to the group of developed regions of the Republic (Karamova et al., 2017).

In the economically developed region of the Republic there are enterprises engaged in the processing of oil and oil products. The ecological environment of these cities is formed by industrial emissions of petrochemical and chemical enterprises and vehicles.

Sterlitamak is the second city of the Republic after Ufa in terms of industrial capacity. This region belongs to the territories of risk according to the relative indicators of primary and general morbidity of the population (The state report, 2017). In this regard, the objective assessment of pollution of these territories and the support of a complex of hygienic measures considering natural and anthropogenic factors are of great importance.

2. THEORY

Economic activity can't happen without connection with the biosphere which provides not only production with raw materials, but also accepts production streams including pollutants.

The chemical and petrochemical industries contribute a big share to environmental pollution by heavy metals because Cr, Ni, Zn, Fe, by V, With, Pd are used as catalysts of an organic synthesis and reburning (Savintsev, 2015).

Heavy metals are one of priority pollutants of atmospheric air, the soil and water of reservoirs on a global and regional scale that, considerably, relates to their biological activity (Hu, W., Zhang and other, 2017). They are steady in the environment, can collect in fabrics of live organisms and to be transferred on food chains (Kamani et al., 2017).

The results of researches conducted including the territory of the Sterlitamak district are devoted to questions of assessment of pollution of the environment with heavy metals and optimization of health of the population in conditions, the large industrial cities have (Daukaev,2010).

The analysis of the state of health of the population of the area shows that from the various risk factors united according to the WHO classification in 4 groups (a way of life, the habitat, heredity and quality of the medical and sanitary help) health of the population is generally influenced by a way of life and the habitat, and in rural areas the factor of the level of development and availability of medical care is added (The state report, 2017). At the same time, some researcher's growth of mortality from diseases, for example, of the blood circulatory system, connect not so much with questions of deterioration in an ecological situation, but with change of tenor of life of many people (Murzagalin et al, 2018).

The soil is not only the indicator of anthropogenic pollution of the environment, but also a source of interenvironmental transition of elements to the atmosphere, water and food, especially for agrarian regions. On average with phytogenesis food 65 - 70% of heavy metals come to a human body (Li H. et al, 2017). The chemical composition of soils, the acid and main and oxidation-reduction conditions, physical and chemical properties, level of microbiological activity, natural and anthropogenic factors exert impact on intake of heavy metals in plants (Meli M. and other, 2013). It should be noted that, plants accumulate heavy metals selectively, possessing a certain protective system in relation to toksikant (Van Dijk et al, 2015). At the same time uneven distribution of chemical elements on bodies of plants is noted (Wang et al, 2015; Wang, 2015).

In this regard the purpose of our researches was assessment of the potential risk connected with pollution of the soil with heavy metals, dangers of the consumption of the vegetables which are grown up in the conditions of technogenic loading and the state of health of the population of the Sterlitamak district of the Republic of Bashkortostan.

3. DATA AND METHODS

The methods defining research methodology were: the dialectic, a lowering to investigate processes in unity, distinction and historical development; historical by means of which dynamics of relationship of amount of pollutants and demographic indicators of the population are kept track; system on which interrelations on operation of natural resources and restoration of a qualitative condition of components of the environment (soil) are based, standard, used for establishment of objective borders of permissible anthropogenic load.

In work the information and statistical database submitted by reports of the Ministry of Natural Resources and Environmental Protection of the Russian Federation, Ministry of environmental management and ecology of the Republic of Bashkortostan, the Ministry of Agriculture of the Russian Federation and also Materials to the state reports "About a condition of sanitary and epidemiologic wellbeing of the population in the Russian Federation across the Republic of Bashkortostan", territorial authority of Federal State Statistics Service in the Republic of Bashkortostan for 2011 - 2018 are used.

3.1. METHODS OR MODEL

The basis for complex researches are the methodology of ekologo-geochemical and social and hygienic monitoring of territories with taking into account regional factors, the methodology of integrated assessment of risk of pollution of soils considered from a two-uniform position: dangers of the approach of negative consequences to the soil as a basic component of an ecosystem as a result of violation of its stability and for health of the population and the methodology of demographic anticipation which is based on positions of food, ecological security and quality of life of the population (Ovchinnikova , 2004).

In general, for this work the methodology can be defined as a way of identification and taking into accounting of opinions of experts on the directions in the solution of the problematic issues (connected with environmental protection and rational environmental management) and clarifications of the corresponding leading tendency (in the state of health) which is formed based on forecasting.

4. RESULTS

Sterlitamak - the second city of the Republic on population and industrial power after the capital – Ufa. More than 43% are the share of a share of these two cities in the general emissions of the pollutants coming to atmospheric air in Bashkortostan (Gabdrakhmanov et al, 2017).

The comparative analysis of volumes of emissions per unit of area of building and on one inhabitant characterizes an ecological condition of the territory. In 2016 the volume of emissions of the substances polluting the atmosphere per 1 hectare of the territory of the city of Sterlitamak was 5,9 t., exceeding average density on the region more than by 90 times, it is the highest chemical loading per unit area of territories in the republic. The volume of emissions of pollutants in the atmosphere in the territory of the area for 2011 - 2016 on average is 226 kg/year on one inhabitant (On the state…,2017).

The agroecological inspection of soils and plants which is carried out by us on personal plots, which are in differend distances from pollution sources, to the period from 2015 to 2016 (page. Roshchinsky, of Buguruslanovk, of Maksyutovo) hasn't revealed excesses of maximum allowable concentration on any elements (Zubkova et al, 2017).

Assessment of level of pollution of the soil as an indicator of an adverse effect on health of the population in the TM mobile forms indicates excess of their concentration in comparison with background values by 1,1 – 16,6 times (Zubkova et al, 2017).

It should be noted that on all sites excesses of background values on Cr are noted (on the first site it is the greatest – by 1,9 times). In this connection we have calculated a cancerogenic risk at intake of chrome orally. For calculation and assessment of the risk caused by cancerogenic chronic influence of chrome at oral receipt its average concentration (mobile and gross forms) in the soil selected in the territory of the Sterlitamak district of the Republic of Bashkortostan are used.

As calculations of individual cancerogenic risk at an oral route of intake of chrome with the soil, have shown it corresponds to a maximum permissible risk, that is the upper limit of an acceptable risk (an individual risk during all life more than 1·10-6, but less than 1·10-4). These levels are subject to constant control, in certain cases at such risk levels events for their decrease (tab. 1) can be held.

Table 1 – The individual risk to the population connected with the pollution of soils with chrome.

Forms	1	2	3
Mobile	1,54652E-08	1,961E-08	1,65699E-08
Gross	3,73562E-06	2,815E-06	3,03855E-06
Total	3,75108E-06	2,835E-06	3,05512E-06
Range	2	2	2

Source: Author

Values of cancerogenic risks reflect, mainly, the long-term tendency to change of an oncological background which is formed on condition of observance of all initial conditions accepted by the researcher (for example, a certain duration and intensity of influence, the invariance of an exposition in time, concrete values of factors of an exposition, etc.) (Jayarathne et al, 2018).

Assessment by us of microelement structure of vegetable production has shown that the individual cancerogenic risk at an oral route of receipt with food of such heavy metals as cadmium and lead corresponds to maximum permissible risk (tab. 2).

Table 2 – The individual risk to the population connected with the pollution of food with heavy metals.

Metals	Cd	Pb	Cr
Individual risk	4,18E-05	2,99E-05	7,67E-04
Range	2	2	3

Source: Author

And risk assessment to the population in connection with intake of chrome from vegetables indicates the unacceptable level of danger to the population in general (risk level more than 1·10-4, but less than 1·10-3) and demands development and taking the planned improving actions which are based on results of profound assessment of various aspects of the existing problems and also establishment of the degree of their priority in relation to other hygienic, environmental, social and economic problems in the estimated territory (Motuzova, Karpova, 2013).

One of the indicators reflecting interaction with the environment is the demographic characteristic of health of the population (Karamova et al, 2017).

In general, in all years of the last decade in the Sterlitamak district mortality exceeded birth rate, in the city of Sterlitamak this tendency has begun to be shown in the last 2 years (tab. 3).

Table 3 Indicators of the natural movement of the population of the Sterlitamak district and city of Sterlitamak of the Republic of Bashkortostan, %.

Years	Sterlitamak district			City of Sterlitamak		
2011	11,6	13,6	- 2	14,7	11,6	3,1
2012	12,8	13,2	- 0,4	15,2	11,4	3,8
2013	10,7	12,5	- 1,8	15,1	11,7	3,4
2014	10,5	13,3	- 2,8	15,1	11,7	3,4
2015	10,4	12,3	- 1,9	15,5	11,8	3,7
2016	11,0	12,1	- 1,1	14,3	11,3	3,0
2017	11,1	13,4	- 2,3	10,4	10,6	-0,2
2018	13,2	13,7	- 0,5	11,0	11,2	-0,2

Source: Author

The integrated indicator reflecting both an ecological situation, and quality of the provided medical care in the concrete region is infantile mortality. According to the last, available in literature data the level of infantile mortality in Bashkiria for the first half of 2017 has grown by record 8,4%. At the same time according to official figures, infantile mortality in Russia has reached a historical minimum. For the first half of the year 2017 this indicator was reduced by 13,1%. If in the first half of the year 2016 6,1 died newborns were the share of 1000 Russians, then in 2017 for the first half a year this number has fallen to 5,3. Such growth of infantile mortality in Bashkiria means that 7,2 died babies are the share of 1000 inhabitants (Waseem et al,2014).

The special alarm in the Republic is caused by rapid growth of number of the dead from new growths. So during the period from 2010 to 2017 the number of the dead from new growths has increased from 5889 to 7355 people a year, having reached 180,9 persons on 100 thousand of the population.

5. CONCLUSIONS OR DISCUSSION AND IMPLICATION

Settlements in which the enterprises of petrochemical and chemical industry, as a rule, are located represent the large cities where the tenor of life, social and socio-economic factors are different from other settlements.

The ecological situation in them is formed by the large volume of emissions of pollutants from industrial productions, vehicles, powerful heat and power plants, household and industrial wastes.

The current state of the environment in industrially developed regions and the cities is characterized by considerable technogenic loading. At a complex of harmful substances there are substances of 1-2 classes of danger possessing allergic, cancerogenic, embriotoksichesky action on a live organism. The city of Sterlitamak on the IZA level, reaching in separate years 12 is included into the list of the most polluted cities of Russia.

And one of the most widespread types of technogenic changes of natural objects and factors is environmental pollution by heavy metals. The danger of heavy metals to the environment and health of the person is caused by the fact that they have ability to collect in an organism, to interfere with a metabolic cycle; to change the chemical form upon transition from one environment to another quickly, without being exposed to biochemical decomposition and also to enter numerous chemical reactions with each other and biologically important nonmetals. In certain cases, heavy metals can be the leading hygienic factor defining the character and the direction of the development of biogeocenoses (Song et al, 2017).

Therefore, the actions reducing ecological tension in trophic chains are necessary. First of all, selection of plants, either least accumulating the toxic elements or which, on the contrary, are hyper accumulants (Khanipova, Zubkova,2017) is recommended.

The state of environment of industrial cities form the peculiarities of the state of health of the population. In this regard development of the concept of the ecological safety directed to elimination of the obvious and potential danger to health of the person connected with pollution of the habitat is becoming especially urgent special and is among priorities of sustainable social economic development of the country (Coman et al, 2015).

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ORIGINAL RESEARCH PAPER

ENVIRONMENTAL AND EPIDEMIOLOGICAL FEATURES OF TUBERCULOSIS

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ABSTRACT

The studies are devoted to the ecological and epidemiological features of tuberculosis in Troitsk and Troitsk District of Chelyabinsk Region, located in the area of atmospheric emissions of PC WGC-2 Troitskaya Hydroelectric Power Station. The objects of the study were air samples for which the API (atmospheric pollution index) and CAPI (complex atmospheric pollution index) values were calculated according to the concentration of nitric oxide (IV), sulfur oxide (IV), carbon oxide (II), suspended solids, benz(a)pyrene and cadmium compounds; statistical reports of State-Funded Budgetary Public Health Facility "Regional Tuberculosis Hospital No. 13" during 2015-2017 (Troitsk, Chelyabinsk Region, Russia). For mathematical processing of the research results, the computer programs "Microsoft Excel-2003" and Statistica were used. It is established that the industrial zone of Troitsk and the impact zone of Troitsk District belong to areas with very high levels of pollution (CAPI = 15.81 and CAPI = 14.97); the residential zone of the city and the buffer zone of the district are areas with high levels of pollution (CAPI = 8.87 and CAPI = 8.37). This fact causes the excess of indicators if compared with the regional average values, such as the incidence of tuberculosis, the prevalence of tuberculosis, including bacterial excretion, death rate due to tuberculosis, the rate of relapses, and a decrease in the level of clinical cure. The obtained results determine the need for further studying the air pollution effect on the epidemiological features of tuberculosis in combination with HIV infection.

JEL classification: I10, Q19

Keywords: *air pollution, tuberculosis, HIV infection, epidemiology*

1. INTRODUCTION

Social and environmental conditions of life determine the level of population health, both in Russia and abroad. According to the World Health Organization, due to adverse environmental factors 25-35% of people have various deviations in health (Geger, 2008). Therefore, the problem of assessing the correlation of human health with the environment state is urgent today. One of the most important social problems of our time is tuberculosis, which causes enormous economic and biological damage to humans (Mamaev, 2005; Rieder, 2002). Although environmental factors have not been considered for a long time when considering the epidemiological situation of tuberculosis, in recent years their influence on this pathology has been proved. The level of environmental pollution and the degree of the total impact of a complex of environmental factors, including anthropogenic, determine the population's incidence of tuberculosis as a result of the interacting social and natural environment of humans (Akuginova, 2003; Mamaev, 2005; Mironova, 2011; Perova, etc., 2013; Zhu et al., 2018). Therefore, the study of epidemiological tuberculosis characteristics in connection with environmental factors is the basis for predicting the population's incidence, which makes it possible to develop measures to ensure favorable sanitary living conditions, as well as to increase the effectiveness of preventive and therapeutic measures. At the same time, a few works are devoted to this problem to actualize the topic of research.

2. LITERATURE REWIEW

Tuberculosis is a disease, with its epidemiological situation being determined not only by a combination of social factors, but also by the environment conditions (Kirillova et al., 2012; Ifedayo et al., 2017). The incidence rate of tuberculosis at the local level reflects the comfort of living conditions of the population, including natural and socio-economic components (Gakayev, 2016). It has been proved that anthropogenic pollution is a collective risk factor affecting the entire population of a man-made province (Pletneva, 2003).

Atmospheric air and toxic substances in it are of the greatest importance for the epidemiology of tuberculosis. Industrial territories characterized by high levels of environmental pollution are also distinguished by a higher incidence of tuberculosis among the population (Gakayev, 2016; Jessica L. Elf et al., 2017). Air quality directly affects the state of human lungs, as they have constant contact with toxic substances, and determines their susceptibility to pathological factors. Therefore, the air pollution index correlates with incidence rates of destructive forms and death rates due to tuberculosis (Mironova, 2011). Similar conclusions were drawn by Pletneva (2003), noting the existing relationship between various epidemiological indicators and the level of air toxicants, such as sulfur oxide (IV), hydrogen sulfide and aromatic hydrocarbons.

The incidence of tuberculosis is affected not only by the concentration of toxic substances in ambient air, but also by the size of xenobiotic particles (Zhu et al., 2018). So, when exposed to particles with a diameter of less than 10 microns, the tendency to tuberculosis increases, especially in the case of excessive levels of nitrogen oxide (IV), sulfur oxide (IV), ozone and suspended solids (Smith et al., 2016; Jamaati et al., 2018). At the same time, pathology appears more often in men than in women and middle-aged adults than older people (Ge et al., 2017).

The incidence of tuberculosis among the population is also associated with residential air pollution. The main source of toxicants is the process of burning various types of fuels and smoking (Lin et al., 2007; Sumpter et al., 2013; Jessica L. Elf et al., 2017; Ifedayo et al., 2017).

Consequently, the presence of pollutants in the atmospheric air, the source of them being industrial enterprises, initiates in humans the anti-infection barrier reduction, especially in the lungs, favoring the introduction of mycobacterium tuberculosis. In addition, pollutants directly or indirectly inhibit the rate of exchange reactions, reduce the level of specific resistance, contributing to the development of pathology (Martsev et al., 2014). Therefore, the residence of people in the zone of industrial emissions contributes to increasing incidence of tuberculosis.

In addition to tuberculosis, one of the global problems of the present time is HIV infection. On the one hand, tuberculosis is the main cause for the death of HIV-infected people, on the other hand, HIV is a biotic factor contributing to increasing incidence and prevalence rate of tuberculosis (Darisheva et al., 2014). The features of the immunodeficiency pathogenesis contribute to the development of mycobacteria in the human body (Cowley, 2001; Kouassi et al., 2004). This creates a vicious cycle that ultimately leads to death. This problem is especially acute in developing countries, where people seropositive for HIV infection almost always suffer from tuberculosis (Harries, 1990).

The analysis of literary sources makes it possible to draw the conclusion that the effect of atmospheric air quality on the incidence of tuberculosis has been proved due to vehicles, heavy industry enterprises, and mining enterprises. However, the epidemiological features of tuberculosis are poorly studied under the conditions of thermal power plants.

3. METHODOLOGY

The study was approved by the Committee on Bioethics of South Ural State Agrarian University to be based on the use of existing reported data of the regional health care not requiring the consent of patients and direct contact with patients. The objects of the study were air samples and statistical reports of State-Funded Budgetary Public Health Facility “Regional Tuberculosis Hospital No. 13” during 2015-2017 (Troitsk, Russia).

Chelyabinsk Region is an industrial region and ranks third in Russia in terms of emissions of pollutants into the atmosphere from stationary sources. The most polluted is the atmospheric air in the industrial centers of the region, Troitsk also belonging to them (MPE excess is 58%) (Comprehensive report on the environmental conditions). In Troitsk and Troitsk District, located in the southern part of Chelyabinsk region bordering with Kazakhstan, the environmental conditions are determined by emissions of PC WGC-2 Troitskaya Hydroelectric Power Station, Public Corporation “Electromechanical Plant”, Public Corporation “Diesel Plant”; Public Corporation “Mineral-Cotton Plates Plant”, etc. At the same time, the main anthropogenic pollutant is PC WGC-2 Troitskaya Hydroelectric Power Station. For Troitsk, the proximity of the main industrial enterprises to the residential area is specific, which causes the population’s exposure to the effects of industrial emissions. To obtain information on the degree of air pollution for the Troitsk territory, we chose two zones: I – industrial, where the power station is located; II – residential (the capital residential buildings, mainly of average height (3-5 floors), the private sector, accounting for about 50-60% in the housing stock).

Troitsk is the administrative center of Troitsk Municipal District, its area is 3,958.67 km^2. According to its main stationary pollutant (PC WGC-2 Troitskaya Hydroelectric Power Station), three zones were identified on the territory: I – impact, exposed to the greatest man-made pressure (rural settlement Bobrovka), II – buffer, characterized by the highest dispersion of atmospheric emissions (rural settlement Morozkino), III – background, clean-polluted (rural settlement Yasnyiye Polyany).

Air sampling was carried out according to GOST 17.2.3.01-86 Nature Conservation. Atmosphere. Rules of air quality control of settlements. In the selected air samples, the concentrations of nitric oxide (IV) (NO_2), sulfur oxide (IV) (SO_2), carbon monoxide (II) (CO) were determined using the pump of the NP-3M sampler and a set of indicator tubes (Russia), the gravimetric method was used for suspended solids, Fluorat-02 fluid analyzer (Russia) was used for benz(a)pyrene and the spectroscale MAX GVM (Russia) was used for cadmium compounds (Cd).

According to the results of the studies, the API (atmospheric pollution index) and CAPI (complex atmospheric pollution index) were found according to the formulas:

$$\mathrm{API} = \left(\frac{C_i}{\mathrm{MPCd.a}}\right)^{N_i}$$

and

$$\mathrm{CAPI} = \sum \left(\frac{C_i}{\mathrm{MPCd.a}}\right)^{N_i}$$

, where C_i is the actual concentration of the pollutant, mg/m^3; $MPC_{d.a.}$ is maximum permissible daily average concentration of pollutant, mg/m^3; N_i is a constant depending on the hazard class of the pollutant.

For the mathematical processing of the research results the computer program “Microsoft Excel-2003” and Statistica program for the correlation analysis were used. To determine the level of significance of indicators Mann-Whitney U-test was used.

4. EMPIRICAL FINDINGS

For integrated assessment of the degree of atmospheric pollution, two indicators were used the API for each substance and the CAPI to consider the air pollution as the sum of substances. The analysis of the air composition showed that in Troitsk the air is the most polluted in the industrial zone, and in Troitsk district – in the impact zone (rural settlement Bobrovka), located near of the source of pollution (Table 1). For all controlled substances, the API was higher than one, except for cadmium.

Table 1. The API and CAPI values during 2015-2017

Indicator	$MPC_{d.a.}$	Hazard class	Troitsk		Troitsk District		
			Studied zones				
			Industrial	Residential	Impact (Bobrovka)	Buffer (Morozkino)	Background (Yasnyiye Polyany)
Suspended solids	0.15	3	2.88± 0.09	1.45± 0.03	2.13± 0.07	1.40± 0.04	0.67± 0.009
CO	0.05	4	4.10± 0.17	2.84± 0.09	4.71± 0.18	2.69± 0.10	0.63± 0.01
NO_2	0.04	2	3.72± 0.12	1.69± 0.04	2.69± 0.07	1.69± 0.02	0.14± 0.002
SO_2	0.05	3	1.40± 0.04	1.00± 0.01	1.80± 0.03	0.60± 0.01	0.20± 0.008
Benz(a)pyrene	0.01	1	2.71± 0.10	1.56± 0.04	2.97± 0.11	1.99± 0.03	0.68± 0.016
Cadmium	0.0003	1	1.00± 0.007	0.33± 0.011	0.67± 0.01	-	-
CAPI			15.81± 0.38	8.87± 0.26	14.97± 0.58	8.37± 0.31	2.32± 0.06

Source: Author

In the atmospheric air of Troitsk residential zone, the API highest values were recorded for CO, suspended solids and NO_2, amounting to 2.84 ± 0.09; 1.45 ± 0.03 and 1.69 ± 0.04, respectively. A similar tendency is also characteristic of the buffer zone of Troitsk District (rural settlement Morozkino), where the API for the analyzed substances were: 1.40 ± 0.04 (suspended solids); 2.69 ± 0.10 (CO); 1.69 ± 0.02 (NO_2); 0.60 ± 0.01 (SO_2) and 1.99 ± 0.03 (benz(a)pyrene). The variability of the API values in the zones of the city and rural areas determined the CAPI values, which in Troitsk industrial zone and the impact region of Troitsk Disrtct were 15.81 ± 0.38 and 14.97 ± 0.58, respectively; and in the residential and buffer zones – 8.87 ± 0.26 and 8.37 ± 0.31.

The analysis of the reported medical documentation showed that the incidence of tuberculosis in Troitsk during the 3-year observation period had a positive tendency to decrease (Table 2) and was less than the regional average values. In Troitsk District, on the contrary, the opposite tendency was observed. The indicator systematically increased, exceeding the city level during 2015-2017 by 13.1%, and the region level by 9.4%.

Table 2. Epidemiological indicators (cases per 100 thousand population)

Indicator	Study site	2015	2016	2017	2015 - 2017
Incidence of tuberculosis	Troitsk	62.0	49.6	53.2	54.60±3.77
	Troitsk District	64.8	65.9	75.5	68.73±3.39*[1]
	Average for the region	63.8	58.3	53.6	58.57±2.94
Prevalence of tuberculosis	Troitsk	172.7	146.4	180.8	166.63±10.38
	Troitsk District	247.7	238.1	240.9	242.23±2.85*[1]*[2]
	Average for the region	135.5	135.3	127.6	132.80±2.60*[1]
Prevalence of tuberculosis with bacterial excretion	Troitsk	87.6	68.6	75.8	77.33±5.54
	Troitsk District	111.4	118.1	136.0	121.83±7.34*[1]*[2]
	Average	54.0	52.7	50.5	52.40±1.02*[1]

Indicator	Study site	2015	2016	2017	2015 - 2017
	for the region				
Death due to tuberculosis	Troitsk	17.0	14.5	16.0	15.83±0.72
	Troitsk District	34.3	11.5	11.7	19.17±7.56
	Average for the region	15.5	9.8	10.0	11.86±1.96
Clinical cure for tuberculosis	Troitsk	28.6	27.2	21.1	25.63±2.30
	Troitsk District	15.9	31.5	24.2	23.86±4.50
	Average for the region	29.9	25.5	28.7	28.03±1.31
Tuberculosis relapses	Troitsk	10.5	13.2	14.6	12.76±1.20
	Troitsk District	11.4	19.2	23.3	17.96±3.49
	Average for the region	7.8	8.6	10.2	8.86±0.70*[1]
Registered for the first time in life due to tuberculosis diagnosing combined with HIV infection, %	Troitsk	23.4	24.1	25.2	24.23±0.52
	Troitsk District	12.3	13.8	14.5	13.53±0.65*[1]*[2]
	Average for the region	30.9	31.1	32.4	31.46±0.47*[1]
Patient population suffering from tuberculosis combined with HIV infection, %	Troitsk	11.2	14.5	17.0	14.25±0.54
	Troitsk District	8.9	9.8	10.2	9.65±0.38*[1]*[2]
	Average for the region	20.1	23.2	25.5	22.93±1.56*[1]

Note: *[1] - $p<0.05$ between Troitsk and Troitsk District, average for the region values; *[2]- $p<0.05$ between Troitsk District and average for the region values

Source: Author

The prevalence of tuberculosis in the city during all the studied years was less than in Troitsk District. At the same time, it exceeded the regional average values, respectively, by 75.6 and 109.4 cases per 100 thousand population. A similar dependence was found in relation to the indicator “Prevalence of tuberculosis with bacterial excretion” (Table 2). The higher level of incidence and prevalence of tuberculosis in Troitsk and Troitsk District reflected in the death value, clinical cure for tuberculosis, and the occurrence of relapses. The value of these epidemiological indicators, firstly, exceeded the average oblast, and secondly, in rural areas was significantly higher than in the city.

The level of infection with the immunodeficiency virus affects the epidemic process of tuberculosis. So, during 2015-2017 on average in Chelyabinsk Region, among those registered for the first time due to tuberculosis diagnosing, pathology was combined with HIV infection in 31.46 ± 0.47% of cases (Table 2). In Troitsk and Troitsk District, this indicator was 1.29 ($p<0.05$) and 2.33 ($p<0.05$) less than in Chelyabinsk Region, respectively. A similar dependence was also detected among the patient population suffering from tuberculosis combined with HIV infection.

To assess the relationship between air quality and epidemiological indicators for tuberculosis, a correlation analysis was performed, with average values for the 3-year period being used. Direct positive correlations were revealed in the following pairs of indicators: the indicator “Prevalence of tuberculosis” – the API of carbon monoxide (II), the indicator “Incidence of tuberculosis” – the API of carbon monoxide (II). These correlations were found in the industrial and residential areas of Troitsk, the impact and buffer zones of Troitsk District. The values of the correlation coefficients fluctuated at the level of $r=0.78$-0.81 ($p<0.05$).

5. CONCLUSION

On the territory of Troitsk and Troitsk District, the main source of air pollution is PC WGC-2 Troitskaya Hydroelectric Power Station, which is due to Ekibastuz coal used as a fuel with 40.0-43.0% ash and 6.0-9.0% moisture, insufficient cleaning of smoke emissions. Therefore, the air in the industrial and residential zones of the city, in the impact and buffer zones of Troitsk District, is characterized by the API values higher than one for the main "classical pollutants": suspended solids, CO, NO_2, SO_2 and benz(a)pyrene, most of them having irritant effects and negatively affect the human respiratory system, increasing the population susceptibility to infection with mycobacteria (Ghanbarian et al., 2018; Zielinski et al., 2018].

Although in Chelyabinsk Region there is a decrease in the main epidemiological tuberculosis indicators, but in Troitsk and Troitsk District, on the contrary, their systematic growth is noted, which is reflected both in the level of clinical cure and occurring relapses. At the same time, the epidemiological indicators in rural areas are significantly higher than in urban areas. Consequently, the environmental impact of the stationary pollutant – PC WGC-2 Troitskaya Hydroelectric Power Station causes the tense environmental situation for the territories located in the area of atmospheric emissions of the enterprise, increasing the people's propensity to become infected with mycobacteria (Fernandes et al., 2017). The main reason is decreasing human adaptive abilities under the conditions of constantly exposing chemical pollutants due to fuel combustion (Jessica et al., 2017). It is possible that tuberculosis in the bodies of the most sensitive people is the result of "the effects of the immediate action of toxicants", with inhalation of polluted atmospheric air with fine particles with a diameter of less than 2.5 microns being the most dangerous (Robert et al., 2017).

Due to the synergistic linkages between tuberculosis and HIV infection, the risk for tuberculosis for HIV-infected people is high (Jessica et al., 2017; Fernandes et al., 2017). Our studies are in keeping with this conclusion, as under the conditions of Troitsk, Troitsk District and Chelyabinsk Region among those registered for the first time in their lives due to tuberculosis diagnosing and the patient population suffering from tuberculosis, a systematic increase in the combination of pathology with HIV infection is observed.

The presence of positive correlations between the incidence of tuberculosis, the prevalence of tuberculosis and the API value of carbon monoxide (II) prove the influence of the air quality on the epidemiology of tuberculosis. Therefore, this toxicant is a releaser initiating an imbalance for human natural resistance, increasing the risk of the incidence of tuberculosis and reducing the effectiveness of its treatment.

The results of our research allowed us to draw the following conclusions:

1. The environmental stress of Troitsk and Troitsk District is due to the technogenic impact of the city-forming enterprise PC WGC-2 Troitskaya Hydroelectric Power Station. Due to the atmospheric emissions of the enterprise, the industrial zone of Troitsk and the impact zone of Troitsk District belong to areas with very high levels of pollution (CAPI = 15.81 and CAPI = 14.97); the residential zone of the city and the buffer zone of the district belong to areas with high levels of pollution (CAPI = 8.87 and CAPI = 8.37).

2. The high level of air pollution in the industrial and residential zones of the city, the impact and buffer zones of Troitsk District causes increasing incidence, prevalence, including bacterial excretion, death rate, relapses and lower clinical cure, compared with the values average for the region.

3. In Troitsk District, in comparison with the city, there is a higher level of epidemiological indicators of tuberculosis with a uniform level of air pollution indicating the social differences between the city and the rural area.

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ORIGINAL RESEARCH PAPERS

PROBLEMS AND METHODS OF ECOLOGICAL SAFE POULTRY MEAT PRODUCTION

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ABSTRACT

Our research is devoted to the study of problems and ways of producing ecologically safe broiler meat under conditions of technogenic agroecosphere. The work was carried out based on a typical Ural farm (Chelyabinsk region, Russia); the work was consisted of two stages. The content of chemical elements in soil, water and feed samples was determined at the first stage; a method of reducing toxic elements in poultry meat was tested at the second stage. The broiler chickens of the "Smena 2" crossbreed was formed in 4 groups. The 1st group was the control group; the 2nd, 3rd and 4th (the experimental groups) received the basic ration of a biologically active complex of lucerne extract at a dose of 15, 30 and 60 mg per one kg of body weight, respectively, beginning from the 5th day of age. It was established that the content of cobalt, nickel and lead in the samples of soil, water and feed is in the upper limits of the standard values. The active complex of plant origin in the studied doses contributes to the removal of toxic elements from the broiler muscle tissue: lead was reduced by 1.23-1.86% and nickel - by 10.8-12.4%. The research results determine the possibility of testing a biologically active complex of plant origin to reduce the level of toxic elements of meat products obtained from other farm animals.

JEL classification: *Q13, Q18*

Keywords: *ecological safety, biologically active complex of plant origin, growth, broiler meat, heavy metals*

1. INTRODUCTION

One of the most important state priorities of Russia and the EU is to ensure reliable food security of the country, the goal of which is the health and welfare of the nation, economic and political independence, as well as the formation of the principles of social responsibility and environmental thinking (Rebezov M.B., 2017). The main factor of economic success is the eco-friendly production, which is achieved through the transition to the new international ISO14000 environmental management standards, as well as the rejection of the use of antibiotics as feed additives in the poultry industry (European Probiotic Association, 2013; Hattak F., 2013; Ushakov A.S., 2018). One of the achievements of world scientific and technological progress in recent decades is the study of feed additives of plant origin in the diets of birds that represent an alternative of the antimicrobial drugs (Topuriya G. M., 2016). There is evidence in the literature that feed additives of plant origin have immune-stimulating activity (A lHajj M.S., 2015; Loretts O.G., 2018), antibacterial effects (Wu S., 2018; Kiczorowska B., 2017), antioxidant effects (Ghiberti G., 2018; Ognik K., 2015), growth-promoting effects (Topuriya G. M., 2016; Hattak F., 2013), they can normalize the metabolism (Symeon, G., 2014; Santi Devi Upadhayas, 2017), stimulate the digestion (Jakobsen, M., 2015) and increase the productivity of chickens (Hattak F., 2013; Banzkiewicz T., 2018). This updates the research on the evaluation of the effectiveness of the use of feed additives of plant origin to reduce the level of toxic elements in poultry meat, increasing the environmental safety of poultry products.

2. THEORY

The Chelyabinsk Region is an industrial region of Russia, in which the anthropogenic stress from metallurgical, mining, energy etc. enterprises are superimposed on the geochemical background. The problem of pollution of environmental objects with heavy metals is critical, which determines the need for continuous monitoring of the level of toxic sub stances in environmental objects (Samsonova T.S., 2017; Skripnik A.L., 2018).

Present industrial poultry farming is one of the high-tech industries with high development dynamics (FisininV.I., 2018). Improving the efficiency of the poultry industry requires organizing full-fledged feeding and management of poultry under the conditions of technogenesis, ensuring the maximum full realization of the bird's genetic potential and as a result, obtaining environmentally friendly poultry products (Zabashta N. N., 2016; Nikonov I., 2018; Ovseychik E.A., 2018). In this regard, one of the solutions is to use effective and safe products of plant origin, capable of complete biodegradation to natural products of the biotope, not causing bacterial resistance and side effects in animals (FisininV.I., 2018; FisininV.I., Ushakov A.S., 2018; Loretts O.G., 2018).

A biologically active complex of plant origin, obtained from lucerne extract, has a great prospect of use in animal husbandry and poultry farming. The hydro-baro-thermal processing of the rough part of the plant, during the destruction of the lignin-carbohydrate complex, hydrolysis of the plant tissue occurs with the formation of mono- and disaccharides: glucose, sucrose, fructose, etc. As a result, soluble ash substances, part of proteins and other nitrogenous substances, such as pectin, pass into the aqueous extract. The organic part of the extract includes amino acids, including essential (valine, isoleucine, leucine, lysine, methionine, threonine, phenylalanine), uronic acids, monosaccharaides, organic acids, humic substances, chlorophyll, tocopherol (Krakowska A., 2017; Sosnowski J., Jankowski K., 2014). In the lipid fraction of plant cell membranes there are ubiquinones, phenolic compounds and flavonoids. The complex contains minerals: iron, copper, cobalt, zinc and titanium. This complex is referred to chelating complexes of transition metals with polydentate ligands of plant extracts (Loretts O.G., 2018).

In those provinces where there is a deficiency of mineral elements in the soil, their deficiency in the body is noted as well, which leads to a decrease of the immune resistance and productivity (Fisinin V.I., Miroshnikov S.A., 2018; Bykova O.A., 2018; Gumenyuk O. A., 2018). The need for mineral substances is especially high in the poultry that is kept indoors (Loretts O.G., 2018). Therefore, it is necessary to study the effect of feed additives of plant origin on the quality and safety of the poultry products (Lukashenko V.S., 2018).

Analysis of the literature has led to the conclusion that one of the modern ways of obtaining environmentally safe products to preserve the health of the nation is the use of natural dietary supplements. Especially this issue is relevant of the production in the conditions of anthropogenic agro-ecosystems.

3. RESEARCH METHODOLOGY

The studies were performed in years 2006-2018 based on a typical Ural farm (Chelyabinsk region, Russia), which produces animal feed, cultivates farm animals (poultry, pig, cattle) and sales the final products. The studies were conducted in order to determine the content of toxic chemical elements in soil, water and feed, as the first stage of work. The sampling from the arable horizon (0-30 cm) was carried out in accordance with GOST 28168-89; water samples were selected according to GOST 31862-2012, feed samples – in accordance with ISO 6497-2011, followed by spectrophotometric determination.

In order to study the problems and ways of obtaining ecologically safe meat of broiler chickens, considering the ecological characteristics, uniformity of technology for keeping and feeding broilers, their crossbreed, scientific and economic experience was conducted at the second stage of research.

The conditions of the birds were identical and complied with zoo hygienic standards. Feeding was carried out in accordance with the norms of Russian Research and Technological Institute of Poultry of the Russian Academy of Sciences. Four groups of broilers of the “Smena 2” crossbreed were formed: the chickens of the control group received the basic diet; the 1st experimental group received a biologically active herbal complex during the entire period in a dose of 15 mg per kg of body weight, the2nd group received 30 mg per kg of body weight, the 3rd group – 60 mg per kg of body weight.

At the end of the experiment, at the age of 42 days, 6 broilers from each group were slaughtered, followed by anatomical cutting, assessment of broiler meat productivity and determination of the chemical composition of meat. The chemical composition and ecological purity of the products were evaluated according to the results of the study of meat and internal organs, and the content of iron, cobalt, manganese, zinc, lead and nickel was evaluated. The content of toxic elements was determined on an atomic adsorption spectrometer (Kvant-2A, Russia) in the laboratory of the South Ural State Agrarian University.

Digital material was processed by a biometric method of variation statistics using programs of Microsoft Excel 2003, the accuracy of deviations of each value from the average was calculated with a probability of 95% ($p < 0.05$).

4. THE RESULTS

Analysis of the elemental composition of the soil at the sampling points showed that the content of such chemical elements as cobalt, nickel and lead was within the upper limits of the normative values; iron concentration exceeded the average value in Russia by 1.80 times. The content of toxic chemical elements in water samples did not exceed the limits of the TLV.

Table 1. The content of chemical elements in the blood of broilers, µmol/l ($\overline{X} \pm S\bar{x}$; n=10)

Element	Reference value	Group			
		control	1st experimental	2nd experimental	3rd experimental
Fe	4475.0	7100.24 41.98	4719.51 50.86	4720.69 46.78	4720.92 45.83
Cu	13.34	6.72 1.68	11.13 1.27*	11.13 1.27*	11.13 1.27*
Zn	106.5	34.81 2.40	51.53 4.28*	52.39 5.16**	52.40 4.41*
Co	0.85	0.10 0.12	0.69 0.12*	0.79 0.11**	0.83 0.11***
Pb	0.74	0.89 0.08	0.39 0.10**	0.22 0.04***	0.18 0.09***
Mn	3.70	2.38 0.15	2.56 0.24	2.60 0.13	2.66 0.17
Ni	1.703	2.26 0.15	0.98 0.24**	0.62 0.26***	0.50 0.21***

*- p< 0.1; ** - p < 0.05; *** - p < 0.001

Source: Author

The zinc content in the feed exceeded the maximum permissible concentration by 2.6 times, and the concentration of toxic elements such as nickel, cadmium and lead were within the upper limits. It was established that some chemical elements, which enter the gastrointestinal tract with the feed, can be eliminated from the body, but others can be accumulating in a certain amount, which leads to toxicosis and decreased productivity.

Studies have shown that the iron content exceeds the reference values by 1.59 times, lead – by 20.27% and nickel –32.94% in the blood of broilers of the control group. On the background of high concentrations of toxic elements, the concentration of biogenic elements of copper, zinc, cobalt is below the reference values by 1.98; 3.06 and 8.5 times, respectively. It should be noted that with a high concentration of cobalt in the feed, its content in the blood of broilers is 0.20 0.12 µmol/l. Probably, cobalt in the feed is contained in a difficult digestion form, or it has an antagonist relationship with other chemical elements in the gastrointestinal tract of animals.

Table 2. The content of chemical elements in the liver and muscle tissue of broilers, µmol/kg ($\bar{X} \pm S\bar{x}$; n=6)

Group	Chemical element						
	Fe	Cu	Zn	Co	Mn	Pb	Ni
Liver							
Control	1342.05 155.74	154.96 18.16	409.66 77.54	2.06 0.72	48.84 6.84	2.70 0.25	7.76 1.60
1st experimental	755.26 100.12**	226.13 19.52*	607.58 71.67	6.93 0.79**	86.00 10.85*	1.20 0.28*	3.54 0.39
2nd experimental	780.56 128.71*	212.84 14.37*	612.89 91.58	7.07 0.85**	87.00 11.35*	1.12 0.08**	3.17 0.39
3rd experimental	824.65 27.35*	220.79 13.12*	623.96 68.39	7.19 0.45**	108.23 12.71**	1.01 0.07***	3.08 0.29
Reference value	895.0	314.0	1530.0	25.45	91.0	2.9	8.5
Muscle tissue							
Control	349.35 28.75	64.29 3.66	226.46 7.57	1.01 0.13	15.14 1.60	2.07 0.13	0.87 0.21
1st experimental	135.35 23.94	59.21 5.60	150.22 11.36	0.98 0.02	12.34 2.39	1.68 0.48	0.09 0.002*
2nd experimental	165.31 17.33	61.46 8.94	159.68 13.51	1.00 0.03	12.83 1.92	1.24 0.17*	0.07 0.003**
3rd experimental	167.66 25.26	62.56 7.08	160.47 19.36	0.99 0.02	13.07 2.19	1.11 0.19**	0.07 0.02**
Reference value	895	78.5	1071.0	1.01	10.9	2.4	1.7

*- $p < 0.1$; ** - $p < 0.05$; *** - $p < 0.001$

Source: Author

A decrease in the content of toxic elements below the reference values and an increase in the concentration of essential elements – zinc, copper, and cobalt on average by 1.48; 1.66 and 7.6 times, respectively, were found in the broilers that received the biologically active complex. The safety of raw materials is important in providing quality products of animal origin for population (Rebezov M.B., 2014). We carried out a chemical analysis of the internal organs and muscles for the presence of chemical elements in them; the data are presented in Table 2.

There was a redistribution of chemical elements in the liver, kidneys and muscle tissue on the background of the use of a biologically active complex of plant origin. The amount of iron in the liver of chickens of the control group exceeded the value of the reference value by 49.95%. In the experimental groups, the amount of iron in the liver is lower than in the control group: in the 1st group – by 77.69% (p 0.01), in 2nd – by 71.93%, in 3rd – by 62.74% (p 0.05). With an increase in the dose of the herbal complex in the diet of broilers, the concentration of iron in the liver increases, but does not exceed the reference value. The copper content in the liver of broilers of the 1st, 2nd and 3rd experimental groups exceeds the values of the control group by 45.93%, 37.35% and 42.48% (p 0.05), respectively. The concentration of zinc in the liver of broilers of the 1st, 2nd and 3rd experimental groups increases by 48.51%, 49.61% and 52.31%, respectively, in comparison with the control group, but it is 2.4-2.5 times lower than the reference value. With an increase in the dose of the biologically active complex, the content of cobalt and manganese in the broiler liver of the experimental groups increases. So, the content of cobalt of the 1st, 2nd and 3rd experimental groups is higher by 3.3, 3.4 (p 0.01) and 3.5 times (p 0.001), respectively, in comparison with the control group; and manganese – by 1.8, 1.9 (p 0.05), 2.2 times (p 0.01), respectively. When the content of the essential elements in the liver of experimental broilers is increasing, the content of the toxic elements is decreasing. The amount of lead in broilers of the 1st, 2nd and 3rd experimental groups decreased by 2.25 (p 0.05), 2.4 (p 0.01) and 2.7 times (p 0.001), respectively; and nickel – by 2.2 (p 0.05), 2.4 (p 0.01) and 2.5 times (p 0.01), respectively.

Analysis of the microelement composition of the muscle tissue found that the content of toxic elements in the muscle tissue of broilers of the 1st, 2nd and 3rd experimental groups is reduced under the influence of different doses of the biologically active complex. Thus, the lead concentration decreased by 1.23 (p 0.05), 1.68 (p 0.05) and 1.86 times (p 0.01), respectively; and nickel – by 10.8 (p 0.01) and 12.4 times (p 0.01), respectively, in comparison with the values of the control group and below the reference values, on average, by 1.79 and 2.2 times.

5. CONCLUSION

The studies have shown that the production of ecological safe raw meat materials is possible only as a result of systematic monitoring of environmental objects (water, soil), feed and agricultural products, and they should not contain toxic elements.

The research results confirm the effectiveness of the dietary supplements for farm animals, which was earlier described by several other studies (Loretts O.G., 2018; Bykova O.A., 2018; Topuriya G.M., 2016; Hattak F., 2013). The use of the biologically active complex of plant origin in the ration of broilers contributed to the normalization of metabolic processes, helped reducing the level of toxic chemical elements in the blood and poultry meat and thereby improved the quality indicators of production. There was a redistribution of biogenic and toxic elements in the broiler liver; the number of biogenic elements of copper, zinc, cobalt, manganese increased by an average of 1.42; 1.5; 3.43 and 1.92 times, respectively; the level of nickel and lead decreased by an average of 2.37 and 2.45 times, respectively. As a result of the application of the biologically active complex of plant origin, it was noted that with an increase in its dose, the content of toxic elements (lead and nickel) in broiler meat decreased by 1.19-1.46 and 1.89-1.92 times, respectively, in comparison with the control group.

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ORIGINAL RESEARCH PAPER

ECONOMIC ASPECTS OF USING THIENCARBAZONE-METHYL WHEN PROTECTING CORN FROM SEGETAL VEGETATION

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ABSTRACT

The problem of corn infestation is becoming acute when a culture is advancing from the south to the north of Russia. Its control is most problematic in the marginal areas of cultivating, which include the Trans-Urals. The present paper presents the results of a seven-year field experiment, its objects being the cultural and weedy components of corn agrophytocenosis, as well as post-emergence herbicides of two groups: with a predominantly translaminar and combined nature of action, combining the translaminar activity with a prolonged soil effect. The purpose of the research is to substantiate the optimal choice of herbicidal preparations for controlling mixed vegetal vegetation in corn crops, considering the influence of phytocentric and abiotic external factors. As a result of research conducted in 2012-2018 in the northern forest steppes of the Trans-Urals, the control of annual monocotyledons is proved to be the most problematic. With the single-wave nature of the germination of the main mass of weeds against the background of deficient and normal moisture in 2012-2014, there were no fundamental differences between the most effective herbicides belonging to the two groups. On the contrary, with enough moisture, favoring several waves of vegetal vegetation, the advantages of the new active ingredient thiocarbazone-methyl with a combined (translaminar and soil) effect are revealed. This is a enough condition for the cost-effective use of herbicides containing this compound.

JEL classification: Q16, Q20

***Keywords**: corn, segetal vegetation, herbicides, translaminar and soil effect, weed infestation, yield, conditional profit, profitability.*

1. INTRODUCTION

The concept of integrated plant protection, among other principles, provides for the use of chemicals based on objective information concerning the phytosanitary condition of crops and the assessment of expected economic damage. The main criteria for making technological decisions in this case are the economic thresholds of harmfulness of biotic stressors. The modern range of herbicides recommended for use in corn crops is quite diverse in chemical composition, mechanisms and spectra of action, methods of application. Among them there are compounds that can be attributed to herbicides mainly of preventive or, conversely, operational purpose. The indicated groups of herbicides can be considered in technological schemes as alternative or complementary depending on the reliability of the forecasted vegetal vegetation damage, as well as on the resource capabilities of agricultural producers. The uncertainty of these factors favors the creating of herbicides that combine the properties of both groups in one formulation, as well as the assessing of the biological and economic effectiveness of their use in specific agroecological conditions.

2. LITERATURE REVIEW

The problem of corn infestation is becoming more acute as the crop is advancing from the south to the north of Russia. Its control in the marginal areas of corn farming is the most problematic, the Urals being among such areas. This is due to several agroclimatic and phytocenotic peculiarities. They include the replacement of medium and late ripening hybrids by early ripening and ultra early hybrids. This leads to a sharp decrease in projective covering and late closing of crops (Kazakova, 2011), the role of projective covering when forming the competitive relations between corn and segetal plants being also revealed in the conditions of the southern European continent (Simic, Dolijanovic, Maletic, Stefanovic, & Filipovic, 2012). The consequence of this is the lengthening of the gerba critical period: if in traditional zones of corn-growing its duration does not exceed several weeks (Hailegiorgis, Huluka, & Mekuria, 2012) (Bagrintseva, Kuznetsova, & Guba, 2011), then in the Trans-Urals it may coincide with the period of laying and formation of the crop (Panfilov, 2014).

The second feature is a small gap in time between the snow melt and the start of field work, a slow warming of the soil: most weeds begin to germinate in the post-sowing period, which virtually eliminates preventive measures for reducing infestation. Moreover, in order to maximize the use of a short period of active vegetation, it is necessary to sow corn in the early stages (Panfilov & Kazakova, 2010) to increase the proportion of late spring, mainly miliary weeds in crops.

The described circumstances substantially correct the expected effectiveness of the methods for controlling infestation. Thus, in traditional regions for corn production, the difference in yields of infested and clean crops ranges from 8 to 24 percent (Mkhoyan & Agaronyan, 2014) (Konoplya, Masliev, & Kurdyukova, 2014) (Liu, Huang, Xie, Zhang, & Shi, 2012) (Khan, N., Khan, N. W., & Khan, I. A., 2012). Under the conditions of the forest steppes of the Trans-Urals with typical infestation along with early sowing dates, the corn yield may decrease by 7-15 times or does not form at all (Ivanova, 2016).

The most problematic is the control of young grass weeds. This is due, firstly, to the abundance of seeds in the soil (Berzsenyi & Foltin, 1992) (Doronina, 2015), and secondly, to the extended periods of germination of different-quality seeds of late spring species (millet weed, panic grass, bristle species, etc.) along with slow soil heating (Korystin, 2006). The situation is still worse on the fields weeded with oat grass: in this case, in addition to late spring weeds, there is at least one wave of early infestation.

As a result, the main condition for realizing the potential of corn is a reliable complex system of protection from weeds, based primarily on operational techniques (mainly on the use of cross-spectrum herbicides) and ensuring their control throughout the entire gerba critical period. With the multiwave character of sprouting, double spraying is usually required: soil herbicide before sowing and post-sowing in the period of appearing from 3 to 5 leaves (Lazic, 1990) (Stepanovic, et al., 1986) (Panfilov & Sinitsyna, 2012). Such a protection scheme is quite tense from an organizational and economic point of view and is characterized by a high degree of risk associated with one or both untimely operations under the influence of, for example, weather conditions.

Refusal from this scheme is possible only based on fundamentally new models of cross-spectrum herbicides, simultaneously having a translaminar effect on vegetative weeds and a screen (soil) effect to suppress their subsequent sprouting. Such properties are possessed by the active ingredient thiencarbazone-methyl of a new class of ALS-inhibitors – sulfonyl-amino-carbonyl-triazolinones, its prolonged effect on segetal vegetation in corn being found in various soil and climatic conditions (Zayats, 2010) (Kolesnik & Stashkevich, 2010) (Bagrintseva, Kuznetsova, & Guba, 2015).

3. METHODOLOGY

The studies aimed at determining the effectiveness of thiocarbazone-methyl were conducted in the period from 2012 to 2018 on the experimental field of the Institute of Agroecology of South Ural State

Agrarian University. The objects of research were the cultural and segetal components of the agro-phytocenosis of corn grown for grain in the forest-steppe zone of Chelyabinsk region, as well as chemical means of controlling segetal vegetation. The research method was field experiment. The soil of the experimental plot was ordinary medium heavy black humus loamy. In the experiment, an ultra-early corn hybrid Obsky 140CB was used. Herbicides were introduced at the phase of 3-4 leaves, grass weeds having from 2 to 4 (up to 5) leaves. At the phase of 7-8 leaves (10-12 days after spraying), background inter-row processing was performed. The method of infestation accounting in the experiments was quantitative-weight. To test the statistical hypotheses the variance analysis method was applied.

At present, thiencarbazone-methyl is not registered in its pure form for use in corn crops. One of the ways for its use is in the composition of the oil dispersion in combination with the active substances foramsulfuron and iodosulfuron-methyl-sodium, as well as cyprosulfamide as an antidote. Nearly the same preparation that does not contain thiencarbazone-methyl is composed of water-dispersible granules, which contain foramsulfuron and iodosulfuron-methyl-sodium. In the experiment, it was used as a prototype, the comparison with it making it possible to extract the effect of thiencarbazone-methyl in the form of decreasing segetal mass, an increase in the crop yield and the economic parameters of corn production.

4. EMPIRICAL FINDINGS

The initial infestation of the experimental plot according to the group and species composition was quite typical for the region: perennial dicotyledonous (root-looking) species were represented by thistle, bindweed and perennial sow thistle, accounting for 10 to 17% of the segetal biomass. More than 60% of its percentage were cereal weeds (millet weed and wild oats as dominant species, as well as common panic grass and bristles green as marginal ones). About 20% of the mass were annual dicotyledon weeds. The total level of infestation was typical: in the control at the phase of 5-6 leaves, the number of segetal plants exceeded 200 ind./m^2, and their dry biomass varied from 191 to 488 g/m^2.

Against this background, the use of the studied combinations each year led to a sharp infestation decrease: the biological efficiency of the prototype exceeded 80% on average, and the additional effect due to thiencarbazone-methyl was 8.4% (Table 1).

It is due, firstly, to the more acute effect of this compound on perennial root-sprouting weeds (the “burning” effect), and secondly, by the prolonged effect on the late waves of segetal species, mainly millet weed and occasionally black nightshade.

Table 1. The effect of herbicides on the infestation of corn (dry biomass of weeds, g/m^2 45 days after treatment) in 2012-2018

Year	Variant			Thiencarbazone -methyl effect	HCP$_{05}$
	Control (herbicide-free)	foramsulfuron, 45,0 g/ha + iodosulfuron-methyl-sodium, 1,5 g/ha	foramsulfuron, 47,2 g/ha + iodosulfuron-methyl-sodium, 1,5 g/ha + thiencarbazone-methyl, 15 g/ha		
2012	190.8	35.7	5.6	-30.1	23.4
2013	229.2	30.2	11.6	-18.6	20.2
2014	488.0	23.0	13.6	-9.4	16.3
2015	478.2	68.8	12.9	-55.9	26.8
2016	316.9	75.4	54.2	-21.2	2.7

Year	Variant			Thiencarbazone-methyl effect	HCP05
	Control (herbicide-free)	foramsulfuron, 45,0 g/ha + iodosulfuron-methyl-sodium, 1,5 g/ha	foramsulfuron, 47,2 g/ha + iodosulfuron-methyl-sodium, 1,5 g/ha + thiencarbazone-methyl, 15 g/ha		
2017	269.2	67.0	50.6	-16.4	11.3
2018	247.4	71.8	36.2	-35.6	15.6
EMBED Equation. 3	317.1	53.1	26.4	-26.7	8.8
Biological effectiveness, %		83.3	91.7	8.4	-

Source: Author

It is necessary to note some instability of the noted effect: against the background of predominantly single-wave germination of grass weeds (2013 and 2014), when the screen (soil) effect of thiencarbazone-methyl does not play a significant role, the effect is not statistically proven.

The differences in the effectiveness of using two herbicidal combinations are associated with the peculiarity of the infestation dynamics: as a rule, within 10-12 days after their application, a sufficiently sharp decrease in the segetal biomass to the almost zero value was observed due to the rapid extinction of the aboveground weed organs. At the same time, there were no significant dynamic differences between the two variants. However, on the twentieth day after treatment, shoots and seedlings of the second wave were observed in 70 percent of cases in the variant with foramsulfuron and iodosulfuron-methyl-sodium, and in 15 percent the third wave of weeds, which by the end of the observations formed a mass of about 20 percent in comparison to the control plot. Against the background of the combination of active ingredients containing thiencarbazone-methyl, the late segetal plants either did not appear or were represented by single specimens with limited growth processes.

The corn grain yield being closely dependent on infestation, the maximum productivity (on average 5.8 times higher than on the control plot) was ensured by the use of a three-component combination with thiencarbazone-methyl (Table 2).

Table 2. The effect of herbicides on corn grain yield (t/ha) in 2012-2018

Year	Variant			Thiencarbazone-methyl effect	HCP05
	Control (herbicide-free)	foramsulfuron, 45,0 g/ha + iodosulfuron-methyl-sodium, 1,5 g/ha	foramsulfuron, 47,2 g/ha + iodosulfuron-methyl-sodium, 1,5 g/ha + thiencarbazone-methyl, 15 g/ha		
2012	0.22	3.03	3.24	0.21	0.16
2013	2.23	7.35	7.31	-0.04	0.27
2014	0.47	3.33	3.62	0.29	0.31
2015	0.82	5.82	7.20	1.38	0.72
2016	0.73	4.76	5.58	0.82	0.58
2017	0.46	5.08	6.13	1.05	0.41
2018	2.15	5.24	7.81	2.57	0.63
EMBED	1.01	4.94	5.84	0.90	0.19

Year	Variant			Thiencarbazone-methyl effect	HCP05
	Control (herbicide-free)	foramsulfuron, 45,0 g/ha + iodosulfuron-methyl-sodium, 1,5 g/ha	foramsulfuron, 47,2 g/ha + iodosulfuron-methyl-sodium, 1,5 g/ha + thiencarbazone-methyl, 15 g/ha		
Equation. 3					

Source: Author

A significant increase in yield was observed against the background of a two-component combination of active ingredients (prototype); however, the private economic effect caused by the use of thiencarbazone-methyl was evident every four years out of seven and in these situations ranged from 17 to 49 percent.

This is a enough condition for the cost-effective use of the herbicide containing this compound when analyzing long-term rows (Table 3). Thus, the additional net income due to thiencarbazone-methyl over seven years on average amounted to 3.5 thousand rubles per sown hectare, and the conditional profitability of corn grain production against the background of a three-component combination is 14 percent higher than when using the prototype.

Table 3. Economic effectiveness parameters when using herbicides in 2012-2018

Year	Conditional net income, rubles/ha		Additional net income thiencarbazone-methyl, rubles/ha	Conditional profitability of grain production, %	
	foramsulfuron + iodosulfuron-methyl-sodium	foramsulfuron + iodosulfuron-methyl-sodium + thiencarbazone-methyl		foramsulfuron + iodosulfuron-methyl-sodium	foramsulfuron + iodosulfuron-methyl-sodium + thiencarbazone-methyl
2012	1127.6	1146.7	19.1	7.3	6.8
2013	19987.4	19778.9	-208.5	97.8	96.8
2014	2437.3	2795.6	358.3	15.4	16.3
2015	13307.9	19272.6	5964.7	71.2	94.8
2016	8680.3	11816.6	3136.3	49.6	62.6
2017	10077.3	14348.0	4270.7	56.4	74.1
2018	10775.8	22080.2	11304.4	59.7	105.8
EMBED Equation.3	9484.8	13034.1	3549.3	51.0	65.3

Source: Author

Economically, the parameters are closely related to crop yield and differences between variants according to this indicator. Therefore, in situations where the soil effect of thiencarbazone-methyl under the influence of a combination of hydrothermal and phytocenotic factors did not have significant technological significance, both herbicidal combinations provided almost the same level of profitability and were comparable according to the conditional net income.

5. CONCLUSION

The high degree of corn infestation by annual cereal species in the forest-steppes of the Trans-Urals is due to the combination of soil-climatic, technological and phytocenotic factors characteristic for the region. Against this background, post-emergent herbicides containing thiencarbazone-methyl and, due to this, combining translaminar and soil (screen) effects on segetal plants, have the advantage in terms of biological and economic effectiveness. However, the use of this compound for protecting corn from weeds is economically feasible when reaching relatively high levels of productivity along with intensive corn cultivation technologies characterized by complex chemicalization and reasonable selection of hybrids.

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ORIGINAL RESEARCH PAPER

SEVERAL SOCIO-ECONOMIC ASPECTS OF THE PRODUCTION OF FUEL CHIPS FROM SALIX: THE CASE OF RUSSIA

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ABSTRACT

In recent years, the world agriculture business has developed the technology of growing fast-growing willow - salix. Salix is a renewable energy resource that is profitable to grow by farmers for their own needs. However, in Russia, small farms often do not have enough resources and funds to purchase expensive equipment. This article proposes technological schemes for collecting and processing salix for fuel chips using a mobile chipper with a shearing device and big-bag soft containers of 1 to 5 m^3 in volume. The article describes a device to produce chips from salix with its loading into soft containers, which allows eliminating chipping machine downtime when working with containers. Technological schemes are proposed in which the method of production of chips from salix using soft containers fully conforms to the conditions of work of small farms.

JEL classification: E23, Q33

Keywords: *renewable energy sources, salix, mobile chipper, soft containers, fuel chips.*

1. INTRODUCTION

The total energy consumption in agriculture in Russia is about 70 billion tons of oil equivalent (Rastimeshin S.A. and other,2012). The main sources of energy are electricity (up to 60%) and liquid fuel (up to 40%). In the cost structure of agricultural products, energy costs amount to up to 30% (Electronic resource). With rising energy prices, shortage is inevitable.

Renewable energy sources can be an alternative to traditional fuel and energy resources (gasoline, diesel fuel, natural gas, etc.). The renewable energy sources in agriculture include biomass of animal and vegetable origin.

The analysis shows that in agriculture in Russia, renewable sources of energy are most appropriate to use for heat and power supply to small farms that do not have centralized electrical networks and reliable transportation services (Dolgov I.U., 2013).

Energy based on renewable sources has several advantages over fossil fuels reduces carbon dioxide emissions, improves the environment, reduces the cost of purchasing and delivering energy and generally improves the efficiency of an agricultural enterprise. Stable energy supply allows for a creation of favorable social conditions for work and life of rural residents (Morozov N.M and other, 2012).

In recent years, the world agriculture business has developed the technology of growing fast-growing willow - salix, as an energy culture. Salix is grown in Sweden, Denmark, Poland, Hungary, and Czech Republic.

Low-productive and unproductive land is suitable for the cultivation of salix. The rapid growth of willow allows harvest every 2 to 3 years at about 20 tons per hectare (Electronic resource).

Fig. 1 – Salix plantation in Sweden
Source: Author

Despite the obvious advantages of salix as an energy crop, even in Sweden, where the plantations of this crop are the largest and constitute approximately 20,000 hectares, the share of chips from salix is tenths of a percent in the total energy balance of the country (Electronic resource). The wide distribution of salix is hampered by the lack of effective technologies and equipment, especially for its collection and processing. Existing technologies are designed for salix plantations with the size of tens of hectares, and the processing equipment costs tens and hundreds of thousands of euros. Such prices are available only to large agribusinesses that are not always interested in developing their own "green" energy.

The experience of many countries shows that it is profitable to grow energy willow near the place of processing and use it for its own needs: for heating industrial premises, greenhouses, drying products, etc. (Electronic resource). However, small farms do not have enough resources and funds to purchase expensive equipment.

This article discusses the technology of collection and processing of salix, with focus on small farms.

2. DATA AND METHODS

This article proposes technological schemes for the collection and processing of salix for fuel chips, which purport for the collection and processing of salix for chips using a mobile chipper with a shearing device and big-bag soft containers of volume between 1 and 5 m^3. The purpose of these technologies is to minimize investment costs due to the minimum involvement of specialized equipment.

The use of soft containers for the transport of chips can improve logistics, mechanize loading and unloading, increase the efficiency of transportation of chips by various types of transport, etc. (Karpachev S.P. and other, 2017). However, as the authors of (Karpachev S.P. and other, 2017) have shown, a significant limitation of the use of soft containers is the occurrence of forced downtime and decrease in chipper productivity due to the limited volume of soft containers and the need to spend time on their installation, packaging and replacement.

In order to reduce the forced downtime of the chipper and increase its productivity, the authors of the article proposed to equip the chipper with a special device - a trailer that holds two or more containers for loading (Karpachev S.P. and other, 2014). Containers are placed on the platforms of the device with the possibility of their inclination, which allows you to dump the packaged containers to the ground by self-detachment.

The general appearance of the device is presented in figure 2.

The proposed system allows minimizing the number of specialized machines and equipment, which accordingly minimizes investment costs. The main specialized machine in the system is a chipper with a shearing device, for example, one from the Danish company Ny Vraa Bioenergi - JF 192-292 (Electronic resource). The remaining machines are general purpose equipment.

Fig. 2 – General appearance of the device for the production of chips from salix

1 - salix, 2 - chipping machine with a cutting device, 3 - chip pipe, 4 - soft containers, 5 – tractor

Source: Author

There are several options for technological schemes for cleaning and processing of salix chips. The most preferred technologies for small farms are listed below.

1. The operation of the machine system with dumping containers to the plantation (figure 3).

The mobile chipper moves along the technological corridor of the plantation, cuts off the trees of the salix and feeds them to the chipper device.

The resulting chips are served in a container that is placed on the tractor trailer. After filling one of the containers, the pneumatic line is transferred to the loading neck of the next empty container. While the empty container continues to be loaded with chips, the already filled container is packed, dumped from the trailer and left on the plantation. Mobile chipper currently continues to work. In place of the unloaded container, an empty container is installed, and the loading cycle is repeated.

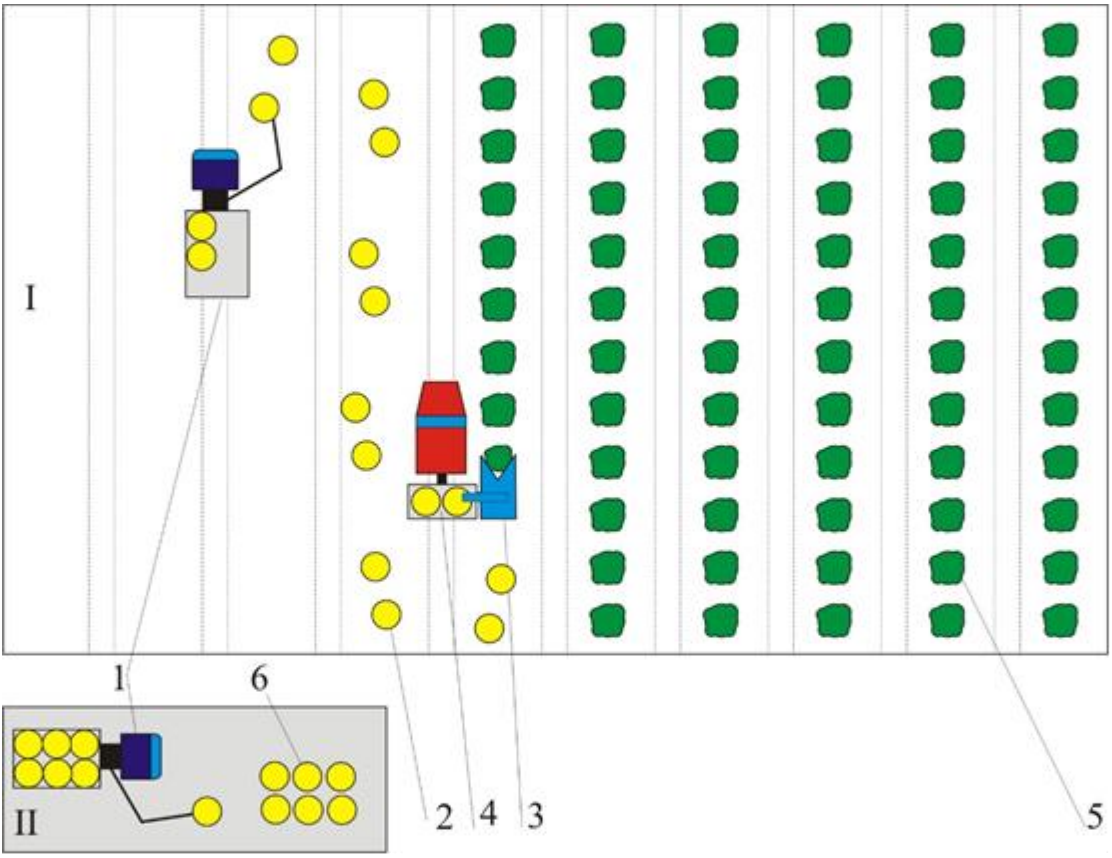

Fig. 3 – The operation of the machine system with dumping containers to the plantation
I - salix plantation, II – chip container storage.
1 - transport vehicle; 2 - soft containers on the plantation; 3 - mobile chipper; 4 - trailer with soft containers; 5 - salix; 6 - containers in stock
Source: Author

Unloaded containers with chips are collected via pick-up transporter and transported to the warehouse, where they are stored.

2. The operation of the machine system with the dumping of containers at the intermediate site (figure 4).

This technology differs from the previous one in that containers are filled with chips and accumulated on the tractor trailer. After filling all the containers with chips, they are delivered to the intermediate platform and unloaded there. At the same time, the chipper with the cutting device is uncoupled from the tractor and temporarily left on the plantation. Containers from the intermediate site are picked up by a transport vehicle and delivered to the warehouse.

Alternatively, containers with chips can be immediately delivered by tractor to the warehouse, bypassing the intermediate site. This option is most preferred for small farms with a small amount of fuel chips for their own needs.

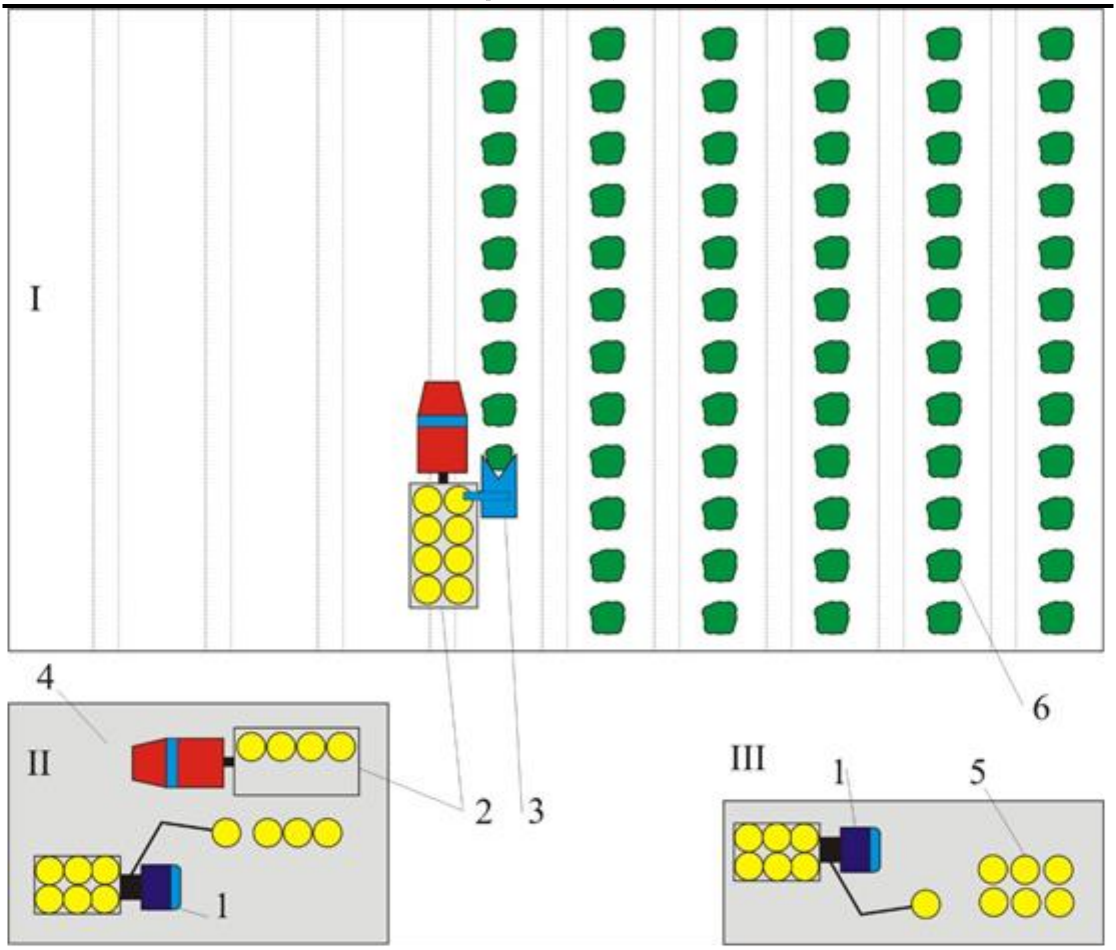

Fig. 4 – The operation of the system of machines with the dumping of containers at the loading area

I - salix plantation, II - intermediate container unloading site, III - chip container storage.
1 - transport vehicle; 2 - trailer with soft containers; 3 - mobile chipper; 4 - containers at the intermediate site; 5 - containers in stock; 6 - salix.
Source: Author

3. CONCLUSION

The results of a preliminary analysis of the above technological schemes for the production of chips from salix using soft containers allow us to draw the following conclusions:

1. The use of soft containers on the chip loading minimizes investment costs in the technology of collecting and processing of salix, which makes this technology affordable for small farms. Additional equipment: mobile chipper with shearing device. The cost of reusable soft polypropylene containers in Russia is 3-5 euro per m^3.

2. The device to produce chips from salix with its loading into soft containers, considered in the article, eliminates chipping machine downtime when working with containers.

3. Proposed technological schemes that use the method of production of chips from salix using soft containers that best consider the working conditions of small farms.

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ORIGINAL RESEARCH PAPER

SOCIAL AND ECONOMIC CONSEQUENCES OF INFLUENCE OF FOOD EMBARGO ON PRODUCTION OF MILK AND DAIRY PRODUCTS IN RUSSIA

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ABSTRACT

Article is devoted to assessment of Russia self-reliance by milk and dairy products in 1990-2017. At the first stage self-reliance indicators by milk and dairy products were calculated. At the second stage the output of milk and dairy products necessary for performance of norms of personal consumption and target level of self-reliance is determined. Results showed that, first, self-reliance of Russia milk and dairy products below target level. After introduction of food embargo in 2014 the indicator of self-reliance increases, however by 2017 did not reach target value. Secondly, the level of self-reliance of Russia milk and dairy products does not allow to execute norms of their personal consumption by the Russian population. In 2017 the actual production of milk and dairy products was 34.7% lower than the output necessary for satisfaction of personal needs of the population according to norms and the target level of self-reliance. Thus, in Russia development of dairy production and, respectively, increase in level of self-reliance by milk and dairy products must become one of paramount tasks which solution is necessary for ensuring food security of the state.

JEL classification: Q13, Q18

Keywords: *milk, dairy products, food security, self-reliance, consumption, personal consumption, production consumption, production, import, import substitution, prices*

1. INTRODUCTION

State self-sufficiency of the milk and dairy products is necessary for its food security. Special relevance the problem of self-sufficiency of Russia food and, in particular, dairy products, got in 2014 when the basis of food policy of the state was formed by policy of import substitution.

Average per capita consumption of milk and dairy products in Russia, by different estimates, is 28-30% lower than norm (Karanina et al., 2017; Krapchina, & Kotova, 2015). Results of regional researches (Ali-Askyari, & Maksudov, 2016; Yashina, & Dolgova, 2017; Smirnov, & Suslov, 2014) also demonstrate insufficient consumption of milk and dairy products. Milk and dairy products are an important component of a food allowance of the person and contain macro - and the minerals necessary for health (Smirnova, 2014; Visioli & Strata, 2014; Trotta et al., 2017). The special value of milk for health is caused by balance of nutrients (Anikiyenko, 2018). Thus, the problem of self-sufficiency of Russia milk and dairy products has not only the political and economic, but also big social importance.

In this regard a research objective - to estimate self-reliance of Russia milk and dairy products in 1990-2017.

2. THEORY

Now the dairy industry in Russia is presented to 21 thousand economic entities and 1.2 million busy population, sales of milk and dairy products form 15% of commodity turnover of retail retail chain stores (Guziy, 2016). The efficiency of the Russian dairy industry is low and significantly concedes on key indicators to the developed countries of the world (Valyavin, 2016). The number of cattle is reduced – including because of price increase for the specialized equipment, the electric power and forages (Smirnova, Smirnov, & Generalov, 2014). Although dairy production takes the third place on the volume of investment into agriculture after poultry farming and pig-breeding, the industry remains import-dependent and does not show steady increase in production (Murtuzalieva et al., 2017). Seifullaeva et al. (2018) call the dairy industry, along with meat, most vulnerable branch of the Russian agriculture as the dairy market in the greatest measure depends on import and shows the maximum increase in prices among the agricultural markets.

Scientists differently assess the consequences for the dairy industry of the food embargo entered by Russia in 2014 Semyonov and Zaychenko (2016) claim what despite revival of functioning of the Russian producers of milk and dairy products, basic changes did not occur. Senotrusova and Svinukhov (2016) note that conducting the bans and restrictions for import to Russia of dairy goods led to short-reception by the Russian budget of customs payments which decrease in 2015 relatively 2013 was more than 315 million dollars. The sharp increase in prices for milk and dairy products caused by additional expenses of producers on modernization of the production necessary for import substitution (Mayorova, 2018) became other consequence of imposition of sanctions.

However, after maintaining food embargo there were also positive changes which increased self-sufficiency and food security of Russia. In comparison with 2014 import was reduced approximately twice (Seifullaeva, 2018). Besides, Wegren & Elvestad (2018) note that even if in the nearest future sanctions and countersanctions will be cancelled, it will be extremely difficult to European exporters of food to occupy the Russian market again.

3. DATA AND METHODS

Initial materials of assessment of self-sufficiency of Russia milk and dairy products were data of Federal State Statistics Service of the Russian Federation for 1990-2017 (Rosstat, 2018) presented in the sections "Resources and Use of Milk and dairy products", "Number and Structure of the Population", the bulletin "Consumption of the Main Food across the Russian Federation" and also the indicators established in the Doctrine of food security of the Russian Federation (2010) and Recommendations about the rational norms of consumption of foodstuff meeting the modern requirements of healthy food (2010).

The research included two stages. At the first stage the indicator of self-reliance of Russia milk and dairy products calculated by the following formula is analyzed:

$$S = O / (PrC + PerC + L) * 100$$

where S – self-reliance milk and dairy products, %;

O – output of milk and dairy products, thousand tons;

PrC – production consumption, thousand tons;

PerC – personal consumption, thousand tons;

L - losses, thousand tons.

At the second stage the self-reliance of Russia is considered by milk and dairy products in interrelation with personal consumption per capita. For this purpose, taking into account the average recommended size of average per capita consumption and population the total necessary amount of personal consumption within the country is calculated:

$$PerC' = N * P$$

where PerC' – personal consumption on condition of performance of norms, thousand tons;

N – average per capita norm of consumption of milk and dairy products, thousand tons;

P – population.

According to Recommendations about the rational norms of consumption of foodstuff meeting the modern requirements of healthy food developed by the Ministry of health and social development (2010), the normal volume of consumption of milk and dairy products is 320-340 kg a year per the person.

Further the output demanded for target self-reliance by milk and dairy to products, the food security of the Russian Federation (2010) established to Doctrine that is at the level of not less than 90% is determined:

$$O'=((PerC'+ PrC +L)*C')/100$$

where O' – the output demanded for enough self-reliance by milk and dairy products, thousand tons;

PerC' – personal consumption on condition of performance of norms, thousand tons;

PrC – production consumption, thousand tons;

L - losses, thousand tons.

S' – a target indicator of self-reliance milk and dairy products, %.

The output demanded for enough self-reliance by milk and dairy products is compared to the actual indicators.

4. RESULTS AND DISCUSSION

During 1990-2017 the self-reliance of Russia milk and dairy products was maximum in 1992 when reached 95.2%. Further in general the descending trend was observed, and changes were wavy – with the greatest values in 2001 and 2008, and with the smallest values in 1997, 2006 and 2013. In 2013 the self-reliance of Russia milk and dairy products reached the minimum and was 77.5%. In 2014-2017 the self-reliance indicator steadily raised and in 2017 made 82%, however remained below values of crisis 2008-2009 and the previous minima of 2013 and 2016 (fig. 1). Without watching a positive trend in 2014-2017, the self-reliance of Russia milk and dairy products following the results of 2017 did not reach the level established to Doctrine to food security of the Russian Federation (2010) yet. For all considered period the specified level – not less than 90% – was reached only twice – in 1992 (95.2%) and in 1993 (91.0%).

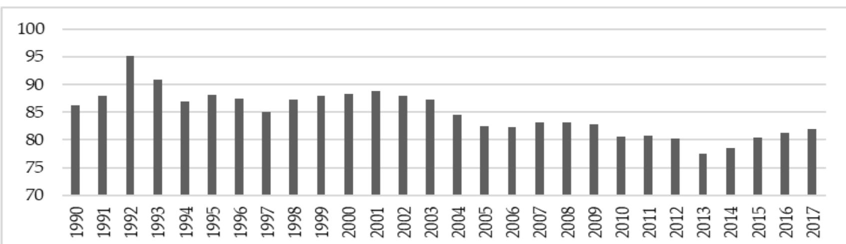

Fig. 1. Self-reliance of Russia milk and dairy products, %

Source: it is calculated by authors based on Rosstat data (2018)

Thus, now Russia provides itself with milk and dairy products insufficiently. Moreover, in the country the rules of personal consumption established by Recommendations about the rational norms of consumption of foodstuff meeting the modern requirements of healthy food of 320-340 kg a year per capita are not respected. Since 1996 and till present average per capita consumption of milk and dairy products is lower than the specified norm. In 2017 it was 231 kg.

At the second investigation phase the volume of personal consumption of milk and dairy products proceeding from the average recommended volume (330 kg a year) and the number of the Russian population was determined. Considering the actual production consumption, the actual losses and threshold target value of an indicator of self-reliance (90%) the required volume of the Russian production of milk and dairy products was calculated.

Results showed that the actual production exceeded the production minimum necessary for ensuring personal consumption and a target indicator of self-reliance, only in 1990-1991. In the next years (1992-1999) the difference between the actual and required production increased (fig. 2). For all studied period the actual production was the smallest share of the required production in 2017 – 65.3%.

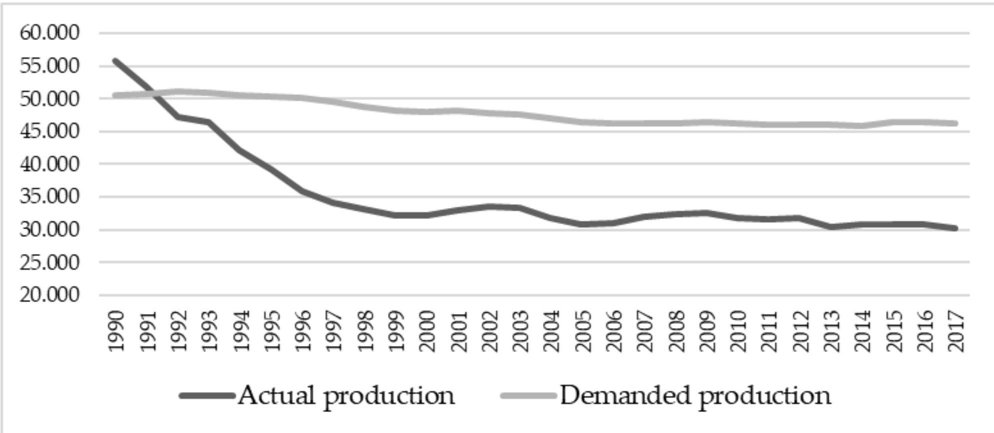

Fig. 2. Actual and demanded production of milk and dairy products in Russia, thousand tons
Source: it is calculated by authors based on Rosstat data (2018)

The similar situation relates to low investment attractiveness of the dairy industry, high cost of production, insufficiently effective and irregular state support, strong volatility of the prices, etc. (Murtuzalieva, 2017). The big complexity for the dairy industry is caused by low competence of workers, one of the reasons of which is the noncompetitive salary. It is known that the human capital is a basis of increase in profitability, overall effectiveness and investment attractiveness (Mironova et al., 2017). In this regard a paramount problem of the dairy industry is development of labor potential. Increase in competence including demands studying of the best foreign practices. For example, experience of the developed countries which shows that in the conditions of market economy the most effective structure are the clusters providing participants with additional competitive benefits can be useful (Veretekhina et al., 2017).

Other problem especially relevant in the context of import substitution, the low technical equipment of the enterprises of the dairy industry is. Despite the innovative way of development approved at the state level, institutional gaps (Galimulina et al., 2016), and an imbalance between science, business and the state are characteristic of the Russian economy (Shikevich et al., 2016) that is fully shown in dairy production. Overcoming the specified problems of the dairy industry requires the state support, including information, and improvement of infrastructure (Krapchina, & Kotova, 2015).

5. CONCLUSION

Results of assessment of self-reliance of Russia milk and dairy products allow to draw the following conclusions. First, since 1994 till present self-reliance of Russia milk and dairy products below target level. The smallest self-reliance was observed in 2013. After introduction of food **embargo,** the indicator of self-reliance of Russia milk and dairy products increases, however by 2017 did not reach target value (not less than 90%). Secondly, the level of self-reliance of Russia milk and dairy products does not allow to execute norms of their personal consumption by the Russian population. In 2017 the actual production of milk and dairy products was 34.7% lower than the output necessary for satisfaction of personal needs of the population according to norms and the target level of self-reliance. Thus, for Russia development of dairy production and, respectively, increase in level of self-reliance by milk and dairy products must become one of paramount tasks which solution is necessary for ensuring food security.

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ORIGINAL RESEARCH PAPER

FEATURES OF ACCUMULATION AND TRANSLOCATION OF ECOTOXICANTS IN THE SYSTEM "FEED-DIET-MILK" IN THE AREA OF FACILITIES FOR STORING AND DESTRUCTING OF CHEMICAL WEAPONS

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ABSTRACT

The paper is concerned with studying the characteristics of accumulating heavy metals and radionuclides by plant foods form the area of facilities for storing and destructing of chemical weapons, and their transfer from cows' feed into milk. The content of heavy metals — copper, zinc, cadmium, lead — is determined by atomic absorption and strontium-90 and cesium-137 radionuclides in feed and milk. The digital material is processed with the help of methods of variation statistics and biometric Student's t-tests. According to the research hypothesis, plant foods have different abilities to accumulate heavy metals and radionuclides, which affect their concentration in feed and the following transfer into cows' milk. The accumulation peculiarities of heavy metals and radionuclides according to the type of feed, as well as the dependence of concentration of toxic substances on their quantity are established. The regression equations to predict the concentration changes of heavy metals and radionuclides in daily diets according to their content in feed are solved. The transfer factors of heavy metals and radionuclides during housing and pasture seasons are determined. They show no relationship between the presence of ecotoxicants in feed and milk. The results of the study will facilitate regulating the flow of toxic elements into animal products by selecting feed components

JEL classification: Q18, Q53

Keywords *heavy metals, radionuclides, feed, diets, cows' milk, transfer factors.*

1. INTRODUCTION

An important aspect in solving the problem of environmental safety of foods is the study of toxic elements accumulated in the biosphere.

The ecological situation in Shchuchansky District of Kurgan Region depends on numerous factors of the natural and anthropogenic origin. The first group of environmental disadvantages is caused by background natural geochemical anomalies, the second one is based on transboundary technogenic pollution due to the South Ural industrial agglomeration and the spread of toxicants in both water and aerogenic ways.

A potential threat to the ecology also exists due to the facilities for storing and destructing of chemical weapons located on the territory of the region. Living near them causes people's fear for health and, therefore, considerable public interest in the environment conditions and the quality of agricultural products.

The main environmental threat is caused by heavy metals and radioactive substances occuring in the human body through trophic chains. These substances consumped in large concentrations by humans through food lead to toxicosis and cause carcinogenic and mutagenic effects (Koshelev, Donnik, Burlakova, & Kushcheva, 2007).

One of the reasons of toxic substances occurring in the human body can be milk as a valuable product. The intensity of ecotoxicants entering cows' milk is determined by several factors, the main one among them being food ((Li, McCrory, Powell, Saam, & Jackson-Smith, 2005) (Koshelev & Kushcheva, 2007)).

So far, the effect of heavy metals on living organisms is proved by numerous scientific data, and the ways to prevent the harm are developed. Nevertheless, further study is needed to determine the influence of the contamination degree of agricultural territories with heavy metals and radionuclides on the characteristics of various types of plant food and their transfer into milk from cows' feed.

Hypothesis: plant foods differently accumulate heavy metals and radionuclides; therefore, their concentration differs in cows' feed and their transfer into milk.

The aim of our research was to study the characteristics of accumulating heavy metals and radionuclides by plant foods and their transfer from cows' feed into milk.

The research tasks are:

- to study the degree of cows' feed contamination with heavy metals and radionuclides;
- to develop regression equations to predict changes in the concentration of heavy metals and radionuclides in cows' feed depending on their content;
- to determine the content of heavy metals and radionuclides in milk;
- to find the transfer factors of heavy metals from feed into cows' milk.

The objects of studying were feed (forage, juicy, concentrated) and black-and-white cows' milk to determine the content of heavy metals — copper, zinc, cadmium, lead, and radionuclides of strontium-90 and cesium-137.

2. LITERATURE REVIEW

In complex processes of environmental pollution, heavy metals and radionuclides play an important role ((Akcil, Erust, Ozdemiroglu, Fonti, & Beolchini, 2015) (Skugoreva, Ashikhmina, Fokina, & Lyalina, 2016)).

Toxic substances enter the human body through the chain, the initial link of which is soil (water), accumulating all harmful substances, then there are plants (feed, diet), animals, animal products and the final link is the man ((Foy, Chaney, & White, 1978) (Suntsova, Petukhova, Ashikhmina, & Kantor, 2015)).

Literature sources contain data on the specific features of accumulating ecotoxicants by various plants and feed crops ((Foy, Chaney, & White, 1978) (Fitamo, et al., 2016) (Inelova, et al., 2018)).

Plant resistance mechanisms to excess toxic substances can appear differently: some species are able to accumulate their high concentrations but be tolerant to them; others seek to reduce the flow of heavy metals by maximizing their barriers.

For most plants, the first barrier level is the root, where the greatest number of toxicants is retained, the next one is the stem and leaves, and the last one is the organs and parts of plants responsible for reproductive functions (seeds and fruits) ((Trifonova & Alkhutova, 2012) (Larionov, 2017)).

The resistance to heavy metals forms genetically. Each plant has its own genetically justified set of elements, and these characteristics are most clearly seen in the composition of regenerative organs. The content of elements in a plant may vary according to its growing conditions. If there is an excess of any element in soil or water, it will be accumulated in other organs of the plant, trying to preserve the genetic code in reproductive organs.

Cultivated plants are less able to accumulate heavy metals and less resistant to them than wild plants. As studies prove, according to the ability of accumulating cadmium cultures can be arranged in the following row (increasing): oats – wheat – beans – peas – sunflower – grasses – corn. Among cereals, rye and wheat accumulate more heavy metals, while oats and barley retain less. Legumes as concentrators of heavy metals are more active than cereals ((Gougoulias, Leontopoulos, & Makridis, 2014) (Karpova, 2008) (Sachko, Lesyk, Luchka, & Nevostruyeva, 2016)).

Heavy metals are accumulated in different ways by plant organs, the maximum quantity of them being found in roots, the minimum – in generative organs. According to the degree of saturation with heavy metals, plant organs can be arranged in the following row: roots> leaves> stems> seeds (fruits) ((Blindauer & Schmid, 2010) (Karnaukhov, 2014)).

Strontium-90 and cesium-137 are characterized by the highest mobility in the chain “plants – animals – products”. The reasons for different behaviors of radionuclides in these migration links are due to the chemical nature of radionuclides determining the peculiarities of its fixation on plants and further transfer into animal products (Bubenchikov, et al., 1995).

Information about the physicochemical forms of radionuclides in plants is insufficient; there are only data on their distribution in the structural elements of cells (Bertilsson, Andersson, & Johanson, 1988). However, information limited but available proves the transfer of radionuclides from animals’ food into their bodies and the products to depend largely on the composition of chemical compounds in food plants. In this regard, the study of the biological availability of radionuclides in various foods is of special interest.

Grasses of natural pastures and hayfields have the greatest ability to accumulate cesium-137. It creates more favorable conditions for the root and basal entry of radionuclides into meadow grasses than into field crops.

Feed crops from arable lands have significant species differences for accumulating of cesium-137 and strontium-90. Perennial cereals have the greatest ability to accumulate cesium, with maize, silage and fodder beet having the smallest one.

The way of ecotoxicants after their entry with feed and their transfer into the body fluids depends on several concurrent competing processes. They can be removed from the body with urine or feces, pass into animals’ milk, retain in tissues or enter the embryo of a pregnant animal through its placental barrier. The concentration of toxic substances in any migration link depends on the cumulative effect of all these processes ((Sansom, 1966) (Grytsyuk, Arapis, Perepelyatnikova, Ivanova, & Vynograds'ka, 2006) (Lane, Canty, & More, 2015)).

3. DATA AND METHODS

The studies were carried out in agricultural enterprises of Shchuchansky district of Kurgan region during the period from 2004 to 2014.

To obtain the most complete information on the contamination degree of the studied objects, the area was divided into five zones according to the presence of industrial centres, facilities for storing and destructing of chemical weapons and geographical location: the northern (village Peschanskoe), southern (village Sukhoborskoe), western (village Beloyarskoe), eastern (village Petrovskoe) and central (rural settlement Chumlyak) zones. The facilities for storing and destructing of chemical weapons are in the central zone.

Feed sampling was carried out according to the state standard (GOST) 27262-87. Milk samples were selected in accordance with GOST 26809-86.

4. METHODOLOGY

The radiochemical studies of feed and milk samples were carried out after their preliminary treatment, including charring and ashing to determine the content of cesium-137 and strontium-90. The radiometry of the samples was performed with the help of a radiological complex “Progress” (Russia).

Samples for toxicological studies were preliminarily mineralized, and then the content of heavy metals (copper, zinc, cadmium, lead) was determined in the ash solution with the help of the atomic absorption method and a SA-10 MP spectrophotometer (Russia) and an analyzer “Spectrum-5” (Russia).

The main criterion for assessing the contamination degree of cows’ feed and milk was the maximum permissible concentration (MPC). The quality of the studied samples was assessed according to the sanitary rules and norms (SanPin) of the Russian Federation 2.3.2.1078-01 “Hygienic Requirements for Safety and Nutritional Value of Food Products”.

The concentrations of heavy metals in the feed were determined in accordance with the following state standards (GOSTs): copper in accordance with GOST 27995-88, zinc in accordance with GOST 27996-88, lead and cadmium in accordance with GOST 30692-2000.

The content of copper in milk was determined in accordance with GOST 26931-86, zinc – GOST 26934-86, cadmium – GOST 26933-86, lead – GOST 26932-86.

The digital material was processed with the help of methods of variation statistics and biometric Student’s t-tests.

5. EMPIRICAL FINDINGS

The contamination degree assessment of agricultural products caused by the activities of facilities for storing and destructing of chemical weapons on the territory of Shchuchansky District of Kurgan Region is urgent today. The current environmental situation in the region is caused by both local and transboundary sources of pollution. Production of environmentally safe products under the conditions of anthropogenic impact and the elaboration of measures to reduce the entry of toxic substances into products and the human body is of great importance.

Toxic elements and their high content in the feed adversely affect its quality, and as a result causes metabolic disorders and diseases in both animals and humans.

The studies didn’t prove the MPC for copper and zinc to be higher than normal. However, the MPC for lead in hay exceeded by 1 and 2% in the northern and southern zones, respectively, and in silage by 3% in the northern zone.

Lead is an important element that determines the toxicity of food products, manifested in hemoglobin synthesis suppression, leading to anemia and negative effects on the human nervous system.

Cadmium is currently considered to be one of the most harmful heavy metals, so any noticeable increase in its content in feed is dangerous to health (Schiptsova & Terentyeva, 2017).

The analysis of feed for cadmium content revealed its highest concentration, not exceeding the MPC in the northern and central zones.

The study found the accumulation of toxic elements in plants to occur in a differentiated way. Sown grasses accumulate heavy metals and radionuclides less than grasses of natural lands. In mixed sowings, the number of toxicants is less than in pure ones.

When analyzing the data obtained, the dependence of accumulating toxicants on the type of rough feed was revealed. According to the degree of concentration increase of heavy metals and radionuclides, they can be arranged in the following row:

straw <legume-grass hay < smooth-brome hay <hay of natural land.

Succulent feeds also differ in their accumulation degree of heavy metals and radionuclides; they can be arranged in the following row according to the increasing concentration of ecotoxicants:

silage <haylage <pasture grass.

Among grain crops, wheat was found to be the most capable of accumulating toxicants, while barley and oats were less capable. According to the degree of concentration increase of heavy metals and radionuclides, they can be arranged in the following row: oats <barley <wheat.

The highest content of copper and zinc is found in concentrated feed, and cadmium and lead retain most in rough feed. The smallest amounts of these elements are found in corn silage. The maximum content of radionuclides is in grass from pastures, the smallest one being in oats grain.

According to the data obtained, the total concentration of toxic elements in cows' daily diet was calculated (Table 1).

Table 1. The concentration of toxic elements in the cows' daily diet

Studied zone	Concentration in the diet					
	Cu (мг)	Zn (мг)	Cd (мг)	Pb (мг)	^{137}Cs (Бк)	^{90}Sr (Бк)
Housing season						
Northern	155.3 3.9	385.9 9.1	6.4 0.8	153.1 4.9	69.9 1.2	73.9 1.8
Southern	119.5 1.9	321.9 5.9	4.5 1.6	112.3 2.7	46.9 0.7	81.5 2.0
Western	107.1 2.5	420.6 6.7	3.3 0.3	79.6 2.6	68.2 1.2	91.9 2.4
Eastern	65.6 2.8	349.4 8.7	3.3 0.2	104.6 2.8	50.2 0.8	79.3 3.9
Central	92.8 3.7	431.2 5.9	3.6 0.6	139.7 5.0	51.9 0.7	76.3 1.2
Pasture season						
Northern	121.7 2.8	253.1 9.5	4.4 0.6	69.0 5.0	45.8 2.3	78.0 1.14
Southern	86.9 4.4	307.8 4.7	3.6 0.6	77.9 5.1	40.3 1.9	74.4 1.96
Western	90.8 2.4	291.1 4.8	4.4 0.6	45.4 3.6	87.9 2.3	91.3 4.1
Eastern	56.4 3.4	419.2 5.0	4.3 0.7	83.3 4.3	40.3 2.2	87.5 2.5
Central	108.3 2.7	235.6 9.7	2.7 0.1	58.3 8.7	88.4 5.0	63.6 1.4

Source: Author

The analysis of the content of heavy metals and radionuclides in cows' feed showed the pollution degree to decrease from northwest to east. This is due to the transboundary anthropogenic pollution of the environment due to water and aerogenic way from Sverdlovsk and Chelyabinsk regions.

During pasture seasons the amount of these substances in feed is less than during housing seasons. This difference is due to the moisture content decrease in feed in winter as compared to the one in summer, which results in the concentration increase of heavy metals and radionuclides in the dry matter.

According to the data obtained, the regression equations were calculated to predict the changes in the concentration of heavy metals and radionuclides in the daily diet depending on their content in feed (Table 2).

Table 2. The relationship between the concentration of toxic elements in the diet and feed

Indicator	Regression equation	Correlation coefficient	Validity criterion
diet – copper in feed	$Y=293.832-1.885X_1+47.306X_2+0.440X_3+0.506X_4-67.273X_5-44.857X_6-35.256X_7$	r = 0.99	p<0.001

Indicator	Regression equation	Correlation coefficient	Validity criterion
diet – zinc in feed	$Y=17.754-2.392X_1+9.985X_2-0.459X_3-1.678X_4+2.182X_5+5.725X_6+7.537X_7$	r = 0.98	p<0.001
diet – cadmium in feed	$Y=0.358-13.545X_1+95.258X_2+1.022X_3+1.094X_4+86.973X_5-105.543X_6+241.389X_7$	r = 0.99	p<0.001
diet – lead in feed	$Y=1081.019-266.650X_1-2020.219X_2+50.146X_3+109.434X_4-9024.986X_5+1932.339X_6-8598.891X_7$	r = 0.99	p<0.001
diet – cesium-137 in feed	$Y=-27.064+15.196X_1+7.511X_2+0.146X_3-4.953X_4-24.609X_5+18.154X_6-148.047X_7$	r = 0.96	p<0.001
diet – strontium-90 in feed	$Y=-8.017+2.777X_1+3.402X_2+0.45X_3+2.499X_4+0.589X_5+12.471X_6-17.44X_7$	r = 0.96	p<0.001

Source: Author

In the regression equations, the argument X_1 determines the content of the toxic element in hay, X_2 – in straw, X_3 – in silage, X_4 – in haylage, X_5 – in wheat, X_6 – in barley, X_7 – in oats.

A high positive significant correlation was found between the concentration of toxicants in the daily diet and the accumulation of these elements in feed.

The quality of milk is directly dependent on the conditions in which it is produced. The intensity of ecotoxicants entering the milk is determined by many factors, animals' feeding among them being the main one.

People eating low-quality food that contains high concentrations of toxic substances can lead to negative consequences. In recent years, the phenomenon of hemophobia among people causes the necessesity of constant monitoring the content of toxicants in produced food (Makhnichenko & Pashchenko, 2016).

While studying it was established that the concentration of heavy metals and radionuclides in milk does not exceed the MPC. The content of toxicants in cows' milk on average per lactation does not fully correspond to their presence in feed (Table 3).

Table 3. The content of heavy metals and radionuclides in cows' milk

Chemical element	MPC	Zone				
		Northern	Southern	Western	Eastern	Central
Cu, mg/kg	1.00	0.220 0.01	0.210 0.010	0.250 0.020	0.200 0.010	0.150 0.010
Zn, mg/kg	5.00	4.150 0.50	4.140 0.420	2.700 0.350	2.270 0.190	4.320 0.530
Cd, mg/kg	0.03	0.009 0.01	0.009 0.004	0.009 0.004	0.009 0.001	0.008 0.001
Pb, mg/kg	0.10	0.038 0.08	0.020 0.004	0.034 0.002	0.026 0.004	0.030 0.004
^{137}Cs,	100.0	2.340 0.15	2.640 0.180	3.550 0.100	2.150 0.070	3.380 0.180

Chemical element	MPC	Zone				
		Northern	Southern	Western	Eastern	Central
Bq/kg	0					
^{90}Sr, Bq/kg	25.00	1.530 0.08	1.590 0.090	2.010 0.050	1.640 0.060	1.790 0.090

Source: Author

The highest copper content is detected in the milk of the western zone. In the northern zone, where this element in the diets is maximum it is 12% less in milk than in the western zone. The milk of the northern, southern and central zones is more polluted with zinc, and the maximum content of the toxicant in the diets of pasture and housing seasons is found in the central and eastern zones. The highest lead concentrations were found in the milk of the northern and western zones, with the content of this element in the diets of the western zone being minimal. The maximum number of radionuclides in cows' milk was observed in the western zone, ^{90}Sr being found in the same amounts. However, the highest concentration of ^{137}Cs in the diets is observed in the western and central zones.

According to the results of studies the content of heavy metals and radionuclides in daily rations and milk was determined by the coefficients of their transfer from the food to cows' milk during pasture and housing seasons (Table 4).

The transfer factors of heavy metals and radionuclides from food to cows' milk during pasture and housing seasons showed that there was no direct relationship between the presence of toxicants in feed and milk. As the toxicity of food increases, the barrier functions of animals' organisms also increase, the transfer factor decreases. This pattern is preserved in any season of the year, but during pasture seasons, the transfer factor is greater than that one during housing seasons: for copper by 1.1 times; for zinc by 1.3 times; for cadmium by 1.1 times; for lead by 1.8 times; for cesium-137 by 1.1 times; for strontium-90 by 1.2 times. This is probably since during pasture seasons animals can eat sod layer, especially when grass is poor.

Table 4. Heavy metal transfer factor in the system "diet – milk"

Studied zone	Transfer factor					
	Cu	Zn	Cd	Pb	^{137}Cs	^{90}Sr
Housing season						
Northern	0.74	1.32	0.72	0.04	4.12	2.55
Southern	0.78	1.49	0.80	0.04	6.63	2.95
Western	0.83	0.94	0.87	0.05	6.21	3.19
Eastern	0.90	0.95	0.87	0.03	5.28	3.07
Central	0.76	1.18	0.82	0.03	6.81	3.35
Pasture season						
Northern	0.78	1.84	0.80	0.07	6.11	2.96
Southern	0.84	1.55	0.85	0.04	7.55	3.14
Western	0.88	1.13	0.80	0.09	5.04	3.20
Eastern	0.95	0.74	0.81	0.05	6.33	2.87
Central	0.74	1.93	0.93	0.07	4.82	3.91

Source: Author

5. CONCLUSION

To obtain ecologically safe agricultural products, all links of the feed-diet-animal-production chain should be controlled for the presence and level of contaminants in order to elaborate due measures to reduce their migration into trophic chain.

The studies showed that plant foods unequally accumulate heavy metals and radionuclides. The highest concentrations of the studied elements were found in the hay of natural lands in comparison with the smooth-brome hay. Among grain crops, wheat showed the ability to accumulate heavy metals and radionuclides more, with barley and oats showing less. The smallest number of studied toxicants in succulent feeds was observed in corn silage.

Various plant foods accumulate toxic elements differently. This knowledge will make it possible to regulate toxic elements entering animal products by selecting the components of diets.

The maximum degree of feed contamination was observed in the northern zone. The dependence of the concentration of toxic substances in feed on their quantity was established. The calculated regression equations have high correlation coefficients which indicate the presence of a close relationship between the concentration of toxicants in daily diets and the content of these elements in feed.

The studies revealed no relation between the content of heavy metals and radionuclides in diets and cows' milk. When the toxicity of feed increases, the transfer factor of ecotoxicants decreases. During pasture seasons, the transfer factor is greater than during housing seasons. The concentration of heavy metals and radionuclides in cows' milk near the facilities for storing and destructing of chemical weapons does not exceed the MPC, which indicates its environmental safety.

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ORIGINAL RESEARCH PAPER

ENVIRONMENTAL EVALUATION OF IN-SOIL APPLICATION OF SOLID ORGANIC FERTILIZERS

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ABSTRACT

The world and domestic agricultural practices prove fertilizers to be key for improving soil fertility. At the same time, organic fertilizers play an important role in agriculture. Their value is determined by a complex positive impact on all factors of soil fertility (agrochemical, agrophysical, biological). The technology of continuous surface distribution of fertilizers with the following embedding into the soil is the most widespread way of application of organic fertilizers. This technology has several disadvantages and is not particularly effective in the cultivation of row crops. In this regard, more and more attention is paid to the search for methods of rational use of organic fertilizers, one of these techniques being in-soil application. The main requirement for soil fertilization is its uniform distribution, deviation from uniformity leading to a decrease in fertilizer payback. The relative content and size of solid inclusions in organic fertilizers, which lead to disruptions in functioning of working parts, are key for the uniformity of distribution. Undue embedding of fertilizers scattered across the field is well known to have an adverse effect on the land and on human health. The in-soil application of solid organic fertilizers being understudied, and technical means being inefficiently used, this technique fail to be widely applied in farms. In this regard, the problem of developing a process of uniform distribution of fertilizers for in-soil application is becoming more acute and is an urgent scientific problem for agricultural production, with the aim being to increase the efficiency of using organic fertilizers. To improve the efficiency of technologies and technical means, a device for applying organic fertilizers is developed. The object of the research is the technological process of applying solid organic fertilizers, the subject of the study being the patterns of interaction of the working parts of the dosing device with the fertilizer during the process of distribution. The working hypothesis was formulated as follows: the in-soil application of solid organic fertilizers will improve the conditions for the growth and development of potato tubers and prevent environmental damage as compared with continuous application. As a result of the research, it was established that the in-soil application of solid organic fertilizers with the help of the developed device has a higher technical and economic efficiency due to increased yields, reduced demand for solid organic fertilizers and prevented environmental damage. The presented technical solutions are recommended to be used in the technology of production of potatoes and other row crops.

JEL classification: Q1, Q57, Q24

***Keywords**: environmental damage, subsurface fertilizer application, potatoes, technological process, device, agriculture, product quality, yield, technical and economic efficiency.*

1. INTRODUCTION

The main requirement for soil fertilization is uniform distribution. Uniformity deviating leads to a decrease in the payback of fertilizers, the untimely incorporation of fertilizers scattered across the field causes the negative impact on soil, on people’s health.

The article is concerned with the environmental aspects of in-soil application of solid organic fertilizers, with the purpose of research being to improve the technology and technical means for in-soil application of organic fertilizers aimed at improving economic and environmental efficiency, when using a complex of interrelated agrotechnical, agrochemical, meliorative, organizational and economic measures for effective cultivating, protecting, improving of cultivated lands along with creating and favoring due ecological conditions.

The object of research being the technological process of applying of solid organic fertilizers, the subject of the study is the patterns for interaction of the working parts of the measuring device with a fertilizer when destributing. The working hypothesis is as follows: the in-soil application of solid organic fertilizers will improve the conditions for growing and developing of potato tubers and prevent environmental damage caused by the continuous application of fertilizers. As a result of the research, it is established that the in-soil application of solid organic fertilizers with the help of the developed device has a higher technical and economic efficiency due to increased yields, reduced demand for solid organic fertilizers and prevented environmental damage. Technical solutions presented in the paper are to be used when producing potatoes and other row crops. Further researching is to be directed to the development of devices for the subsoil introduction of solid organic fertilizers, leading to increasing in profits, as one of the important problems of agricultural production.

2. LITERATURE REVIEW

Agricultural practices in our country and abroad show that the alternation of crops in the system of scientifically based crop rotations is of crucial importance: soil fertility losses should be compensated by introducing special crop rotations, agrotechnical and meliorative measures, and fertilizing. Their value is determined by the complex positive impact on the factors of soil fertility.

In-soil application of solid organic fertilizers has several advantages (Scientific and technological development forecast of the agro-industrial complex of the Russian Federation for the period up to 2030 (March 16, 2017) obtained from HYPERLINK "http://docs.cntd.ru/document/456038646" http://docs.cntd.ru/document/456038646). The effectiveness of in-soil fertilization technology for cultivating potatoes and the modernization of technical means to perform its various operations is considered in basic research and developments by Kalimullin, M.N. Rotary Haulm chopper parameters development and substantiation for root and tuber crops /M.N. Kalimullin, R.K. Abdrakhmanov, S.M. Arkhipov // International Journal of Applied Engineering Research ISSN 0973-4562 Volume 10, Number 10 (2015) pp. 25691-25697, Neubauer W. Pfluglos zu Kartoffeln. Neue Landwirschaft, 1996. 9, s 64-65. Petelkau H. Grenzparametr fur die Bodenbelastung beim Einsatz von Traktoren und Landmaschinen aus der Sicht der Bodenfruchtbarkeit. B: Tagungsbtricht der ADL. Nr.250. Berlin. 1986. 25-36., Wirsing F. Kartoffeln. B: Seifert. Drucch – und Hackfruchtproduktion. Deutscher Landwirtschaftsverlag Berlin. 1981, 399 s., Sturm H., Buchner A., Zerulla W. Gezeilter dungen. 3 Aufl., Verlags Union AgrarvFrankfurt/Main,1994, 471 s., Schuhmann P. Ratgeber fur die Landwirschat in Mecklenburg – Vorpommern. Manuskript der landesforschungsanstalt fur Landwirschaft und Fishherei, Gulzow, 1996., [FAO production yearbook. Food and Agricultural Orqanization United Nations Rome, 1990]., Kalimullin, M.N. Rotary Haulm chopper parameters development and substantiation for root and tuber crops /M.N. Kalimullin, R.K. Abdrakhmanov, S.M. Arkhipov // International Journal of Applied Engineering Research ISSN 0973-4562 Volume 10, Number 10 (2015) pp. 25691-25697.

The ecological aspects of the in-soil application of organic fertilizers as compared with the continuous application include the conservation of soil resources, the reduction of the application rate of fertilizers and the environmental damage to the environment, pastures, etc.

The agroecological evaluation made it possible to establish that the in-soil application caused the full embedding of solid organic fertilizers to a depth of 15-30 cm, the rate of applicated fertilizers decreased by 3-4 times, which prevents the loss of nutrients due to nitrogen leaching resulting from precipitation and increases yields and crop quality.

3. METHODOLOGY

In-soil application makes it possible to embed solid organic fertilizers fully to a depth of 15-30 cm, which prevents nutrient losses due to nitrogen leaching resulting from precipitation. Thus, this operation should be considered as an environmental protection measure.

The economic result of the average protection measures is valued as the annual damage prevented.

$$Э_Г = \gamma \sigma_K M \quad \text{RUB.} \tag{1}$$

where γ is a constant multiplier. γ = 400 RUB/conv.tons; σ_K is a constant with different meanings for different water-resource regions, for the Urals σ_K = 0.5; M is the given mass of the annual outwash of fertilizers in a water-resource region, tons/year

M is determined from the expression

$$M = \sum^{N} A_i m_{i_{i=1}} \tag{2}$$

where N is the total number of impurities discharged by the estimated source; A_i is the indicator of the relative discharge hazard caused by the ith impurity into the water reservoir, conv.tons/t; m_i is the total mass of the annual discharge caused by the ith impurity by the estimated source, tons/year.
Since in solid organic fertilizers the greatest danger is caused by total nitrogen and suspended solids, all further calculations are made for these indicators: for nitrogen A1 = 0.1, for suspended solids

A2 = 0.05.

The total mass of the annual outwash of nitrogen and suspended solids is:

$$\begin{gathered} M1 = 0{,}01 * C * M_г * N \\ M2 = 0{,}01 * C * M_г * C_в \quad \text{tons/year} \end{gathered} \tag{3}$$

where C is the coefficient for the magnitude of lost fertilizers from the field surface. C is equal to 0.1 for N and 0.05 for the dry matter; M is the possible annual volume of fertilizers applied by the unit, tons; N is the percentage of total nitrogen in solid organic fertilizers N = 2.74%; C_B is the percentage of the dry matter in solid organic fertilizers, C_B = 85%.
The possible annual amount of fertilizers is determined by the formula

$$M_г = W * Tз * H \quad \text{tons} \tag{4}$$

where W is the hourly capacity of the unit ha/hour; Tl is the standard annual load of the unit, h; H is the fertilization rate 10 t/ha.

4. EMPIRICAL FINDINGS

The agrotechnical evaluation was conducted to study the effectiveness various doses of fertilizer on potato yield. Organic fertilizers were applied with MTV-82+MVU-4,2 unit according to bed-strip potato growing technology, with a mixture of bird droppings, chopped straw and sawdust being used as an organic fertilizer. The yield of crops according to any way of applying manure increased along with increasing the doses of fertilizers up to 10-12 t/ha. However, further increasing in the doses of fertilizers caused the yield decreasing as a result of the fact that organic fertilizers are rich in nutrients and the plant root system is inhibited. The maximum increase was obtained at the dose of 10 t/ha. The analysis of Table 1 showed that the yield of potatoes in case of in-soil application is 1.3 times greater than in case of surface application.

Production tests showed that the use of in-soil application of organic fertilizers has a higher technical and economic efficiency: in the experiment, the yield increased by 15-20%, fertilizer application rates decreased by 3-4 times.

Table 1. The yield of potatoes with in-soil application of fertilizers depending on the dose

Indicators	Areas				
		1	2	3	4
Soil type		Leached mid humus Low-power medium loamy			
Dose of fertilizer, t/ha		not applied	50 overall application	8 locally	12 locally
Embedding depth, cm			20	3-6 below tubers	3-6 below tubers
Harvesting method	combine				
Yield, c/ha	2016	141	166.0	181	198
	2017		122.0	147	159

Source: Author

5. CONCLUSION

The main requirement for in-soil application of fertilizers is its uniform distribution. Deviation from uniformity leads to a decrease in fertilizer payback. It is well known that undue embedding of fertilizers scattered across the field has an adverse effect on the land and on human health. In this regard, the problem of developing a uniform distribution process for fertilizers for soil application is becoming more acute and is an urgent scientific problem. To improve the efficiency of technologies and technical means, a device for applying organic fertilizers has been developed, as the object of researching was the technological process of applying solid organic fertilizers, the subject being the interaction patterns of the working parts of the dosing device with the fertilizer during distribution. Thus, a method for evaluating the agrotechnical and environmental effectiveness of the in-soil application of organic fertilizers is proposed. As a result of the research, the proposed hypothesis is confirmed. The in-soil application of organic fertilizers is established to have high efficiency: in the experiment the yield increases by 15–20%, and fertilizer application rates decrease 3-4 times.

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ORIGINAL RESEARCH PAPER

ENVIRONMENTAL ASPECTS OF TECHNOLOGICAL IMPACT ON SOIL CAUSED BY TECHNICAL MEANS USED IN AGRICULTURE

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ABSTRACT

Intensification of crop production leads to an increase in man-made pressure on the soil. Over the past decades, mobile technical means used in crop production have increased by 1.5 ... 2.0 times and reached an absolute value of 25 ... 40 tons. When moving these heavy units across the field while performing technological and transport operations their undercarriage systems have the negative impact on soil leading to its degradation. The man-made compaction and destruction of the fertile soil layer disrupt its aeration; worsen the biological processes occurring in it, inhibiting the development and activity of microorganisms, causing erosion processes. Lands become less fertile or completely unsuitable for crop production, which leads to desert advancing and preventing them from agricultural use. The analysis of scientific literature sources revealed one of ways for solving this ecologically acute issue. This paper presents a technique for studying the effects of undercarriage systems of various tractor-transport units on the soil. The revealed dependence of the pressure of their wheels on constructive and operational parameters made it possible to determine that trailer (semi-trailer) wheels have the greatest compaction effect on the soil (causing its structural destruction). To eliminate this negative phenomenon, a constructive solution has been proposed: the installation of additional wheels on a trailer, with the possibility of raising and lowering them due to a pneumatic actuator to increase the unit efficiency when it moves on various bearing surfaces. For an improved design, the rational arrangement of additional wheels on a trailer is justified, a drive scheme being developed, and experimental studies being performed. The results of the study showed that the use of units with improved trailer running systems allows a 25...30% reduction in specific wheel pressure on the soil and the economic effect of using a tractor-transport aggregate for silage making in the amount of 980 RUB/ha due to shortfalls in crop yield, arising from the man-made impact of the undercarriage system on the fertile soil layer.

JEL classification: Q1, Q5, Q15, Q19

Keywords: *soil degradation, technogenic impact, soil compaction, transport unit, wheel pressure*

1. INTRODUCTION

Intensification of agricultural production leads to an increase in man-made pressure on the soil. Over the past decades, mobile technical means used in crop production have increased by 1.5 ... 2.0 times and reached an absolute value of 25 ... 40 tons. When moving these heavy units across the field while performing technological and transport operations their undercarriage systems have the negative impact on the soil leading to its degradation. Man-made compaction and destruction of the fertile soil layer disrupt its aeration, worsen the biological processes occurring in it, inhibit the development and activity of microorganisms, cause erosion processes. Only in the Russian Federation, desert advancing is to some extent observed in 27 subjects on the territory of more than 100 million hectares preventing them from agricultural use.

The solution of this ecological problem is stated in “Fundamentals of the state policy concerning the environmental development of the Russian Federation until 2030” developed and approved by the President of the Russian Federation and is included in the strategies of the environmental safety of the Russian Federation for the period until 2025.

The urgency of this problem is also highlighted by scientists from various countries (Holthusen et al., 2018; Garcia-Tomillo et al., 2018; Gomez-Calderon et al., 2018; Sivarajan, S. et al., 2018; Bennett et al., 2017; Vrscaj et al. 2017).

2. LITERATURE REVIEW

Scientists from various countries of the world have been studying the negative impact of wheeled mobile vehicles on the soil (Keller et al. 2015, 2016; Lamande et al. 2015, 2017; Asoodar et al., 2014; Mion et al., 2016). Their research makes it possible to analyze the process of soil compaction under the action of wheeled undercarriage systems of machines, to determine significant factors, to assess the risk and the degree of their ecological influence on the soil.

Since the advent and use of machines in production processes, scientists have constantly searched for and developed the most rational ways to reduce the man-made impact of the undercarriage systems on the soil, with the following methods can be used:

- constructive: increasing the contact area of the undercarriage system due to the use of track-type propellers, arched or wide-profile low-pressure tires, wheel twinning, etc. (Lamande et al. (2018); Lague, C. (2017); Kotovich (2008)).

- technological: using of constant technological tracks for passing units across the field, using of a system of machines with the same or multiple capture width, decreasing the number of passing machines due to decreased technological operations performed, autopiloting of the units, etc. (Duttmann et al. (2014); Blanco Canqui et al. (2018));

- operational: regulating the air pressure in tires of wheels differentiating the mass of traction means due to provisional weights, etc. (Holthusen and others (2018); Zyryanov and others (2009, 2014)).

A review of the literature revealed that research is mainly aimed at reducing the pressure of the undercarriage systems of technological units. However, transport vehicles also move on fields, transporting agricultural goods (manufactured products, seeds, fertilizers, etc.) and have the negative impact on the soil system. Their man-made impact on the fertile soil layer is currently not fully understood and it is necessary to develop ways to reduce soil compaction caused by the wheels of vehicles, with tractor and transport units being the most numerous.

The paper discusses the environmental aspects of the technogenic impact on the soil due to mobile machines used in crop production, the purpose of the study being to develop a technical solution aimed at reducing soil compaction with the running systems of machines.

The object of the study is the process of soil compaction caused by the undercarriage systems of tractor-transport units, the subject of the study being the patterns of changing the unit pressure on the soil caused by the design and operational parameters.

3. METHODOLOGY

The maximum pressure of a single tractor wheel on the soil was determined according to the following dependence, considering design and operational factors

$$p_{\text{тр}} = \frac{GK_2\lambda}{0{,}5\pi b_{tw} r_0 K_1 n_w \sqrt{1-\left(1-\frac{G}{2\pi p_{\text{t}} r_0 \sqrt{r_0 r_{\text{t}}}}\right)^2}}, \tag{1}$$

where G is the load on the axis, kN; K_2 is the coefficient of longitudinal uneven distribution of pressure on the contact area of the tire (K_2 = 1.5); λ is the load distribution coefficient for the axes of the wheels; b_{tw} is the tire width, m; n_w is the number of wheels on an axis, pieces; r_0 is the radius of the unloaded wheel, m; K_1 is the coefficient depending on the outer diameter of the tire wheel; p_{t} is the tire pressure, kPa; r_t is the tire radius, m.

In the case of using of a tractor-transport unit for transporting agricultural products, the load on a single trailer (semi-trailer) wheel is determined

$$G = \frac{g(m_{\text{c}} + V_b \cdot \rho \cdot \gamma)(1-\beta)}{n_w}, \tag{2}$$

where g is the acceleration of gravity, m/s^2; m_c is the constructive mass of the trailer (semi-trailer), t; V_b is the body volume, m^3; ρ is the density of the transported cargo, t/m^3; γ is the utilization rate of the nominal carrying capacity of the vehicle; β is the mass fraction of the semi-trailer for the hitch tractor device.

Substituting expression (2) into (1), we obtain an analytical dependence for determining the maximum pressure of a single trailer (semi-trailer) wheel on the soil

$$p_{\text{пр}} = \frac{g(m_{\text{c}} + V_b \cdot \rho \cdot \gamma)(1-\beta)K_2}{0{,}5\pi b_{\text{tw}} r_0 K_1 n_w \sqrt{1-\left(1-\frac{g(m_{\text{c}} + V_b \cdot \rho \cdot \gamma)(1-\beta)}{2\pi p_{\text{t}} r_0 n_w \sqrt{r_0 r_{\text{t}}}}\right)^2}}. \tag{3}$$

According to expressions (1) and (3), we determine the maximum pressure of the wheels of tractor-transport units most used in Russia.

Calculations show that at nominal loading of trailers in terms of carrying capacity, the specific pressure of their wheels on the soil is 1.2...1.5 times greater than the pressure of tractor wheels (Fig. 1).

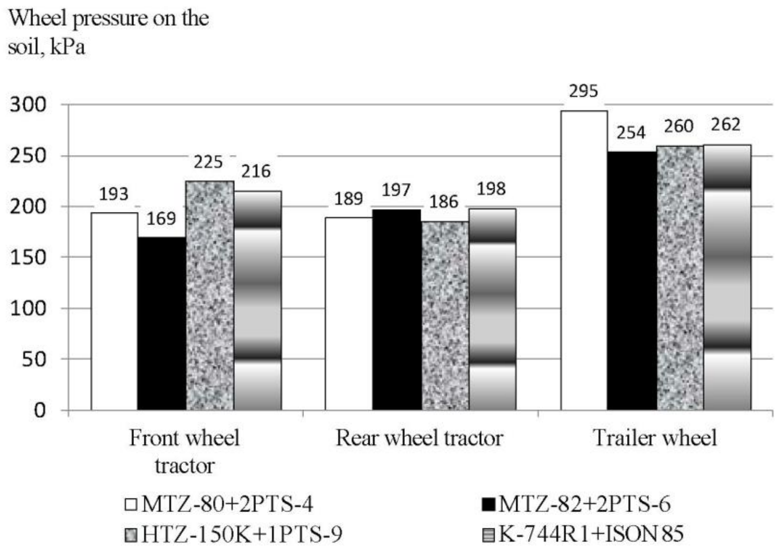

Fig. 1. The maximum specific pressure of the wheels of various tractor-transport units on the soil
Source: Author

The analysis made it possible to reveal that trailer (semi-trailer) wheels have the greatest compaction effect on the soil (causing its structural destruction) when used in tractor-transport units. To eliminate this negative phenomenon, a constructive solution has been proposed: the installation of additional wheels on a trailer, with the possibility of raising and lowering them due to a pneumatic actuator to increase the unit efficiency when it moves on various bearing surfaces. For an improved design, the rational arrangement of additional wheels on a trailer is justified, a drive scheme being developed, and experimental studies being performed.

4. EMPIRICAL FINDINGS

The results of the experiments showed the most significant factors influencing the pressure value of a single wheel on the soil to be the air pressure in the tires and the load on it, arising from the mass of the trailer itself and the cargo being carried. The results of the experiments are presented in Fig. 2

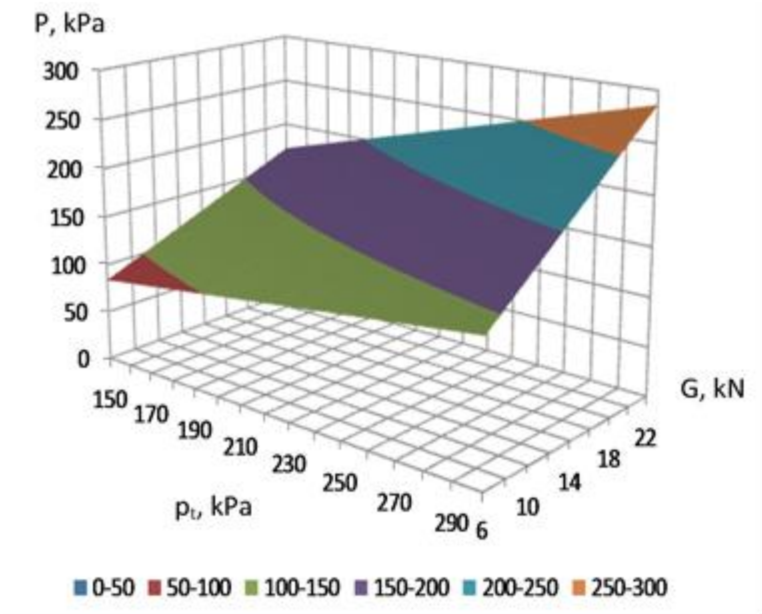

Fig. 2. The change of the pressure of a single 2PTS-6 trailer wheel on the soil from the tire pressure and the vertical load acting on it

Source: Author

The obtained experimental results prove the load which depends on the load of the body relative to the nominal capacity to have the most effect on a single trailer wheel pressing the soil. When the trailer is half full, the pressure of the undercarriage system begins to exceed the pressure of the tractor wheels, and at nominal load it exceeds 1.4 times.

Soil hardness measured on the tractor-transport track showed the negative impact of the wheels to occur at a depth of more than 30 cm, i.e. deeper than the basic tillage. This causes the diet violation for cultivated plants, the deterioration of their developing root systems and, therefore, a decrease in yield. In addition, compacted soil reduces moisture capacity and the precipitation absorption rate, which increases the risk of water erosion and the loss of humus accumulated over thousands of years.

The proposed technical solution for reducing the pressure of the trailer undercarriage system by installing additional lifting wheels on it allows a 25...30% reduction in the pressure of its wheels on the soil as compared to the serial design and to achieve the size of a tractor.

The analysis of the obtained results allowed substantiating the rational constructive location of additional wheels on trailers. To ensure the lowest pressure of the undercarriage system 2PTS-6 on the soil, they should be located at a distance of 1.2...1.3 m relative to its front axis.

5. CONCLUSION

The man-made impact of the undercarriage systems of various tractor-transport units on the soil being studied revealed the wheels of trailers (semi-trailers) to have the most significant effect on the soil compaction and degradation and 1.2...1.5 times higher than the pressure of tractor propulsion units. Soil hardness measured for a tractor-transport track showed the negative impact of the wheels to occur at a depth of more than 30 cm, i.e. deeper than the basic tillage. It is cumulative in nature and cannot be eliminated by mechanical processing.

Based on the revealed analytical dependence of the specific pressure of the tractor-transport unit wheels on the soil on its design and operational parameters, a technical solution is proposed to reduce the man-made impact of the unit on the soil, i.e. improving the trailer design by installing additional lifting wheels on it.

The results of the study showed that this method allows reducing the specific pressure of the unit undercarriage system on the soil by 25...30% and to obtain an economic effect when using the tractor-transport unit for silage making in the amount of 980 RUB/ha due to a decrease in crop yield arising from the man-made impact of undercarriage systems on the fertile soil layer.

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ORIGINAL RESEARCH PAPER

TECHNICAL EFFICIENCY OF ORGANIC WHEAT PRODUCTION IN THE KOSTANAY REGION OF THE REPUBLIC OF KAZAKHSTAN

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ABSTRACT

Kazakhstan, which has extensive land resources, much of which was little cultivated, or was cultivated with little or no use of synthetic means, has unlimited potential in organic agriculture, both in the production of dairy products and meat, and in the cultivation of organic crops. Therefore, organic production is one of the country's national development priorities. The purpose of the study is to develop and test an approach to assessing the effectiveness of the transformation of traditional agricultural production into organic. The object of the research is agricultural enterprises of the grain direction of the Kostanay region of the Republic of Kazakhstan. The subject of research is the economic relations in the process of transition to organic agriculture. The article presents the analysis and calculation of the technical efficiency of the project for the transition to the organic method of growing wheat, on the example of LLP "Asalia" of the Kostanay region of the Republic of Kazakhstan. This assessment is carried out on a comparison of two states: "With the project" and "Without the project". Having a high profitability of wheat production in the traditional way (27.7%), LLP "Asalia" can increase its profitability up to 57.9%. Even though during the transition from traditional to organic production, the company is forced to work 3 years at a loss, this transition is economically justified, efficient and financially viable. The study suggests that the project of growing organic wheat in LLP "Asalia" of the Kostanay region of the Republic of Kazakhstan has good economic resistance to changing economic factors affecting the success of the project.

JEL classification: Q10, Q16, E23

Keywords *organic agriculture, Republic of Kazakhstan, project analysis, technical efficiency*

1. INTRODUCTION

The need to produce ecologically safe agricultural products is realized by both the public of the Republic of Kazakhstan and its Government. Several documents have been adopted in the Republic of Kazakhstan, including the Concept for the transition of the Republic of Kazakhstan to a "green economy" for 2013–2020, approved by a presidential decree in 2013. The Parliament of the Republic of Kazakhstan adopted a law on the production of organic products at the end of 2015. All these documents marked the beginning of a new stage in the development of "green" agriculture.

The government has envisaged the development of standards for products of organic (ecological) agricultural production in accordance with international requirements. However, the standards themselves are not of importance without the development and implementation of an integrated system of production and turnover of organic products. In the process of finding ways of transition to resource-saving and energy-saving ecological farming, several problems were emerged, which cannot be solved without the participation of science. It relates to realization of actions which will allow to estimate objectively expediency of introduction of organic agricultural production including from the economic point of view. However, so far there have been no major achievements in the development of this area in the Republic of Kazakhstan. It is necessary to conduct research in this area of agricultural development, the adoption of state-targeted programs, the introduction of organic agrobiotechnologies, and much more.

Thus, the issue of organic production and, on its basis, increasing the economic efficiency of agricultural enterprises determines the relevance of this study, creates the necessary prerequisites for developing forms and methods that promote the development of organic production.

The purpose of the study is to develop and test an approach to assessing the effectiveness of the transformation of traditional agricultural production into organic.

The object of the research is the agricultural enterprises of the grain direction of the Kostanay region of the Republic of Kazakhstan.

The subject of research is the economic relations in the process of transition to organic agriculture.

2. LITERATURE REVIEW

The agricultural sector of Kazakhstan in recent years has been characterized by an increase in gross output. In 2011, the annual production volume of agricultural products was estimated at a level of 457.2 billion rubles, and by 2015 this figure was 661.4 billion rubles, which is 44.7% more than in the 2011. These facts indicate that the industry is developing dynamically and has a high export potential (Zhaishylyk, N., Sun, F., 2017).

The tendency of transition to organic food is observed all over the world since the 50s of the last centuries. According to the data, the volume of the world market of certified organic products in 2015 amounted to 81.6 billion dollars. (Willer, H., Lernoud, J., 2017)

Organic agriculture is a system of ecological production of agricultural products, considering the preservation of the ecosystem, within which deliberately minimize the use of mineral fertilizers, pesticides, plant growth regulators, feed additives, genetically modified organisms. (Migliorini, P., Wezel,A,2017), (Brzozowski, L ., Mazourek, M., 2018),(Luttikholt, L. W. M, 2007), (Moudry, J., Bernas, J., Moudry, J.,Konvalina, P.,Ujj, A., Manolov, I., Stoeva, A., Rembialkowska, E., Stalenga, J., Toncea, I., Fitiu, A., Bucur, D., Lacko-Bartosova, M.,Macak, M.,2018.),(Xu, Q ., Huet, S., Poix, C., Boisdon, I., Deffuant, G., 2018).

Currently, the market for organic products is one of the most developing and promising areas of agro-industrial production. (Ditlevsen, K., Sandoe, P., Lassen, J., 2019),(Skrodzka, V, 2017), (Brzezina, N., Biely, K., Helfgott, A., Kopainsky, B., Vervoort, J., Mathijs, E., 2017), (Gomiero, T., 2018), (Cox, WJ., Cherney, J, 2017), (Nyussupova, GN., Tokbergenova, AA., Kairova, SG., Arslan, M., 2015), (Billen, G., Le Noe, J., Garnier, J., 2018), (Moschitz, H., Stoeva, S., Slavova, P., Pickard, D., Georgieva, Z., Stolze, M., 2018)

The country's food security, public health and the quality of its life are largely due to the development of organic agricultural production based on innovative developments in the field of alternative land use, the preservation of natural resources, primarily land. (Kozakova, J., 2015), (Lassen, J., Oelofse, M., 2018), (Jarczok-Guzy, M., 2018), (Kutnohorska, O., 2016).

Kazakhstan has everything necessary for the formation of agriculture, focused on the production of organic products: perennial agricultural traditions, vast areas of agricultural land, as well as a low level of intensification and chemicalization of the agro-industrial complex in comparison with industrially developed countries. So, on average in the Eurozone countries, the application of mineral fertilizers is 192 kg / hectare, while in Kazakhstan - 2.8 kg / hectare. (Selskoye, lesnoye i rybnoye khozyaystvo v RK. 2010-2014, 2015)

3. METHODOLOGY

The organizational and economic mechanism of grain production is based on the specific representation of the "economic efficiency" of production and the determination of its production and technological criteria. From this thesis it follows that the transformation of the formation of the organizational and economic mechanism of grain production from theory to practice is carried out on the basis of many factors. (Gorpinchenko, K., 2014), (Petrova, I., 2016.), (Silaeva, L., Kupyreva, L., 2014). The basic elements that form such a mechanism include: a block of state regulation, a block of production and financial and economic activities of agricultural organizations producing grain, soil and climatic conditions for the functioning of economic entities, etc.

If we talk about the features of the analysis and evaluation of grain production in an organic way, then in our opinion, the most appropriate is a project analysis, which consists of several fundamental aspects: technical, institutional, social, environmental, commercial, financial, economic (in terms of profit). (Potasheva, G., 2016), (Bukanova, K., Bryukhanova, G., 2016), (Kirshin, I. Sadykova, A., 2017)

All these aspects allow us to evaluate the project of organic wheat production from the position of transition from the traditional technology of its cultivation to organic. This assessment is carried out on a comparison of two states: “With the project” and “Without the project”. When researching a project, it is necessary to analyze both states and calculate the economic effect for the entire period of the calculation period. In our study, the traditional method of cultivation is the technology that is currently used in agricultural enterprises of the Kostanay region of the Republic of Kazakhstan. This technology involves the use of herbicides and pesticides, which, of course, does not make it possible to consider the resulting grain as organic.

The study used statistical data for 2016-2017, obtained by the method of observation at LLP “Asalia” of the Kostanay region of Kazakhstan, as well as information provided in official sources on agriculture of the Republic of Kazakhstan. (Komitet po statistike Ministerstva natsionalnoy ekonomiki Respubliki Kazakhstan, 2017)

4. EMPIRICAL FINDINGS

To assess the economic efficiency of the production of organic products for LLP “Asalia”, we calculated the economic indicators for traditional wheat cultivation, table 1, during the conversion period - the transition period to organic production, table 2 and the organic method, table 3. During the conversion period, losses were incurred since wheat production uses organic technology, but the products do not meet the standards and cannot be sold at high prices. The yield during this period is also significantly reduced, which leads to additional losses.

Table 1. Indicators of economic efficiency in the traditional method of growing wheat (LLP “Asalia”, 2016)

1	**Selling price, rub / t**	7 500,00
2	**Cost of production from 1 hectare, rub**	7 500,00
3	**Net income from 1 ha, rub**	1 149,29
4	**Profitability, %**	27,7

Source: Author

Table 2. Indicators of economic efficiency in the conversion period

1	**Selling price, rub / t**	7 500,00
2	**Cost of production from 1 hectare, rub**	6 000,00
3	**Net income from 1 ha, rub**	-713,63
4	**Profitability, %**	-10,6

Source: Author

Table 3. Indicators of the economic efficiency of the enterprise operating in the conditions of the organic market

1	**Selling price, rub / t**	13 250,00
2	**Cost of production from 1 hectare, rub**	10 600,00
3	**Net income from 1 ha, rub**	3 886,37
4	**Profitability, %**	57,9

Source: Author

Financial analysis of projects based on a comparison of the optimal states of the “With the project” and “Without the project” objects showed their very high efficiency, tables 4 and 5.

Table 4. Main indicators of production efficiency in situations “With a project” and “Without a project”

Indicators	unit of measurement	LLP "Asalia"	
		Without a project	With a project
Material and cash costs for commercial products	rub.	587471	671363
Proceeds from sales of products	rub.	750000	1060000
Profit	rub.	162529	388637
Profitability	%	27,7	57,9

Source: Author

Table 5. The main indicators of the financial efficiency of the investment project to produce organic wheat

Indicators	unit of measurement	LLP "Asalia"
Net present value (NPV)	rub.	493261.66
Internal rate of return (IRR)	%	75.9370
Profitability Index (PI)	-	1,012
Discounted payback period (DPBP)	years	6

Source: Author

Investment activity always accompanies with certain risks: a project may end up with a fiasco not being economically potential or not profitable enough for an investor if there are no impartial events, but quite likely.

Monitoring the sensitivity of the project to changes in individual source components showed that the project is stable and poorly responsive to changes in almost all parameters and at the same time remains economically attractive, even when the most adverse circumstances occur. However, a two, threefold reduction in the price of products manufactured and a rise in prices for industrial energy or other types of resources can lead to financial inefficiency. To monitor the effectiveness of the project, two possible scenarios of events were analyzed, which are characterized by changes in several parameters, table 6.

Table 6. The main indicators of financial efficiency of the investment project under various scenarios

Indicators	Scenario 1	Scenario 2	Basic scenario
Net present value (NPV), rub.	469773	460992	493261.66
Internal rate of return (IRR) , %	72,32	70,969	75.9370
Profitability Index (PI)	1,117	1,114	1,122

Source: Author

The baseline scenario implies a yield of 0.8 tons / hectare and the price of products remains within the current market price.

Scenario 1 implies that in the second year of the project implementation the planned yield due to adverse weather conditions will not be achieved. Scenario 1 is moderately pessimistic.

In Scenario 2, a 5% reduction in price is added to adverse weather conditions, starting from the 7th year of the investment project, due to an increase in the share of organic wheat in the market.

These scenarios are obviously unfavorable.

Indicators of the project, table 6 talk about maintaining financial prospects in all three projected scenarios. Based on the above, the project for the transition from traditional crop production to organic can be considered economically feasible, because it has low risks.

5. CONCLUSION

The development of organic production in Kazakhstan is in the formative stage. Currently, there are about 30 manufacturers of organic products, which are certified according to international standards, they cultivate more than 300 thousand hectares of land. Now this production is focused primarily on exports, but with the creation of the necessary conditions, Kazakhstan can also produce products for its own domestic market.

Even though during the transition from traditional to organic production, the company is forced to work 3 years at a loss, this transition is economically justified, efficient and financially viable. The study shows that the project of growing organic wheat in LLP “Asalia” of the Kostanay region of the Republic of Kazakhstan has good economic resistance to changing economic factors affecting the success of the project.

Organic farming has profitability perspectives in Kazakhstan and has threefold benefits for the environment, farmers and public health. Preserving soil fertility and ecosystems, organic farming is one of the best practices for ensuring environmental sustainability. It also rewards farmers with sustainable incomes due to the rapid growth in sales of organic products worldwide. In addition, organic products are good for people's health.

Kazakhstan, which has extensive land resources, a significant part of which was little cultivated, or was cultivated with little or no use of chemicals, has unlimited potential in organic agriculture, both in the production of dairy products and meat, and in the cultivation of organic grain crops. Therefore, organic production is one of the country's national development priorities.

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ORIGINAL RESEARCH PAPER

DEVELOPMENT AND APPLICATION OF «SMART GREEN HOUSE» TECHNOLOGY IN HORTICULTURE AND GARDENING

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ABSTRACT

The article deals with the problems of using robotic greenhouses on a non-industrial scale. It clarifies the concept of "smart greenhouse", provides current trends overview of robotic greenhouses construction, as well as the results of the experiment, which consists in developing a "smart greenhouse". Analysis of the results showed that the creation of a "smart greenhouse" implies that the developer has skills in the field of mechanics, electrical engineering and microelectronics, programming, including programming microcontrollers and knowledge bases, as well as knowledge of the growing various crops technology in greenhouse complexes. The lack of thought in any aspect of a robotic greenhouse reduces the efficiency of the technology, and the investment does not pay off. On the contrary, a competent approach to the creation of a "smart greenhouse" can significantly increase productivity while reducing the labor costs of garden plots owners. Thus, timely (instantaneous) notification of emergency situations (output of the controlled parameters values beyond the technological boundaries, equipment failure, etc.) will minimize losses from accidents and violations of the technological regime. At the same time, increasing the level of intellectual greenhouses associated with an increase in the cost of its development. Now, the cost of a robotic greenhouse is quite high for the target audience, which implies further research in the field of creating complex and cost-effective solutions for "smart greenhouses".

JEL classification: Q10, Q18, Q52, Q57

Keywords *smart greenhouse, automated control system, crop production, Arduino*

1. INTRODUCTION

Global warming is a threat to agriculture. Scientists suggest that it may lead to a reduction in the area of land suitable for agriculture, as well as reduce the effectiveness of traditional agricultural technicians due to climate change. The lack of food in this situation becomes a very real threat to all mankind. For this reason, researchers are developing new technologies to increase yields and reduce risks associated with climate change.

Greenhouse crop production is one of the most popular ways to ensure crop yield in unfavorable conditions for plant growth and development, including in Russia. The length of greenhouse complexes can reach several hectares, so the management is interested in automation and robotization of these areas' maintenance.

Now, automated climate control systems have already been developed for large greenhouse complexes, but these solutions are not suitable for small businesses, as well as private farms.

In the Russian Federation, about 50% of the population has garden plots, while working for them in their free time. For households with an income of up to two subsistence levels per person, garden and garden plots are the main source of plant origin food. Of course, the owners of such sites are more interested in reducing physical labor, increasing yields, and reducing the risks associated with weather conditions than, for example, small agricultural enterprises. Unfortunately, the use of traditional greenhouses is not able to solve all these problems.

Now, due to the development of information and intellectual technologies, more and more owners of garden and vegetable plots are thinking about the introduction of robotic greenhouses, which, by analogy with the technology of "smart house" are called "smart greenhouses".

In a general sense, a “smart” greenhouse is a technology for crop production automating (robotization), based on the implementation of intelligent information technologies in greenhouses. The hardware part of the smart greenhouse consists of temperature, light and humidity sensors, as well as a network of electric actuators, which actuate separate parts of the lighting, irrigation and ventilation systems; software - an intelligent system for monitoring the status of sensors and controlling electric drives, which provides the optimal microclimate for a grown crop inside the greenhouse.

2. LITERATURE REVIEW

The analysis of the last years scientific literature has shown that the researchers are mainly considering the development of the large greenhouse complexes micro-climate control systems, at the same time, the emphasis is on the wireless technologies (Chien T. V., Chan H. N., Huu T. N., 2011; Rohit K. Nikhade, Nalbalwar S. L. (2013); Balabanov V. I., 2017, etc.) and IoT technologies (A. Zanella, N. Bui, A. Castellani, L. Vangelista, M. Zorzi, 2014, etc.). This is justified, because such infrastructure solutions do not depend on the topology of land plots and are able to provide coverage of any area.

Some of the works concern the choice of a knowledge representation model that is most convenient for developing a greenhouse management system knowledge base (Azaza, M. A. Mami, Tanougast, S. E. Fabrizio, 2016, etc.). At present, development issues of the element base are almost not affected, since at the present level of electronics, automation and robotics development to solve such fairly simple tasks, you can choose the right combination of sensors, controllers and electric motors without any problems (I. Gavrilova, V. Cherkasov, S. Chistyakova, 2016, and so Further.).

It should be noted that in the last two or three years, the smart greenhouses have been the subject of many student studies, in which young scientists offer various options for the development of smart greenhouses and their effectiveness (Kabanov A. A., Nikonova G. V., 2016; Skorohod A. A., Kirichenko A. S., 2016, Zhashkova T. V., 2017, etc.). Dozens of working projects of smart greenhouses are developed by the owners of garden and garden plots.

3. METHODOLOGY

In our work, we relied mainly on analytical and empirical research methods, which included the analysis of official statistics on the agricultural sector, analysis of trends in regulatory instruments of agricultural regulation in the Russian Federation, the study of domestic and foreign experience in the robotic greenhouses development, presented in scientific journals, as well as an experiment in the smart greenhouses development and application in the garden area.

The experiment was carried out in several stages.

At the first stage, the selection of the element base for future greenhouses was carried out, and the topology of the intelligent greenhouse management system was developed.

At the second stage, the design of "smart greenhouses" nodes was carried out, because it was supposed to compare two options for controlling the greenhouse: with and without human participation.

At the third stage, two versions of the intelligent greenhouse management system were developed: without a decision-maker, a fully autonomous version, and a partially automated version, in which the decision to manage the greenhouse nodes was made by a person.

The fourth stage is the experiment itself, which involves the care of the culture planted in the greenhouse. For the purity of the experiment, seedlings of one tomato variety grown in the same conditions were used.

At the fifth stage, the results of the experiment were analyzed, the cost of solutions was calculated and compared with the income of the target audience, conclusions were drawn.

4. EMPIRICAL FINDINGS

A comparative analysis of the functionality and cost of existing software solutions (OVEN, SIMATIC S7, Priva Connext, ACS MT "Klimat" from research and production association "AvtomatikA") showed that the functional systems are almost identical. They all monitor the status of the humidity, light, temperature, carbon dioxide content sensors and give a signal about going beyond the permissible values. The cheapest solution is offered by the Russian company OVEN - from 300 thousand rubles.

The developed system includes a control unit based on a microcontroller, a measuring sensor of ambient air temperature, a measuring sensor of soil moisture, a measuring sensor of lighting, a voltage separation system, Lan, Wi-Fi and radio interfaces, an LCD screen. The system topology is shown in the figure below.

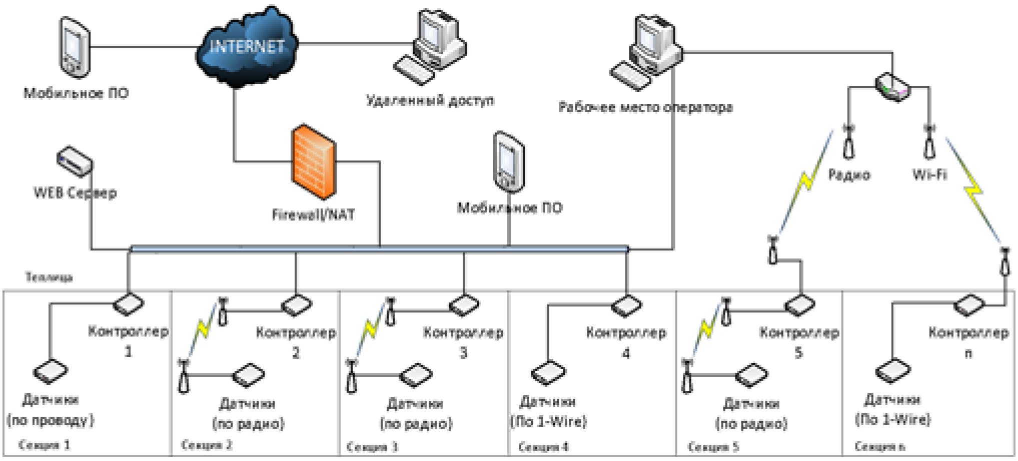

Figure 1 – Topology of the greenhouse intelligent control system
Source: Author

The main criterion for the selection of components for the system were easy availability, low cost, the possibility of repair without the involvement of specialists, ease of operation. The Arduino Mega Board based on the ATmega2560 microcontroller was chosen for the development of the greenhouse complex control system.

The system uses three types of sensors to measure and monitor temperature. This number is due to the specifics of each of them. The DS18B20 is a programmable 9–to 12-bit digital thermometer that can be stored in the instrument's EEPROM memory. The DS18B20 communicates over a 1-Wire bus and can be either the only device on the line or in a group. All processes on the bus are controlled by a central microprocessor. The selected sensor has a waterproof housing and can operate and transmit reliable temperature data, both at 98% humidity and with immersion in water. Si7021-radio transmitter. DHT22-temperature and humidity sensor - is used to measure and transmit to the controller as a digital signal of temperature and humidity of the environment in which it is located.

A soil moisture sensor YL-32/68 with a fork extended to 500 mm is necessary to determine soil moisture.

In the operation of the automated control system, various devices with different power consumption are used: the controller and the sensors connected to it consume no more than 12 volts. The rest of the system requires a higher voltage, from 24 to 220 volts. In order to separate the low-voltage from the high-voltage part, electromagnetic relays of the SONGLE SRD-05VDC brand were used.

In the process of operation, there is a need to quickly check the controller settings, change the previously set parameters or urgently perform the necessary operation for the automated control system. This requires a screen that allows you to check and change settings. The choice was made in favor of two graphics: TFT - screens with a 480×320 resolution and a 3.2" diagonal.

The system development was carried out in the Arduino IDE environment, for which own libraries of work with sensors were developed. The appearance of both systems was the same, the difference was only in the features of interaction with the user.

User installed on the operator's workplace and is designed for data entry and control, configuration of the hardware. The main window of the program is divided into three horizontal parts: the upper part reflects the connection to the controller; the middle part has tabs (working windows) for setting the parameters of the controller, the lower part ("Logs") is designed for visual control of transmitted requests/responses between the controller and the configurator.

To connect and configure the hardware, it is necessary to connect the controller to the operator's workplace greenhouses: on the tab “Connect” to choose how the connection is made, “Pause” makes it possible to stop the configurator, without disconnecting from the controller (the controller will continue to work normally); “Date/Time” sets the current date and time set at the operator's workplace; “Restart” software restarts the controller when errors occur.

All basic settings are divided into the appropriate tabs: - “Monitor”, “Rules”, “Temperature”, “Watering”, “Light”, “Humidity”, “Wi-Fi”, “Logs”, “Water”.

The “Monitor” tab shows the system operation time from the moment of connection, the amount of free memory, the temperature inside and outside the greenhouse, and the state of the windows for ventilation. You can set the operation mode of the windows “manually” and “auto”.

In order to set the settings that require specific execution, you need to select the “Rules” tab (figure 3).

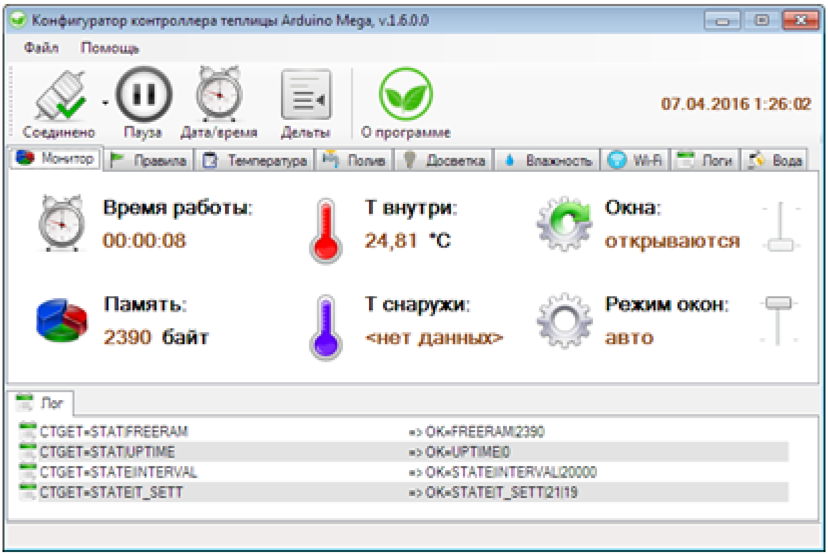

Figure 2 – the appearance of the greenhouses controller configurator

Source: Author

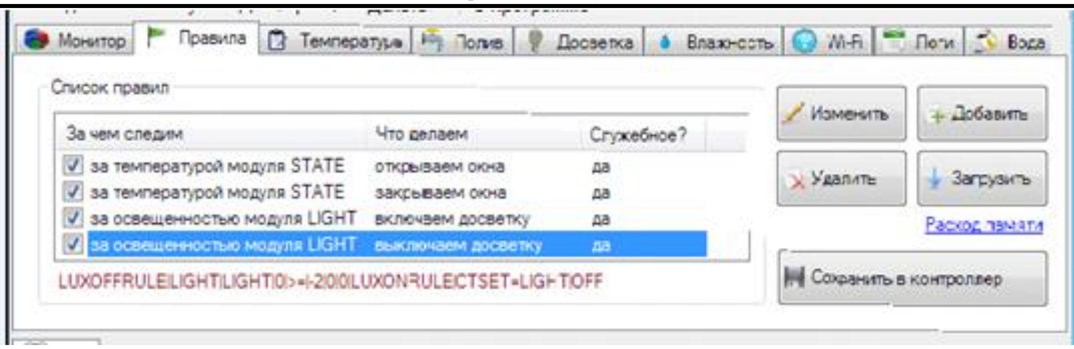

Figure 3 - "Rules" tab

Source: Author

A feature of these settings is the ability to specify the execution of certain controller actions when an event is reached. For example, open window 1 when the humidity level reaches 75%.

For each crop grown requires a different temperature. It is set in the tab "Temperature". In the warm (summer) period, when additional heating of the soil and the air inside is not required, these settings control the operation of the windows for ventilation. In the cold (winter) period, management is carried out by the system of heating the soil and the air inside the greenhouses.

Each irrigation zone is assigned its own water supply valve, so irrigation control can be defined in several ways: separate control of canals or general control of canals.

Channel management is specified in the table form "Channel number". "Start" is the time at which watering will begin. You can set the clock from 0 to 23. "Duration" - the number of minutes to be watered (the valve will be opened). The value is set in minutes from 1 to 60. "Days of the week" - the days on which watering will be carried out. It is possible to turn on watering in manual mode, or to interrupt watering in "auto" mode, to perform unscheduled works inside the greenhouse.

To increase the duration of the "daylight hours", a system of "Lighting" is provided. It is possible to work without indications from the light sensor at a specified time interval.

Relative humidity is transmitted from the sensors as a percentage. This tab is informative. Humidity readings can be used to create rules.

The "Water" tab keeps records of water used for irrigation (general, daily), i.e. the amount of water that passed through the sensor.

It should be noted that the option where the system only sends notifications to the operator and then remotely executes his commands was developed faster due to not having to enter rules.

After the sensors were installed and connected to the smart greenhouse control system, an experiment began, which consisted in regular greenhouses microclimate parameters recording of their decisions on its regulation by the system and the owner of the site. The experiment showed that the solutions did not always coincide – the automated system was wrong more often. Most likely, the reason for this lies in the fact that the knowledge base of the system is not well developed, did not take into account the laws of thermodynamics, led to irrational energy consumption (for example, in the first greenhouse, the window opening system, preventing overheating of plants, then the air due to open windows cooled so that to maintain the temperature had to include heating, another greenhouse with closed windows kept its heat, almost without damage to plants).

The experiment showed that manual control of the sensors, despite the greater complexity compared to fully autonomous control, was more effective since the control system did not always make the right decisions. This shortcoming can be eliminated by more careful consideration of the system knowledge base rules. In addition, the intelligent system must "know" the climatic characteristics of the cultivation of all crops for which it is intended to use the greenhouse. In the case of manual control is not necessary, because the experience of the gardener.

The cost of creating a smart greenhouse was divided into the cost of the software (3 500 rubles) and the cost of equipment for greenhouses (16 500 rubles). The cost of software development (45 000 rubles) and the cost of hardware (35 000 RUB.) were not considered because according to the Russian statistics, at present all households are provided with computers and develop systems are not involved in third-party experts. It should be noted that the system is low-resource, so the most inexpensive configuration is enough. Thus, the cost of robotics greenhouse is about 20 thousand rubles, which is not quite available for personal farming, as well as owners of garden and vegetable plots with average income.

5. CONCLUSION

Thus, the creation of a “smart greenhouse” implies the presence of the developer's skills in the field of mechanics, electrical engineering and microelectronics, programming, including programming of microcontrollers and knowledge bases, as well as knowledge of the growing various crops technology in greenhouse complexes. The lack of thought in any aspect of a robotic greenhouse reduces the efficiency of the technology, and the investment does not pay off. On the contrary, a competent approach to the creation of a “smart greenhouse” can significantly increase productivity while reducing the labor costs of garden plots owners. Thus, timely (instantaneous) notification of emergency situations (output of the controlled parameters values beyond the technological boundaries, equipment failure, etc.) will minimize losses from accidents and technological regime violations. At the same time, increasing the level of intellectual greenhouses associated with an increase in the cost of its development. At the moment, the cost of a robotic greenhouse is quite high for the target audience, which implies further research in the field of creating complex and cost-effective solutions for “smart greenhouses”.

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ORIGINAL RESEARCH PAPER

REDUCING THE ENVIRONMENTAL LOADING OF LIVESTOCK ENTERPRISES ON THE BIOSPHERE

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ABSTRACT

Due to the active development of the agro-industrial complex in many regions of the Russian Federation, the environmental situation is worsening. The aim of the research is to study the possibility of changing the technology of calves' keeping in order to reduce hazardous wastes caused by intensive livestock production. The method of reducing the environmental load of livestock enterprises consisted in one-time processing of the litter material for calves with a biological preparation. When analyzing the results of changing the technology of calves' keeping, generally accepted methods were used. Due to the technologal changes in the group of experienced calves the concentration of harmful gases in the air was reduced. The main indicator of animals' health being their productivity, the control measure showing the effectiveness of changes in the keeping technology was the calves' weight. When analyzing the results obtained, an increase in productivity was observed in the experimental group by more than 11–13% as compared to the control group.

JEL classification: Q18, Q52, Q53

Keywords: *environmental load, ammonia, respiratory diseases, calves, calves' keeping technology*

1. INTRODUCTION

Due to the active development of the agro-industrial complex in many regions of the Russian Federation, the environmental situation is deteriorating (Volkov, V. A., 2014), (Andrishunas, A. M., 2018), (Biktasheva, L. R., 2018). The intensive growth of production fills the market with domestic products (Oshurkova, Yu.L., 2017). The activity of the enterprises of the agro-industrial complex should ensure the release of food, feed and technical products of animal origin with good ecological and veterinary-sanitary quality (Stark, P. C., & Rayson, G. D., 2000), (Stepanenko. V. S., 2012). High concentrations of livestock within limited areas provokes an environmental catastrophe, which causes the release of environmental waste from industrial activities into the environment, pathogens and harmful gases (ammonia, methane, indole, hydrogen sulfide, skatole) into the atmosphere (Kudryavtseva, E. V. , 2002), (Ostroumov, SA, 2006), (Zhang Zhu-ming, Y., 2009), (Minina, V. V., 2011), (Petrov, S. B., 2011), (Ostroumov, S .A., 2012), (Sánchez-Marañón, M., Miralles, I., Aguirre-Garrido, JF, Anguita-Maeso, M. & Soriano, 2017), (Popova, E. V., 2018).

Due to this cyclic process, the ecological load on the human body also increases (Blis, T., 2011), (Otarbayeva, M. B., 2018), (Stepanova, K. V., Shcherbakov, P. N., Shnyakina, T. N., Shcherbakova, TB, 2018).

2. LITERATURE REVIEW

The tendency of increasing environmental stress on animals and humans leads to an increase in chronic diseases, and the diversity and severity of immune disorders arising at the same time determines the urgency of studying the factors favoring the interaction of microbiological and zoohygienic parameters of livestock buildings, which corresponds to the Food Safety Doctrine of the Russian Federation

(Grachev, VA, Rozen, A. Ye., & Vorobyev Ye. V., 2014), (Stepanova, K. V., Shcherbakov, P. N., Shnyakina, T. N., Shcherbakova, T.B., 2018). This Doctrine states that to ensure food independence of the country sustainable development of domestic production, accelerated development of food and nutrition spheres, food safety is required (Lauber, CL, Hamady, M., Knight, R., & Fierer, N., 2009), (Moiseenko, T.I., 2013), (Glukhovtsev, V.V., 2014). This can be done only due to continuous fundemental and applied scientific researching on the biomedical assessing the safety of new food sources and ingredients; introduction of innovative technologies, including bio- and nanotechnologies, technologies to produce food products and food raw materials; increasing the production of new fortified, dietary and functional foods (Mamedov, G. B., Mamedov, E. S., 2017).

3. METHODOLOGY

Today, one of the most promising ways to reduce the environmental burden on the atmosphere is to change the technology of livestock management to minimize hazardous wastes caused by intensive livestock production and their release into the environment (Grachev VA, 2014), (Shcherbakov, PN V., Shcherbakov, N. P., 2016), (Stepanova, K. V., 2017).

The purpose of this research is to study the possibility of changing the technology of calf management in order to reduce hazardous wastes due to intensive animal husbandry.

To achieve this goal, we identified the following tasks:

1. To determine the effect of zootechnical parameters of various methods for breeding young farm animals and their influence on respiratory diseases.

2. To study the hematological and immunological status of calves when changing the technology of breeding due to using the preparation “Biological inactivator of toxic gases in deep litter” to cure respiratory diseases.

3. To study the effect of the preparation “Biological inactivator of toxic gases in deep litter” on reducing and releasing of environmentally hazardous production wastes.

When studying the effectiveness, microbiological methods together with universal and differential diagnostic nutrient media, zoohygienic methods for studying the temperature of the litter material and air pollution with the help of an alcohol thermometer and a universal gas analyzer with indicator tubes were applied. The research materials were: the gas composition of the air in livestock buildings, the temperature conditions of the litter material, as well as the calves’ live weight of the experimental and control groups during the research and production experience. For each study, the statistical data were t-tested and processed with MS-Word 2007 software and Excel 2003. “Biological inactivator of toxic gases in deep litter” was tested at South Ural State Agrarian University, with the staff of the Department of Infectious Diseases being involved, as well as at the farm OOO “Uysky” in Uysky District of Chelyabinsk Region.

4. EMPIRICAL FINDINGS

One of the promising ways of research to reduce the environmental impact of livestock enterprises on the biosphere is changing the technology of youngstock housing with using synbiotic microorganisms as the most active components of the biosphere (Zaitsev, 2006).

Therefore, at the Department of Infectious Diseases of South Ural State Agrarian University, a biological preparation consisting of symbiotic microflora cultures was developed. It has high antagonistic properties in relation to putrefactive microflora. This biological preparation was used once in the form of an emulsion sprayed onto the surface of the litter material while keeping the calves in a “cold” method. For using the preparation, the calves with a similar production weight of 20.0±1.0 kg were divided in two different groups.

The data on air pollution and temperature conditions of the litter material are presented in Table 1.

Table 1. Air pollution in calf houses in the farms of Chelyabinsk Region (n = 15)

Farm name	Ammonia concentration during winter stall-feeding period, mg / l	Calves' raising method
	actually	
OOO "Berlinskoye", Troitsk District, Chelyabinsk Region	21.0±0.36	Traditional
OOO "Uysky", Uysky District, Chelyabinsk Region	17.0±0.21	Cold
Agricultural production cooperative "Voronino", Uysky District, Chelyabinsk Region	18.0±0.52	Cold

Source: Author

Analyzing the air pollution in livestock buildings in some farms in the Southern Urals, we noted that the ammonia amount in the above-litter air layer significantly exceeded the maximum permissible concentration (15 mg/l). In the farms of Uysky District in the above-litter air layer, the ammonia concentration increased by 13.3% and 20.0%, in OOO "Berlinskoye" in Troitsk District – by 40.0% relatively to the maximum allowable concentration.

To establish the relationship between the ammonia release and temperature conditions inside the litter material use for calves' keeping, we determined the temperature conditions of the litter used to keep calves in several farms in Troitsk and Uysky Districts of Chelyabinsk region.

The research results are presented in Table 2.

Table 2. Temperature conditions of the litter material (n = 15)

Farm name	Temperature conditions of the litter material, T°C (reference values +12-15°C)			Calves' raising method
	January	February	March	
OOO "Berlinskoye", Troitsk District, Chelyabinsk Region	10.8±0.25	10.4±0.36	12.8±0.25	Traditional
OOO "Uysky", Uysky District, Chelyabinsk Region	2.8±0.44	3.0±0.66	6.2±0.41	Cold
Agricultural production cooperative "Voronino", Uysky District, Chelyabinsk Region	5.6±0.53	6.3±0.34	9.4±0.59	Cold

Source: Author

We noted the following: the temperature of the litter material in the farm of OOO "Uysky", Uysky District, Chelyabinsk Region, in January was 18.6% of the norm, in February 20.0%, and in March 41.3% with the "cold" method of calves' raising. In agricultural production cooperative "Voronino", Uysky District, Chelyabinsk Region the temperature in the calves' building was 37.3% in January 42.0% in February and 62.6% in March, with the same method of calves' raising being choosen. In OOO "Berlinskoye", Troitsk district, Chelyabinsk Region, the temperature in calves' building was 72.0% of the norm in January, in February 69.3%, and in March 85.3%, with the "traditional" method of growing calves being choosen. According to the analysis of the data given in Tables 1 and 2, an increase in the ammonia concentration in the air layer above the litter correlates to releasing thermal energy from the wet litter material. In its turn, the released ammonia in high concentration in the air in

OOO “Berlinskoye”, Troitsk District, Chelyabinsk Region, in our opinion, is associated with the traditional method of calves’ housing. This is due to the fact that at elevated temperatures of the ambient air and litter, the biochemical reactions at splitting animal excrement are accelerated, as a result, large amounts of ammonia are released into inhaled air, negatively affecting livestock buildings, in particular, and the biosphere as a whole. Ammonia, in its turn, actively adhering to the surface of calves’ respiratory tracts, is absorbed into the bloodstream, causing hypochromic anemia, reducing the activity of digestive enzymes and increasing the load on the liver.

Calves being chronically ammonia poisoned gain their living masses worse, more susceptible to cold and other types of stress, less resistant to infectious diseases. To level the environmental load on the calves’ bodies, the developed biological material was introduced into the litter material used for calves’ keeping.

Table 3. The results of determining the ammonia concentrations in the above-litter air layer when calves’ housing of the experimental and control groups (n = 15)

Group of animals	Number of animals in a group, heads	Ammonia concentration in the air, mg/l		
		the 1st day	the 30th day	the 60th day
control	15	14.2±1.22	15.7±1.51	22.3±0.05
experimental	15	14.7±0.91	6.3±1.23*	4.1±0.98*

Source: Author

According to the table, there was a decrease in the ammonia concentration in the above-litter air layer in 30 days after the introduction of the preparation 2.3 times and in 60 days after the start of the experiment when housing the experimental group of calves. At the same time, in the building for the control group of calves, there was a tendency for an increase in ammonia concentration: on the 30th day of the experiment, the ammonia concentration in the above-litter air layer increased by 1.1 times as compared with the ammonia concentration on the 1st day of research, and on the 60th day of the experiment the ammonia concentration in the above-litter air layer increased 1.5 times as compared with the ammonia concentration on the 1st day of research.

In our opinion, the decrease in ammonia release in the above-litter air layer in the building for the experimental group of calves is due to active multiplication of symbiotic microflora as the part of the preparation “Biological inactivator of toxic gases in deep litter”, which actively splitting the calves’ excrement, isolated less ammonia, and due to their antagonistic activity suppressed the reproduction of putrefactive microflora, which releases large amounts of ammonia into the above-litter air layer when splitting the calves’ excrement.

In order to study the release of thermal energy during the decomposition of animal excrement in the litter, the temperature conditions of the calves’ litter of the experimental and control groups were determined.

There was an increase in temperature in the litter of both groups, while in the litter of the control group the temperature increased 2 times on the 30th day (from 3.2±1.14 to 6.0±1.78°C), and 2.6 times on the 60th day (8.3±1.22°C) of the research, and in the litter of the experimental group the temperature increased 4.5 times in 30 days as compared to the 1st day of research (from 3.6±0.13 to 16,2±1.18°C), and in 60 days 5.3 times (19.1°C).

The release of thermal energy in large amounts during exothermic reactions when splitting the animal excrement and litter material by microorganisms of the biological preparation was more active than in putrefactive microflora, making it possible to maintain a higher temperature in the litter material.

All these phenomena together effectively reduced the environmental load of livestock buildings on the bodies of experimental calves. As a result, by the end of the research, the calves of the experimental group increased their productivity by 131.0 kg on the average, which is 13.2% more as compared to the calves of the control group.

The data are given in Table 4.

Table 4. The results of the calves' live weight increase during the production experiment (n = 15)

Group of animals	Live weight, kg		Live weight increase, kg	
	At the beginning of the experience	At the end of the experience	Average daily, g	Relative, %
control	21.0±0.33	152.0±0.76*	653.0	32.0
experimental	20.0±0.31	136.4±0.69	577.0	27.2
% to control	-	-	113.2	-

Source: Author

5. CONCLUSION

Recently, mainly from the mid-1990s up to the present day in the Russian Federation and many other countries, the problem of the global environmental crisis has become acute. The main reason for which, as shown by the research of many authors, is the active development of industrial animal husbandry. The main problem of intensive animal husbandry is the release of toxic gases into the atmosphere, which adversely affect the ecosystem as a whole and the health of animals and people in particular.

Due to the change in animal keeping technology, which consisted in the changing in the microbiota of the litter material, the environmental load on the calves was reduced, which was manifested in reduced air pollution caused by toxic gases, increased temperature of the litter material, which in general led to an increase in calf productivity by more than 13% as compared to the productivity of the control group of calves. In general, it is possible to make a conclusion on the achievement of the goal, namely the reduction of the environmental load of livestock buildings on animal organisms.

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ORIGINAL RESEARCH PAPER

NECESSARY CONDITIONS FOR LIVESTOCK OUTPUT EQUILIBRIUM IN EAST KAZAKHSTAN REGION

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ABSTRACT

The paper is concerned with the defining the necessary conditions for the livestock output equilibrium in East Kazakhstan region. Today Kazakhstan, which traditionally had enough livestock output, is to import largely, although East Kazakhstan region has a great potential for increasing the livestock output significantly. Initially, the main production factors that significantly affect livestock production are determined, with two target functions to maximize output and maximize profits being considered. To determine the optimal demand, the authors used the logarithmic utility function. The article provides the information concerning beef production, the equilibrium conditions for lamb, pork and poultry can be also determined in the same way.

JEL classification: Q56, Q58

Keywords: *livestock industry, supply, demand, nonlinear programming, utility function*

1. INTRODUCTION

For the Republic of Kazakhstan, the concept of food security is fundamental to the state policy concerning agricultural and food production. In the conditions of the Eurasian Economic Union, which favors free movement of goods, services, capital and labor, to increase the competitiveness of livestock products from Kazakhstan becomes an important state task for agricultural policy. To fulfill this task, it is necessary to have a means for managing the equilibrium in livestock production markets, determining the necessary volumes of competitive animal products for the domestic markets of East Kazakhstan. The hypothesis is that East Kazakhstan region has a enough potential for livestock output to satisfy the internal needs of East Kazakhstan region, and also have some of the products for export.

The main purpose of the article is to determine the conditions under which the domestic needs of East Kazakhstan region will be satisfied, and some part of animal products will be exported, or sent to other regions of Kazakhstan. To do this, it is necessary to solve the problem of analytical connection of livestock output with the main production factors and possible demand by the residents of East Kazakhstan region for animal products, with prices and family budget being considered.

2. LITERATURE REVIEW

The Republic of Kazakhstan as the young but already independent state sets ambitious goals for itself: in 30 years to become one of the 20 leading countries according to economic development. The leading role in solving this problem is given to improving the competitiveness of the livestock industry (Kaliev, 2007; Nazarbayev, 2012; Sadu, 2012). Having great potential for substantial development of the livestock industry, it is necessary to identify the strengths and weaknesses of the industry in order to develop strategies for sustainable development. In (Balabaykin & Korabayev, 2015a, 2015b), the authors developed supply functions and demand functions for various livestock products.

In (Intriligator, 1975) the instruments for utility functions, production functions, as well as linear and nonlinear programming techniques are described in detail. In (Appleby & Mitchell, 2018; Gao, 2012; Grigoras, 2017) the trends in the livestock industry in Romania are analyzed. The empirical data were collected by the National Institute of Statistics for the period from 2007 to 2016. The volume of livestock production decreased by 30%, and in 2016 amounted to 23.8 billion lei. Prices for farm products and basic prices for livestock products showed an increase in the analyzed period. However, they are not high enough to cover production costs, mainly in the production of milk and pork, despite the allocated subsidies. Romania remains a true importing country for livestock products. The equilibrium model (Xiong, Yi, & Li, 2017; Yu, Hertel, Preckel, & Eales, 2004) was used to analyze the dependence of the consumption of meat products and vegetable oil. Initially, the models used parameters of processing the statistical data for 2006-2009. The growth rates for counterfeit vegetable oil were calculated. The authors then used the second set of parameters obtained due to processing the statistical data from 2010 to 2013 to predict the situation on the vegetable oil market in China.

The livestock sector supports the growth of the regional economy. Migration of people, development of tourism, increase in population, globalization, urbanization, increase in the economic status of people in combination with adequate measures of governments as factors contribute to the increase in demand for livestock products. Forecast for the next two decades are calculated (Singh, 2015).

The ability of agriculture to feed the world's population in changing climate conditions requires the prediction of future food demand. The authors compared food demand forecasts for 2050 for different regions. In the reference scenario, the demand for food increased from 59 to 98 for the period from 2005 to 2050. The range of results turned out to be very large, in particular, for the calories of animal products (from 61% to 144%) (Valin et al., 2014).

Long-term forecasts of global food demand largely depend on the functional dependency used in the food demand equation. The key element is the dependence of income elasticity on the volume of products sold, this dependence ensuring the share of the budget for food always to lie within some acceptable range (Gao, 2012).

Computable General Equilibrium models are increasingly being used to design global food markets in order to support long-term analysis of agrifood policies. Simple functional relationships can lead to unrealistic forecasts, failing to catch changes in the elasticity of demand for food (Gao, 2012).

Agricultural production in the region is not just a complex of industries developing independently, but a rational and systematic combination of all elements and factors of production in certain specific natural and economic conditions. It is important to note that between agricultural production and food consumption in agro-industrial countries there is a direct link, since the producers of these products and most of its consumers are the same people. Taking into account the principles of agricultural production location and a number of the above-mentioned problems, it is reasonable to raise the problem of self-sufficiency of the region with the main types of food that should be available to the average consumer (Mushtay & Shumkova, 2017).

Food security and sustainable development are the primary goals of global policy in the 21st century. Livestock plays an important role in ensuring food security and nutrition, since animal products are important in people's diets. Knowledge of animal behavior, favorable conditions for livestock rising contribute to all three main ways of sustainable agricultural development: economic profitability, social justice and environmental health (Appleby & Mitchell, 2018).

The demand for beef as a source of protein is increasing worldwide, although in most countries beef consumption is significantly less than half of the total amount. In each region, there are differences between countries in beef production and its marketing. They are characterized by differences in production factors, including the availability of natural resources and climate peculiarities, population, traditional culture and degrees of economic development, including industrial and technological developments (Smith, Gotoh, & Greenwood, 2018).

The European Union is the world's third largest beef producer. This determines the development of rural areas, public life, culture and gastronomy in Europe. Beef production faces unprecedented problems associated with the maintenance and care of livestock, environmental impact, animal origin, breed authenticity, nutritional benefits and nutritional quality of beef. Different future scenarios can be written depending on the main driving forces meat consumption, climate changes, environmental policies, and the future organization of the livestock supply chain (Hocquette et al., 2018).

In (Liefert & Liefert, 2015) the main systemic and political changes for agriculture in Kazakhstan, Russia and Ukraine are examined. These marks being important as indicators when these countries changed their economic systems from planned into market. These changes affected the structure of commodity composition and agricultural production in these countries. The article also discusses the main changes in the organization, structure and management of farms after the collapse of the Soviet Union in 1991, which also affected production.

3. METHODOLOGY

The initial data for practical calculations were obtained from statistical collections "Rural, forestry and fisheries of East Kazakhstan region", "East Kazakhstan region" by the statistics department of East Kazakhstan region for 2009-2016.

During the period from 2009 to 2016 the labor productivity in agriculture, on average, in the Republic of Kazakhstan increased from 304.2 thousand tenge to 498 thousand tenge per year for one employee. The average growth rate was 9.3% per year. The share of agricultural production in the gross domestic product in 2016 was 5.1%. 7.48 million people live in rural areas, which is more than 45% of the total population of the republic. The main problems in the livestock industry of Kazakhstan are: low level of labor productivity, outdated technologies for fattening animals, small-scale production. These are, in general, the main reasons for the low competitiveness of the livestock industry.

In the changed conditions of the external and internal environment, it is necessary to develop strategies for the sustainable development of the livestock industry for medium and long terms. Table 1 provides the information on the ratio of exports and imports of meat and dairy products, on average, for the period from 2015 to 2017 in the Republic of Kazakhstan.

According to this table the import of meat products is 15-20 times higher than their export. For dairy products, imports are 10 times higher than exports. In addition, it should be emphasized that the per capita consumption of dairy products in Kazakhstan is twice less than the medically substantiated, regulatory consumption of dairy products. We see that in the current situation, when the share of imported meat products is about 25% of the production and import supplies of dairy products account for about 10% of the produced dairy products, it is necessary to increase the production of own products.

East Kazakhstan region produces 11-14% of the entire livestock production of the Republic of Kazakhstan; therefore, identifying patterns for the main factors determining the total volume of livestock production in a decisive way will be the information base according to which effective production strategies will be developed.

The Republic of Kazakhstan, in general, and East Kazakhstan region simultaneously pursue two goals in the livestock industry.

First, it is necessary to solve the problems of food security and provide the domestic market with animal products. Therefore, the first goal function will characterize the conditions for maximum production of livestock products.

Secondarily, it is necessary to consider the fact that the Republic of Kazakhstan is currently a member of the Eurasian Economic Union; therefore, the competitiveness of livestock products is urgent.

Therefore, the second goal function will describe the conditions for maximizing profits in the production of livestock products.

Table 1. Balance ratio of export and import supplies of livestock products in the Republic of Kazakhstan (thousand tons)

Indicators	**2015**	**2016**	**2017**
Meat and meat products			
Stocks at the beginning of the year	216.8	150.0	97.8
Own production	931.0	960.7	1017.6
Import supplies	236.4	226.8	244.4
Domestic consumption	1210.5	1215.4	1232.6
Export supplies	14.0	14.9	11.8
Other uses	9.7	9.4	9.6
Stocks at end of year	150.0	97.8	105.8
Milk products			
Stocks at the beginning of the year	531.4	402.3	371.1
Own production	5182.4	5341.6	5503.4
Import supplies	568.9	592.4	574.0
Production consumption	1593.3	1634.4	1704.7
Export supplies	97.1	46.8	54.8
Domestic consumption	4157.9	4251.6	4350.7
Domestic consumption per capita	237.0	238.9	241.2
Other uses	32.1	32.4	32.2
Stocks at end of year	402.3	371.1	306.1

Source: Author

We will consider the following indicators:

w is the volume of beef (thousand tons);

z_1 is the number of animal heads (thousand heads);

z_2 is the animal productivity (kg);

z_3 is the specific weight of elite animals (%);

z_4 is the cost of fixed assets (million tenge);

z_5 is the number of employees (people);

z_6 is the animal yield (heads per 100 dams);

z_7 is the loss of animals (thous. heads);

z_8 is the total acreage (thousand ha);

z_9 is the acreage for grain crops (thousand ha);

z_{10} is the forage acreage (thousand ha);

z_{11} is the prices for beef (tenge/ton);

z_{12} is the level of livestock mechanization (the ratio of the volume of work fulfilled with mechanization means to the total amount of work in the livestock industry) (%)

The production of beef is only calculated, as for the other types of livestock products the calculations are similar.

To determine the conditions under which enterprises producing livestock products will give the maximum possible output, we will use linear programming models.

The first goal function for the maximum livestock output will look like this:

$$FC(\overline{Z}) = a_0 + \sum_{i=1}^{12} a_i z_i \to \max \tag{1}$$

where a_i is the coefficient in the linear model to reflect the effect on the resulting index of the i^{th} factor. The numerical values of the coefficients in the linear model were given by experts who have extensive experience in livestock enterprises in East Kazakhstan region.

In practical activities, it is not reasonable to manage all 12 factors; therefore, it is necessary to select only those factors that essentially determine the resulting indicator. For these purposes, it is necessary to calculate the matrix of pairwise correlations between independent factors and the dependent one.

The analysis of this matrix showed that the following factors are significant:

z_2 is the animal productivity (kg);

z_3 is the specific weight of elite animals (%);

z_4 is the cost of fixed assets (million tenge);

z_6 is the animal yield (heads per 100 dams);

z_7 is the loss of animals (thousand heads);

z_9 is the acreage for grain crops (thousand ha);

z_{10} is the forage acreage (thous. ha).

Then the first goal function for the beef production will be as follows:

$$FCG1(\overline{z}) = (ag)_0 + \sum_{i=1}^{7} (ag)_i \, z_i \to \max \tag{2}$$

4. EMPIRICAL FINDINGS

The regression equation we got is the first goal function in the linear programming model.

The solutions of this model are presented in Table 2, according to which the maximum beef production in the total volume will be equal to 123.7 thousand tons.

Table 2. The optimal values of production factors for livestock enterprises in East Kazakhstan region

FCG1($\bar{z}$)	z_2	z_3	z_4	z_6	z_7	z_7	z_{10}
123.7	331	8.3	41126.4	82	1.9	581.7	312.7

Source: Author

The second goal function will be as follows:

$$FCG2(\bar{z}) = (cg)_0 + \sum_{i=1}^{7} (cg)_i z_i \rightarrow \max \tag{3}$$

where $(cg)_i$ is the coefficient in the linear model to reflect the effect on the resulting index of the i[th] factor. The numerical values of the coefficients in the linear model were also given by experts who have extensive experience in livestock enterprises in East Kazakhstan region.

The solutions of this model are presented in Table 3, according to which the maximum value of the profit will be equal to 2 20032.4 million tenge.

Table 3. The optimal values of production factors for livestock enterprises in East Kazakhstan region, if the goal function is profit maximization

FCG2($\bar{z}$)	z_2	z_3	z_4	z_6	z_7	z_9	z_{10}
20032.4	357	9.9	44723.5	91	1.2	617.3	335.6

Source: Author

The analysis of Table 2 and Table 3 shows that two main goals in the livestock industry are achieved with different values of the main production factors. This feature must be considered when determining the equilibrium conditions in the markets for animal products in East Kazakhstan region.

In order to balance the volumes of livestock output, it is necessary to develop a mechanism for domestic demand for livestock products by the residents of East Kazakhstan region.

Let 4 types of meat products be acquired (m_1, m_2, m_3, m_4):

Where m_1 is beef meat; m_2 is lamb meat; m_3 is pork meat; m_4 is poultry meat. To determine the analytical dependence several indicators will be used:

c_i is the cost of the i[th] meat products; *SBUD* is the part of the family budget for purchasing livestock products. Therefore, the following inequality will be:

$$\sum_{i=1}^{4} c_i m_i \le SBUD \tag{4}$$

According to this inequality only such an amount can be spent on meat products, which will not exceed the part of the family budget for these purposes.

For East Kazakhstan region is characterized by the fact that residents have large variations in income, so it is reasonable to use some utility function. The utility function quantitatively reflects the preference for purchasing various types of meat products. It can be the logarithmic utility function:

$$FUNP(m_1, m_2, m_3, m_4) = \sum_{i=1}^{4} a_i (\ln(m_i - \overline{m_i})) \tag{5}$$

where a_i is the coefficients reflecting the buyer's preferences when purchasing various types of meat products;

$\overline{m_i}$ is the minimum amount of meat products of the i^{th} species, purchased by the buyer.

m_i is the preferred volume of purchasing the i^{th} type of meat products. It is necessary to consider that $a_i \geq 0, \quad \mathrm{m_i} \geq \overline{m_i} \geq 0$.

Each buyer will try to maximize the utility function, with the amount of family budget being limited.

The size of the family budget and the system of preferences between the types of meat products (the values of the parameters a_i were determined by expert surveys in each district) mainly determine the set of meat products necessary for the buyer.

The buyers' strategies will be directed at maximizing utility functions:

$$\left.\begin{array}{l} \sum_{i=1}^{4} a_i \ln(m_i - \overline{m_i}) \to \max \\ \sum_{i=1}^{4} c_i m_i \ \leq SBUD \\ m_1 \geq 0, \ldots, m_4 \geq 0 \end{array}\right\} \tag{6}$$

According to the solved non-linear model (6), it is possible to determine the set of meat products that will be beneficial for the buyer. These meat products maximize the utility function, and the total cost of all meat products does not exceed the size of the SBUD family budget.

The system is effectively solved with Lagrange multiplier method.

$$FL(m_i, \ldots, m_4, y) = \sum_{i=1}^{4} a_i \ln(m_i - \overline{m_i}) + y(SBUD - \sum_{i=1}^{4} c_i m_i) \tag{7}$$

Only two factors were considered for analysis: the prices of meat products and the part of the family budget. Changing the quantitative values of these factors can cause changes in demand for meat products. This analytical relationship must be considered by meat producers.

5. CONCLUSION

The applied approach made it possible to obtain the necessary information on the livestock industry of East Kazakhstan region. According to this information, it is necessary to develop some due agrarian policy of the Republic of Kazakhstan, which will raise the livestock industry to the level of successful competing with the livestock output from developed countries. As the size of the article is limited, the calculations only for beef are presented; similar calculations (all necessary data are available) can be made for pork, lamb, and poultry to determine the maximum value of the utility function. All calculations were performed in Excel.

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ORIGINAL RESEARCH PAPER

ANTHROPOGENIC IMPACT ON WATER BODIES WITHIN THE AREA OF ACTIVITIES OF LIVESTOCK COMPLEXES

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ABSTRACT

The social role of ecology in the modern society consists in orienting of scientific, industrial and technical solutions to comply with the humanistic ethics to become the environmental ethics. The purpose of the paper is to consider the problem of pollution of water bodies with manure-containing waste waters within the territory of livestock enterprises. The analysis of anthropogenic impact on water resources within the area of activities of agricultural enterprises is carried out and a technique to study the pollution of water resources with manure-containing water wastes has been developed.

JEL classification: Q10, Q16, Q34

Keywords *Social ecology, cattle-breeding enterprises, waste waters, manure-containing, hydroponics, closed system, water supply, drainless water use, pollution, wastes.*

1. INTRODUCTION

Continuous intensification and expansion of economic activities of the modern human society lead to aggravating environmental problems.

To study the progressive deterioration of the environment is the target of socio-ecology as this science studies socio-ecosystems, including the territorial groups of the human society and the surrounding natural environment within different regions.

The comprehensive indicator characterizing the state of the human society is the health level of its members. In our time, the close relationship between the public health and the environment state is the precisely established pattern.

This article will consider only one aspect of social ecology, concerning agricultural ecosystems, the effect of livestock waste on water bodies.

The livestock concentration in large numbers in farm enterprises and livestock conversion on the industrial basis are global ((Asonov & Iliasov, 2003) (Iliasov, 2004)). Thus, in Russia, in Romania, and in Italy, there are gigantic livestock complexes capable of producing 108 and 216 thousand pigs per year. In the United States, there are complexes for cattle fattening with capacities from 20-30 thousand to 250 thousand cattle. In Texas, about 2 million cattle are being fed within the territory of 180 km. About 70% of the meat on the market is produced by large enterprises with more than 1000 cattle.

In our country, there are more than 2000 large livestock enterprises and complexes, and the volume of livestock wastes with the moisture content of 90 percent and more has reached 1 billion cubic meters per year (Iliasov, 2004).

Industrial methods of livestock breeding are cost-effective to make it possible to solve the problem of supplying the population with meat and dairy products within short periods of time. However, the construction and operation of livestock farms and complexes raises several serious issues related to the environmental protection. This problem is complex and requires a joint solution by specialists of the hygienic, technological, agricultural and construction profiles ((Koshelev & Kuscheva, 2007) (Tikunov & Chereshnia, 2017)).

2. LITERATURE REVIEW

According to bacterial contamination of soil, air and water resources, livestock farms and complexes are equal to the most harmful enterprises. The area of their location, the soil of agricultural fields irrigated with livestock wastes are rich in pathogenic microorganisms and helminths. A. N. Ivanov determined that in the layer (up to 20 cm thick) up to 20-25 trichocephalic eggs per 1 kg of soil are constantly found in summer. The total bacterial content is equal to 2 106 microbial bodies/g, with the coli-titer being 0.001 ((Nikitin, 1980) (Ivanov, 1977) (Obshchesoyuznyye normy tekhnologicheskogo proyektirovaniya sistem udaleniya, obrabotki, khraneniya, podgotovki i ispolzovaniya navoza i pometa, 1982)). Other researchers proved 9.2% of studied soil samples to have Salmonella constantly. According to A. K. Baubinas and his co-authors, with the watering rate of 300 m^3 per 1-hectare salmonella in livestock wastes penetrate into the soil up to 50 cm or more and survive for two years.

In livestock wastes, especially caused by pig breeding, the following various pathogenic and conditionally pathogenic microorganisms are found: enterococci, staphylococci, pseudomonads, hemophilic sticks ((Zubareva, 2018) (Liu, Wang, Wen, & Tang, 1999) (Smolenski, 2001). In livestock wastes, the amount of salmonella can reach up to 334 thousand per liter.

Salmonella found in livestock wastes range from 3.3 to 36.9%. As reported by W. R. Kelley, up to 66% of livestock wastes contain salmonella, and according to P.W. Jones salmonella are found in 90% of the livestock waste samples.

The samples also contain Brucella, leptospira, Yersinia, mycobacteria, clostridia, actinomycetes, filamentous fungi and yeast, various viruses (FMD virus, Aueska disease virus, bacteriophages for E. coli and others).

Nonsterilized waste waters can contain viable helminth eggs and protozoa cysts amounting from a few tens to several tens of thousands per 1 liter. These are mainly ascarid eggs (up to 400 or more in 1 liter of waste waters), strongylats, esophagostomy, trichocephalus, trichinella, teniid, whipworms, coccidian cysts, balantidium coli. Waste waters are contaminated with helminth eggs because of the high prevalence level of farm animals, especially pigs, with ascarids, whipworms, as well as other helminthes, with most of the animals being parasitized with balantidium coli.

The viability time of pathogenic microflora and helminth eggs in the environment (especially in liquid manure) are quite long. So, according to A. V. Selivanova and G. A. Grinitsina (Trifonova, Podolets, Selivanov, & Martsev, 2018) in manure, the causative agent of listeriosis in the autumn-winter period lives up to seven months, and in the autumn-summer months it remains viable and retains its virulence for three months. The experiments conducted in the Moscow and Belgorod regions, have shown that the causative agent of paratyphoid cattle Salm. dudlim survives in liquid manure for 85 days in summer, and up to 158 days in winter and spring. Some researchers believe that Salm. typhi, Salm. paratiphi B, E. coli, and other members of the intestinal group may servive in river and waste waters for up to 300 days. Pathogens of swine erysipelas remain viable for 92–157 days.

Brucella die in liquid manure of cattle and pigs in summer and spring only in 3-4 months, in autumn and in winter – in 6-8 months. Tuberculosis microbacteria in the same manure remain viable for more than 1.5 years. FMD virus retains the ability of causing disease in experimental animals for 42 days in summer, in frozen manure for up to 192 days. Leptospira occurring in water bodies from livestock complexes remain viable for 20-30 days and remain moist for more than 6 months in wet soil. The most resistant viruses can persist for a long period of time in waste waters, as well as in the water of polluted water bodies. So, enteroviruses retain infectious properties and viability at +9 - +15 ° C for up to 200 days. Helminth eggs can maintain the viability for a longer period of time. For example, ascaris eggs die in non-disinfected swine manure only in 12-15 months from the beginning of its storage, and cattle helminth eggs (fasciol, strongylum, monies) die in liquid manure only in 6-8 months. According to the All-Union Institute of Helminthology, liquid manure fractions for irrigation fields contain many helminth eggs (about 30%), which remain invasive for more than two years in the topsoil. In liquid manure stored in manure accumulator's helminth eggs retain their viability for over a year.

In this regard, there is a real danger of accumulation of pathogens in soil, contamination of agricultural crops, groundwater, atmospheric air and open water bodies, which inevitably leads to diseases of animals and people ((Koshelev, Donnik, Burlakova, & Kushcheva, 2007) (Skugoreva, Ashikhmina, Fokina, & Lyalina, 2016) (Gogina, Shmal'ko, & Tolstoy, 2018)). To eliminate the epidemiological risk and negative impact on the environment, manure should be pretreated, which would ensure, in addition to deodorization and mineralization of organic compounds, its disinfection. Long-term maintenance of livestock waste in the manure does not give the desired effect. It is known that the coli-titer and the titer of enterococcus in 6 months in waste liquid increases by 2-4 folds of magnitude and ultimately is at the level of 10-5 – 10-4 and 10-5 – 10-2, respectively, and the number of helminth eggs decreases through 10 months by only 2.8 times.

Contamination of surface and ground waters with wastes of large livestock farms and complexes is one of the most important aspects of the considered problem of environmental pollution. In several regions that have not previously experienced water starvation, a shortage of fresh water has emerged, which hampers their economic development. Some of the most important water sources are heavily polluted, self-purification processes are impaired ((Miskevich, 2017) (Yunusov, 2017)). In such situations massive emissions from modern livestock complexes, of course, can significantly worsen the overall sanitary situation, and in some cases deprive the population of traditional water sources ((Amirov & Ismilov, 1966) (Trifonova, Podolets, Selivanov, & Martsev, 2018)), despite powerful sewage treatment plants, liquid effluents of large pig farms negatively affect the sanitary state of water bodies within more than 30 km. Pathogens from waste waters can be transported with a stream of river water up to a distance of 200 km. The effect of wastewater from livestock farms on water bodies causes a decrease in the content of oxygen dissolved in water, the appearance of putrid odors and colors waters in dark brown. In such water bodies biological oxygen demand and oxidability increase dramatically cause the reservoir gradually to lose the ability of self-purification and reduction processes take place in it instead of oxidative processes. Thus, the reservoir ceases to be alive and turns into a gutter. Water consumption from such water bodies causes gastrointestinal and other diseases in humans and animals ((Goncharuk, Bagdasar'ian, Baubinas, & Kalinauskas, 1983) (Bakulov, Grishaev, & Michko, 1979) (Wang, 1990)). Fish die in such rivers and ponds as livestock waste is dumped. N. Stamantin with co-authors observed the death of 50% of the fish in the reservoirs from Listeriosis, caused by the waste waters dumped from the enterprise for processing livestock raw materials, the observations being confirmed bacteriologically.

3. METHODOLOGY

The purpose of the paper is to examine the problem of pollution of water bodies with manure-containing wastewater within the territory of livestock enterprises.

The studies were carried out from 1994 to 2017 at the cattle complex of the experimental production farm (EPF) "Sverdlovskoye" (Sverdlovsk region) in the experimental production workshop, the objects of studies being pigs and cows. Manure-containing wastes from EPF were discharged into the Iset River.

The chemical analysis of the pollutant concentration in waste waters, chemical oxygen consumption (COC), biological oxygen consumption (BOC), environment acidity (pH) were carried out according to Yu. Lurie's method in a certified chemical laboratory of the Russian Scientific Research Institute of Water Management in Ekaterinburg.

Hypothesis 1: Liquid wastes from livestock farms and complexes have a negative impact on water resources.

Hypothesis 2: Qualitative characteristics of manure-containing and industrial waste waters make it possible to judge about the on the possibility of pollution of water bodies located in the vicinity of livestock farms.

Hypothesis 3: The developed classification of liquid manure and wastes according to their fertilizing value favour the solving of environmental problems along with the introduction of innovative environmental protection engineering technologies based on hydroponics using.

4. EMPIRICAL FINDINGS

Liquid wastes from livestock farms and complexes, which can fall into water bodies either as wastewater through sewage pipes (point sources), or as distributed runoffs from fields of agricultural use, have a negative impact.

The daily discharging and moisture of excrements from one animal at pig and cattle enterprises are given in Tables 1 and 2.

Table 1. Daily excrement discharging at the pig complex

Indicators	He-swine	She-swine			Weaned pigs up to 30 kg	Fattening pig with weight, kg		
		Single	Pregnant	With piglets		up to 40	40-80	over 80
Excrement, kg/day	11.1	8.8	10.0	15.3	2.4	3.5	5.1	6.6
Moisture, %	89.4	90.8	91.0	90.1	86.0	86.6	87.0	87.5

Note: when adding process water to the excrement in relation to their volume of 0.2; 0.5; 1.0; 2.0; 5.0 the moisture content of liquid manure reaches the values of 90, 92, 94, 96, 98%, respectively.

Source: Author

Table 2. Daily excrement discharging at the cattle complex

Excrement, kg	Servicing bull	Cows	Calves up to 6 months, fattening up to 4 months	Young cattle			
				6-12 months, fattening for 4-6 months	fattening for 6-12 months	12-13 monts and heifers	fattening over 12 months
Excrement	30.0	35.0	5.0	10.0	14.0	20.0	23.0
Urine	10.0	20.0	2.5	4.0	12.0	7.0	12.0
Total	40.0	55.0	7.5	14.0	26.0	27.0	35.0

Source: Author

The composition of liquid manure or waste waters is mainly determined by the technology of manure removal, which, in its turn, depends on the amount of process water used either for cleaning the houses or transporting manure. The average characteristics of manure-containing wastewater from cattle complexes are given in Table 3.

Table 3. Characteristics of manure-containing wastewater

Indicators	Measurement units	Complexes for growing and fattening pigs				Complexes for cattle		
		Manure removal systems						
		gravity-flowing		flushing		gravity-flowing		flushing
		continuously acting (self-running)	periodically acting (gate)	sluicing devices (non-chanel)	case-checkers in channels with grids	continuously acting (self-running)	periodically acting (gate)	case-checkers in channels with grids
Suspended substances	mg/l	30000	25000	20000	15000	50000	40000	30000
COC	mg/l	30000	25000	20000	15000	60000	50000	35000
$BOC_{complete}$	mg/l	25000	21000	17000	12500	20000	18000	11000
BOC_5	mg/l	12500	10500	8500	5250	6700	5700	4000
N_{total}	mg/l	1500	1250	1000	750	1700	1400	1000
Phosphorus	mg/l	600	500	400	300	1000	900	600
Potassium	mg/l	700	600	500	350	1500	1300	900

Note: COC is chemical oxygen consumption; $BOC_{complete}$ is complete biological oxygen consumption; BOC_5 is biological oxygen consumption for five days; N_{total} is total nitrogen

Source: Author

Process waste waters from livestock enterprises are also an extremely powerful source of environmental pollution (Table 4).

Natural uncontaminated waters contain small amounts of biogenic substances. The content of ammonium nitrogen in unpolluted water of rivers rarely exceeds 1-2 mg/l, with the nitrite concentration being even lower.

The main element controlling the production processes in water bodies is phosphorus. This conclusion was made in the 1940s according to the results of studies of 49 lakes in the USA. Other researchers came to the same conclusion. They proved that phosphorus as one out of ten major biogenic and some nutrient elements regulate production processes. Critical concentrations of biogenic elements limiting the primary production are 0.3 mg/l of nitrogen and 0.01 mg/l of phosphorus.

Wastewater from livestock enterprises can in some cases become the main source of pollution of natural waters with nutrients. Researchers found a positive correlation between the removal of nitrogen from the water-producing area and the livestock number. The amount of biogenic substances making up the excrement of domestic animals kept in the territory of the Midwest United States is equivalent to the amount caused by the activity of 350 million people.

Table 4. Characteristics of process waste waters

Indicators, mg/l	Wastewater group				
	total runoff	from feed houses	from veterinary sanitary inspection, laboratories, insulators, quarantine houses	from dairy equipment washing, milking areas, ways to them	transport washing and disinfection
pH	7.5	6.5	7.5	7.0	7.0
Suspended substances	400.0 500.0	6000.0 7000.0	350.0 500.0	350.0 450.0	700.0 3000.0
COC	350.0 400.0	2000.0 3000.0	350.0 550.0	350.0 550.0	150.0 250.0
$BOC_{complete}$	300.0 400.0	1600.0 1800.0	300.0 450.0	300.0 450.0	100.0 200.0
BOC_5	250.0 350.0	1000.0 1200.0	200.0 300.0	200.0 300.0	50.0 100.0
Oil-products	5.0 20.0				75.0 900.0

Note: the indicators of total runoff pollution are given according to the waste water purification at local facilities.

Source: Author

In our country, the amount of wastes from livestock enterprises is 400 million tons per year, large complexes giving from 300 to 3000 cubic meters of liquid wastes per day. The problem of preventing the pollution of natural waters with livestock wastes has become particularly acute as milk and meat are industrially produced. The new technology adopted in industrial-type livestock complexes is characterized by its high livestock concentration and complete mechanization of the processes of removing liquid manure manure from animal houses. These conditions cause the forming of a qualitatively new type of waste, i.e. liquid manure with a moisture content of up to 92-95%.

The high content of biogenic substances in manure and manure-containing run-offs makes them a highly effective organic fertilizer. V. I. Surnin (Surnin, 2007) with co-authors classified layerless manure according to the process water added to it as a technological fertilizer (Table 5).

Table 5: Classification of liquid manure and waste waters according to their fertilizering value

Name	Excrement amount with water per 100 kg of weight, kg	Dry matter content , %	Average composition, %			
			nitrogen	phosphorus	potassium	sum, %
Layerless manure (excrement)	10.000	10.000	0.500	0.180	0.520	1.200
Semi-liquid manure	20.000	5.000	0.250	0.090	0.260	0.600
Liquid manure	40.000	2.500	0.120	0.050	0.130	0.300
Very liquid manure	80.000	1.200	0.060	0.020	0.070	0.150

Name	Excrement amount with water per 100 kg of weight, kg	Dry matter content, %	Average composition, %			
			nitrogen	phosphorus	potassium	sum, %
Very concentrated waste water	160.000	0.600	0.030	0.010	0.040	0.080
Medium concentrated waste water	320.000	0.300	0.015	0.005	0.020	0.040
Concentrated waste water	640.000	0.,150	0.008	0.002	0.010	0.020
Lightly concentrated waste water	1280.000	0.070	0.004	0.001	0.005	0.010

Source: Author

5. CONCLUSION

Today only rational nature management can provide a high-quality environment that determines the due level of public health to favour the high quality of social and labor potential ((Jones, 1980) (Kainulainen, Holopainen, & Oksanen, 1995)). Thus, the population health is a necessary condition and at the same time the main criterion for successfully solving of the socio-ecological problem.

Manure according to its excellent fertilizing properties is widely used in agriculture to increase the humus of arable land and, on this basis, to favour the production of agricultural products. In this regard, the liquid manure irrigation for agricultural crops was legalized as the main and, perhaps, the only way of it using. But huge amounts of accumulated manure and litter at livestock and poultry enterprises leads to increasing the environmental impact on water resources.

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ORIGINAL RESEARCH PAPER

REDUCTION OF THE ECOLOGICAL AND SOCIAL FUNCTIONS OF THE FORESTS IN THE NOGINSKY DISTRICT, MOSCOW REGION, AS A RESULT OF THE RAPID GROWTH OF THE BARK BEETLE'S POPULATION

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ABSTRACT

Natural forests are the essential component of the biosphere. Large green areas have a significant ***environmental*** *impact and perform ecological and social functions. One of the most important reasons for the drying up of spruce forests in the Moscow Region is the mass reproduction of the bark beetle (Ips typographus L.). Bark beetle is the cause of forest dieback, not only in Russia but also in the countries of northern Europe with the prevailing growth of spruce. In 2012, according to official data provided by the Moscow Region Government, only their bark beetles destroyed 34 thousand hectares of spruce plantations, at the beginning of 2014 - about 70 thousand hectares. This article contains a study of the bark beetle's mass reproduction in the zone of mixed coniferous-broad-leafed forests within the territory of the Noginsky forestry. Studies were conducted using pheromone traps. The results of the study will allow us to understand the mechanism of the bark beetle's mass reproduction in the Moscow Region forests and to take effective sanitary and protection measures to preserve natural forests.*

JEL classification: Q18, Q57

Keywords: *bark beetle, spruce forests, spruce forests' drying up, The Moscow Region, forest's sanitary and hygienic role, sustainability, social and ecological functions.*

1. INTRODUCTION

Natural forests are an essential component of the biosphere and home to millions of living organisms. Large green massifs perform the environment-forming function, regulate the amount of precipitation, effectively clean the air from pollutants, protect the ground vegetation from various types of erosion and gullying, protect aquatic ecosystems, they are carbon depositors and suppliers of oxygen and phytoncides to the environment. [25].

The growth of the population of large cities increases the human need to communicate with nature. Forests are not only a place of recreation for the population of large cities and a source of biological resources, they also contribute to sanitation by extracting biologically active substances that inhibit the growth and development of pathogenic microorganisms.

For example, according to the report "Bactericidal properties of volatile phytoncides of tree-shrub species" by Artyukhovsky A.K., the wound phytoncids of the spruce fir (Picea excelsa) show high bactericidal activity to the cells of the intestinal bacillus, white Staphylococcus. Primary volatile secretions of Serbian spruce needles (Picea omorica) cause a high percentage of death among colonies of white Staphylococcus and a lower percentage of mortal colonies of Staphylococcus aureus [2].

The forest heals people not only by extracting phytoncides, but also by emotionally affecting them, improving their mood and health. Studies show that different types of forests are attractive to humans in various ways.

However, it should be emphasized that the implementation of ecological and social functions by forests depends on the viability of the forest crop, and on the ability of the forest ecosystem to resist various diseases and pests [26].

The Moscow Region is located mainly in the forest zone. Forests occupy about 44% of its territory. In the north and northwest there is the taiga zone with the prevailing conifers. Spruce is the indigenous tree of this natural area. Spruce ecosystems occupy about 20% of the territory of the Moscow Region. Under conditions of dense population, including lots of large industrial enterprises, the role of forest ecosystems in the Moscow Region is extremely essential. Increased anthropogenic pressure leads to the fact that spruce stands with a certain periodicity reduce their stability and begin to dry up. Periods of mass drying up in the Moscow Region were recorded in 2010-2012. The drying process during this period is recognized as the most massive over the entire observation period and requires careful analysis and assessment of the significance of various pathological factors.

One of the main reasons for the drying up of spruce forests in the Moscow region is the rapid growth of the bark beetle's population (Ips typographus L.).

2. THEORY

A typographer (Ips typographus l.) is a beetle from the Scolytidae subfamily (Bark beetles), it is also called a large spruce bark beetle, or bark beetle of a typographer, and feed mainly or exclusively on wood) [6].

The Subfamily of bark beetles consists of 140 species of European fauna, however there are more than 750 species of them, which are described. They belong to the group of 4 - articular beetles (Tetramera) and are very close to the weevil family (Curcuilionidae) [6].

Bark beetle reaches a length of 5.5 mm, width - 2 mm [21]. The typographer's body shape is cylindrical, black or dark - brown, moderately glittering [22, 23].

In order to identify new focuses of spruce ecosystems' drying up, it is necessary to know the basic patterns of reproduction and distribution of the bark beetle, as well as to plan activities aimed at preventing mass reproduction.

The micro focuses of the print bark beetle arise as a result of the immigration of beetles from the surrounding forest crop, their concentration and the colonization of groups of the most weakened and damaged trees. Then the beetles expand, and, under favorable conditions, the area of the focuses is expanding. With a relatively simultaneous occurrence of local focuses of xylophages over a large area and their expansion, there form concentrated pandemic focuses, spreading over hundreds and thousands of hectares.

Bark beetle is the cause of forest death not only in Russia, but also in the countries of northern Europe and America with the prevailing growth of spruce. So, it is noted that the three most important factors for the destruction of the Norwegian spruce (Picea abies) in northern Europe are root rot, wind and the bark beetle. [12, 15, [24].

Forests in Poland, Slovakia and other Eastern European countries suffer from the impact of the. [9, 10]. Considerable damage by the bark beetle activity was caused to the specially protected natural area of the Belovezhskaya Puschcha. [9].

The activity of the bark beetle significantly alters natural ecosystems, reduces hygienic and recreational functions, leads to drying up of natural forests and changes in the habitat of living organisms. [4, 11, 23]. According to many scientists, the rapid growth of bark beetle population is associated with global climate change processes. [29, 30]

3. DATA AND METHODS

A study was conducted in 2016 to analyze the impact of the bark beetle (Ips typographus L.) on spruce ecosystems of the Moscow Region, also here were analyzed data about the rapid growth of the pest population from 2012.

The Moscow Region is in the central part of the East European Plain. Forests cover about 40% of the Moscow region territory. But their distribution throughout the region is extremely uneven. The northern part of the region is forested much more than the southern. In the north, forest cover reaches 80%, in the south about 20%. In the north of the Moscow Region (on the territory of the Upper Volga lowland) and partly in its western part (on the territory of the Mozhaisky, Lotoshinsky and Shakhovsky districts), coniferous forests, mainly spruce forests, are common.

In 2012, according to official data of the Moscow Region Government, only in the Moscow Region forests 34 thousand hectares of spruce plantations were destroyed by bark beetles, at the beginning of 2014 — about 70 thousand hectares [20, 21].

According to data of the Rosselkhoznadzor, in 2012 about 100 thousand hectares of forests in the Moscow Region dried up [91]. In 2014, in the Moscow Region, the bark beetle attacked 6% of the Moscow Region's forests - 117 thousand hectares [28].

In connection with such a large scale of the problem, the latest technologies are used to combat the bark beetle, including satellite observations, the use of natural enemies, and computer simulation [1, 5, 12, 16, 28].

Research on this issue took place at the branch of the municipal institution "Mosoblles" in the city of Noginsk, the Moscow Region.

The forests of the Noginsk Forestry are assigned to the zone of coniferous-deciduous forests, the area of coniferous-deciduous forests of the European part of the Russian Federation. The forests on this territory were largely attacked by the bark beetle in 2010–2012.

4. RESEARCH METHODOLOGY

The studies were carried out in accordance with the Methodological Guidelines for the Supervision, Accounting and Prediction of Massive Breeding of Stem Pests and Forest Sanitary Conditions 2006 [18, 19].

Information on the number and density of the bark beetle population in a certain forest area was obtained from the results of pheromone surveillance (forest pathological analysis). For this purpose, pheromone traps were used, which were hung on the studied forest square in a specific order.

The traps were hung at the beginning of the flight of the beetles. Each week, the caught bark beetles were counted, and entered in a special list [18].

The assessment of the spruce plantations condition and the degree of their colonization by the bark beetle was carried out on the temporarily sample areas by counting trees according to their condition categories with the help of a special scale.

Depending on the kind of damage (weakening) of the spruce stand, the working area can be tape-like, 10 m wide, rectangular or in the form of 3 ... 5 circular pads with a radius of 20 m. The number of trees on the runway depends on the amount of attrition of stand and the required accuracy of accounting. In order to achieve the usual practiced accuracy of accounting, equal to ± 20%, and with an attrition up to 10%, at least 150 trees are subject to accounting, and with a higher fall, 100 trees.

In mixed forest stands on the working area, at least 80 trees of the main species should be taken into account. The results of the enumeration are recorded in the list: the number of trees in each category of condition (pieces and% per plot area), the number of trees occupied (spoiled) by the bark beetle, in addition, these indicators are determined per 1 hectare of the focus. Than the average category of the state of plantings as a weighted average is calculated. The scale has 6 gradations - from 1 (with no signs of weakening) to 6 (old deadwood). The scale is specified with a different type of damage (weakening) of spruce — in the focus of root rot, needle pests, fires, etc., in a comprehensive assessment of the condition of the entire tree.

The state of trees is assessed considering the condition and damage of its crown, trunk and root paws (integrated assessment). In the case of latent damage to the tree by rotten diseases, the stem is tapped or its root paws is drilled. According to the results of the analysis of all model trees, the average reproduction rates of the bark beetle are calculated for each working area and focus of this type as average values.

5. RESULTS

We obtained the information on the number and density of the bark beetle population on the certain forest area from the results of pheromone surveillance (forest pathology analysis) in accordance with the Methodological Guidelines for the Supervision, Accounting and Prediction of Mass Reproduction of Pests and Forest Sanitary Conditions.

For this purpose, pheromone traps were used, which were hung on the test square of the forest in a certain order.

The traps were hung at the beginning of the flight of the beetles. Each week, the caught bark beetles were counted, and the data were recorded in a special list. [1]

In 2012, in the square No. 46, 147,984 bark beetles were collected using pheromone traps (data obtained in the Noginsk branch of the State Institution “Mosoblles”).

As a result of the study, pheromone surveillance was carried out on the number of bark beetles in the square No. 46 of the Lukovsky forestry of the Noginsk District from April 25 to June 2, 2016.

On the working area were hung 20 pheromone traps. The traps used aggregation pheromone, which has the same effect on male and female individuals. The hanging of the traps was made on April 25, 2016 and during the month they were regularly checked. Traps were placed along forest paths at a distance of 20-30 meters from each other. Counting of bark beetles in each trap was carried out manually. The data were recorded in a special list.

Table 1. Pheromone surveillance data.

Quarter	**allotment**	**№ traps**	**Date of traps' hanging**	**The number of beetles in the traps on the dates of accounting**				
				02.05.2016	**09.05.2016**	**16.05.2016**	**23.05.2016**	**30.05.2016**
46	1	1	25.04.2016	0	5	6	1	1
	1	2		0	8	6	1	1
	1	3		7	10	5	0	0
	1	4		10	15	6	6	0
	3	5		16	8	10	5	1
	3	6		10	20	6	0	1
	3	7		30	40	6	0	0

Quarter	allotment	№ traps	Date of traps' hanging	The number of beetles in the traps on the dates of accounting				
				02.05.2016	09.05.2016	16.05.2016	23.05.2016	30.05.2016
	3	8		6	6	3	1	1
	3	9		5	6	10	5	1
	3	10		10	7	10	5	1
	3	11		3	6	4	5	1
	3	12		9	10	8	1	1
	3	13		4	0	7	5	1
	3	14		3	6	8	5	1
	3	15		11	6	8	1	1
	3	16		12	5	9	5	1
	3	17		30	18	6	0	1
	3	18		10	10	10	5	1
	3	19		6	6	3	1	1
	3	20		6	6	3	1	1
Total				589				

Source: Author

In the course of studies conducted in 2015-2016, it was revealed that the number of bark beetle has decreased to the natural number. The data obtained are explained by the reduction of the beetles food supply and less favorable climatic conditions. Spruce forest on the investigated square was destroyedby bark beetle.

In 2016, on the territory of the Noginsk District were cut down 2.9 g of forest destroyed by bark beetle.

The consequences of the bark beetle mass breeding and as the result - drying up of the spruce forests have not been fully studied. Obviously, they can be mainly forest-ecological and economic.

The number of trees colonized by the bark beetle depends on the phase of development of the focus. This indicator is maximum in the initial phase (2012 - when the bark beetle settled on the windfall available that year), as well as in the 1st and 2nd years of the peak phase (2013, 2014, when the typographer multiplied a lot to settle growing trees). During the crisis years, at the time of the studies (2016), the values of this indicator dropped sharply, and during the depression of focus (2010, 2011, 2015), it barely exceeded the level of natural attrition.

Investigating the condition of spruce by categories of state it was identified, that some squares are more damaged by the bark beetle than the rest.

The study revealed that out of 32,000 hectares of forests in the Noginsk District, 6,000 hectares are completely lost sustainability of their forest stand, so, on this territory is necessary continuous sanitary felling. According to our data, the area of damaged by the bark beetle forests is about 3000 ha.

12,000 hectares of forest crop with impaired sustainability requiring selective sanitary felling. There are 2700 hectares of illiquid wood.

In the forests, are necessary immediate sanitary cuttings and windfalls dismantling, since heaps of trees contribute to the spread of other stem pests.

6. CONCLUSION

In the course of the study was carried out pheromone surveillance on the number of bark beetle (Ips typographus L.) at section No. 46 of the Lukovsky forestry of the Noginsk District. With its help was established the reduction of the population of bark beetles due to the complete destruction of the food supply. Also, was obtained the information on the possibility of infection of adjacent squares of forest with the area studied.

During the assessment of the bark beetle impact, it was revealed that more than 1000 ha of spruce ecosystems were destroyed or damaged by insect activity. Of the 32,000 hectares of forests in the Noginsk District, 6,000 hectares with completely lost sustainability of forest corps, this area need continuous sanitary cutting down. According to our data, the area of damaged by the bark beetle forests was about 3000 ha. 12,000 hectares of stands with impaired stability requiring selective sanitary cutting down. There are 2700 hectares of illiquid wood. As a result of the bark beetle activity the forests of the Noginsk District, the Moscow Region, have largely lost their sanitary-hygienic and recreational properties.

The consequences of the rapid growth of bark beetle population will be localized for several more years. Now forests need prompt cutting down of affected trees and windfalls dismantling to prevent an increase in number of stem pests and loss of ecological functions by forest ecosystems.

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ORIGINAL RESEARCH PAPER

SAFE TREATMENT TECHNOLOGY FOR SEEDS OF GRAIN CROPS

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ABSTRACT

The paper is concerned with the accumulation of heavy metals and radionuclides by plant foods, and their transition. Therefore, the experimental data on the safe technology of seed treatment before sowing to ensure stable and high yields of high-quality durum wheat and corn in the conditions of the steppe zone of Chelyabinsk region are presented. As a result, the effect of pre-sowing seed treatment with the growth regulator “Growth Matrix” on the yield and grain quality of durum wheat and corn is studied. The crop structures, field germination, vitreousness, the content of the gluten mass fraction is found. The positive effect of the pre-sowing treatment of seeds by the regulator “Growth Matrix” on the grain quality and increase in the yield of grain crops is confirmed, it is recommended for use in the cultivation of grain crops.

JEL classification: Q13, Q19

Keywords *pre-sowing treatment of seeds, durum wheat, corn, growth regulator, herbicide, yield, gluten, fertilizers*

1. INTRODUCTION

One of the main tasks of agricultural production is ensuring the safety of grain for people. At the same time, in recent years, the production of high-quality and safe grain has noticeably decreased.

This is since most of the currently used preparations for presowing treatment of seeds are chemical compounds which pollute the environment. They are often mutagens, cancerogenes that have a cumulative effect. In recent years, environmentally safe technologies for pre-sowing treatment of seeds to eliminate pathogenic infections become more used in agricultural production.

2. THEORY

Currently, methods of physical exposure for seeds are widely used. Seeds are treated with gamma radiation, electromagnetic field, ultraviolet, X-ray, infrared, visible rays, microwave radiation, radio-frequency, electric, magnetic fields, gravitational effects, alpha and beta irradiation, ions of various elements (Dolgov & Ognev, 2014) (Kontorina & Rubtsova, 2013) (Gordeeva, Shoeva, Yudina, Kukoeva, & Khlestkina, 2018).

Gamma and X-rays are dangerous to human life and therefore are little used in agriculture. Problems arise when using ultraviolet, ultra-frequency and radio frequency radiation (Khasanov, Kamaletdinov, & Khayrullin, 2010).

Therefore, most of the physical methods for seed treatment are not widely used due to their inefficiency, operation difficulties and unsafety.

Many investigations are concerned with pre-sowing seed treatment with ozone (Baskakov, Orobinsky, Tarasenko, Chernyshev, & Khorosheva, 2016) (Tyshkevich, Shabin, & Vinogradova, 2015).

A promising method of pre-sowing preparation for seeds of grain crops is the treatment with Ozonofol, which is a mixture of ozone ions with a complex of micronutrients. The mixture is environmentally safe for all crops and humans (Taskaeva, Medvedeva, Mukhamanturov, & Kas'yanov, 2016). However, to prepare Ozonofol solution is impossible without a special installation.

Nanotechnologies for seed treatment are becoming used more (Tereshchenko, et al., 2017)

Growth regulators for seed treatment are also of great interest (Shevelukha & Blinovsky, 1990) (Kausar & Shahbaz, 2017) (Konotop, Kovalenko, Matušíková, Batsmanova, & Taran, 2017). Many researchers found synthetic regulators to have a bactericidal effect, high efficiency in protecting crops from adverse environmental factors and pathogens. They stimulate growth, have anti-stress and immunostimulating effects, including the control of plant resistance to phytopathogenic infection (Tsyganov & Masterova, 2012) (d'Aquino, de Pinto, Nardi, Morgana, & Tommasi, 2009) (Kaya, Akram, Ashraf, & Sonmez, 2018)

The use of growth regulators has been found to reduce the entry of heavy metals into wheat grain (Baranova, Kalaev, & Voronin, 2014) (Bibi, et al., 2017).

The purpose of this paper is to study the effect of pre-sowing seed treatment with growth regulator "Growth Matrix" on the growth, productivity and quality of durum wheat and corn.

3. DATA AND METHODS

The study of the treatment effectiveness of spring durum seeds and corn with the growth regulator "Growth Matrix" was carried out at the family-operated farm "Ural" located in Kartalinsky district of Chelyabinsk region, at the the family-operated farm "Karsakbaev K.B." located in Agapovsky district of Chelyabinsk region.

Field experiments were carried out in accordance with the experimental methodology in four replications. The way of placing the fields is randomized (Dospekhov, B. A., 1985).

The object of research was the spring durum wheat variety "Bezenchugskaya" and the corn variety "Obsky-140".

The durum wheat and corn seeds were treated with the growth regulator "Growth Matrix" at the doses of 0.14 l/t and 0.6 l/t, respectively.

"Growth Matrix" is a 15% water-soluble concentrate of polymeric biologically active substance from the class of pyrrolidium compounds. It is a biostimulant of plant growth, has anti-stress adaptogen action, increases resistance to adverse environmental conditions (diseases, weather conditions, toxic chemicals). "Growth Matrix" has due bactericidal and antiseptic properties toward various types of bacteria, viruses, protozoa, molds, microscopic fungi and some parasites resistant to other chemical and biological preparations. "Growth Matrix" accumulates in the soil and completely decomposes along with the formation of ammonia, organic acids, water and carbon dioxide. It is non-toxic for mammals, fish, bees and other insects.

The preparation passed state tests and is recommended for agricultural crops: spring and winter wheat, spring barley, sunflower, soybean, corn, sugar beet, potatoes.

Foe the experiments, the seed treater "Premis", carbamide and Banwell herbicide were also used at the doses of 0.2 l/t, 25 kg/ha and 0.4 l/ha, respectively.

When studying the effect of treating corn and seeds of vegetative plants with the biostimulator, there were four variants:

For the first variant (control) the corn seeds were not treated with the growth regulator "Growth Matrix", in the phase of 5-7 leaves the plants being sprayed with the tank mixture of carbamide and herbicide without adding the growth regulator.

For the second variant the corn seeds were treated with the growth regulator "Growth Matrix", in the phase of 5-7 leaves the plants being sprayed with the tank mixture of carbamide and herbicide without adding the growth regulator.

For the third variant the corn seeds were not treated with the growth regulator “Growth Matrix”, in the phase of 5-7 leaves plants being sprayed with the tank mixture of carbamide and herbicide and the biostimulator “Growth Matrix” being added at the dose of 150.4 l/ha.

For the fourth variant the corn seeds were treated with the growth regulator “Growth Matrix”, in the phase of 5-7 leaves the plants being sprayed with with the tank mixture of carbamide and herbicide and the biostimulator “Growth Matrix” being added at the dose of 150.4 l/ha.

4. METHODOLOGY

The research methodology in this paper is the systematic approach as plant protection improving at the present stage of development of science and practice is impossible without the systematic approach widely applicating. The modern concept of plant protection unites into a whole the use of immune varieties or crops that are most resistant to harmful circumstances, adapted agrotechnical methods and biological control methods.

Therefore, exemplified with grain crops, an ecologically adapted system for protecting plants from diseases is developed as an integral part of the technology of their cultivation.

5. EMPIRICAL FINDINGS

The use of the growth regulator “Growth Matrix” significantly influenced the field germination and yield of durum wheat.

Table 1. The effect of pre-sowing seed treatment with the growth regulator “Growth Matrix” on the field germination, tillering factor and yield of durum wheat

The method of seed treatment	Field germination, %	Tillering factor	Yield, t/ha	Increase, t/ha
“Premis”	57	2.1	2.18	-
“Growth Matrix”	65	2.4	2.41	2.3
HCP_{05}	1.84	0.24	0.20	-

Source: Author

When treating durum wheat seeds with the growth regulator “Growth Matrix” instead of the seed treater “Premis”, the seed germination increased by 8%, the tillering factor by 14%, the grain yield by 2.3 t/ha.

The increase in the durum wheat productivity is due to the increase of its tillering factor and field germination causing the formation of strong root systems and more efficient use of moisture during the critical period in July. It appears that the wheat treated with the regulator became more disease-resistant and more easily withstand to dry conditions.

The ability to estimate due to what elements the biological yield increased (the planting density, the productive tillering, the ear grain content, the one-ear mass of grain) gives an opportunity to study the yield structure that makes possible to change the cultivation technology of durum wheat and corn: to change the seeding rate, the seeding depth, the sowing method, the system of fertilizers.

In this work, the following elements of the yield structure are studied: the number of productive stems, the number of grains per ear and the mass of 1000 grains.

Table 2. The effect of pre-sowing seed treatment with the growth regulator “Growth Matrix” on the yield structure of durum wheat

The method of seed treatment	The number of productive stems, pcs/m^2	The number of grains per ear, pcs	The mass of 1000 grains, g
“Premis”	228	23	40,7
“Growth Matrix”	291	21	39
HCP_{05}	6.27	0.92	1.45

Source: Author

As can be seen from Table 2, when treating seeds with the treater “Premis”, the number of productive stems was 228 per m^2, with the mass of 1000 grains being 40.7 grams. When treating seeds with the growth regulator “Growth Matrix”, the number of productive stems increased up to 291 per m^2. The decrease in the mass of 1000 grains after treating with the growth regulator “Growth Matrix” can be considered as due to the large plant density and, consequently, the more explicit competition for nutrients.

The analysis of the yield crop structure proved the number of productive stems to cause the yield formation of durum wheat.

The grain quality indicators of durum wheat, such as the vitreousness, quantity and quality of gluten, determine the flour and baking qualities of wheat.

These indicators are unstable and depend on climatic conditions, weather conditions and varietal characteristics.

In this work, we determined the mass fraction of gluten, the vitreousness of the grain, depending on the pre-sowing treatment of durum wheat seeds.

Table 3. The effect of pre-sowing seed treatment with the growth regulator “Growth matrix” on the vitreousness and gluten mass fraction of durum wheat

The method of seed treatment	Vitreousness, %	Gluten mass fraction, %
“Premis”	64.5	27.1
“Growth Matrix”	67.2	28.2
HCP_{05}	2.37	2.31

Source: Author

The results showed the durum wheat grain vitreousness of the variety “Bezenchugskaya” to increase when it was treated with the biostimulator “Growth Matrix” instead of the seed treater “Premis”.

The indicator determining the high classiness of durum wheat grain is the content of raw gluten, for the first class the content being at least 28%. When seeds were treated with the seed preparation “Premis”, the gluten mass fraction was 27.1%. When seeds were treated with the growth regulator “Growth Matrix”, the gluten mass fraction increased up to 28.2% being in accordance with grain of the first class.

The technological quality of durum wheat grain improved after its treatment with the biostimulant “Growth Matrix”.

When treating the seeds of corn and vegetative plants with the growth regulator “Growth Matrix”, an improvement in their yield formation was also observed.

Table 4. The effect of the growth regulator treatment on the yield of corn green mass

Variant	The average height of stems, sm	The green mass, t/ga	Increase, t/ga
1	134	13.6	-
2	150	14.5	0.9
3	161	16.6	3.0
4	167	17.3	3.7
HCP_{05}	10.2	0.58	-

Source: Author

As can be seen from the table, when treating corn seeds with the growth regulator “Growth Matrix”, the average height of stems increased by 11.9% and the yield of green mass by 0.9 t/ha. The average height of stems and green mass significantly increased when the seeds were treated with the growth regulator “Growth Matrix” and the biostimulator was added to the tank mixture of carbamide and herbicide.

Table 5. The effect of treatment with the growth regulator on the corn yield structure

Variant	The number of stems per m^2	The number of ears per plant, pcs	The number of grains per ear, pcs	The mass of 1000 grains, g	Grain yield, t/ha	Increase, t/ha
1	4.7	1.4	229	96.2	1.55	-
2	4.9	1.45	238	97.6	1.65	1.0
3	4.8	1.56	243	100.1	1.83	2.8
4	4.9	1.58	249	102.2	1.99	4.4
HCP_{05}	0.21	0.08	2.7	2.35	0.03	-

Source: Author

The analysis of the corn yield structure proved that when the corn seeds were treated with the growth regulator “Growth Matrix”, the number of ears, the number of grains per ear and the mass of 1000 grains increased. The grain yield increased by 1 t/ha. The treatment of seeds and vegetative plants with the growth regulator “Growth Matrix” led to an additional yield increase by 4.4 t/ha.

Therefore, the seed treatment and spraying of corn plants with the growth regulator favours the more efficient use of the fertilizer, reduces the stress caused it using and is environmentally safe.

6. CONCLUSION

Due to the field experiments with the use of the growth regulator “Growth Matrix” the following was established:

When treating durum wheat seeds with the plant growth regulator “Growth Matrix” instead of the seed treater “Premis”, the field germination, tillering factor, yield, grain vitreousness and gluten mass fraction increase.

1. When treating corn seeds with the growth regulator “Growth Matrix”, the yield of green mass, the number of ears and the number of grains in them increase.

2. The treatment of seeds and vegetative corn plants with the growth regulator “Growth Matrix” increases the efficiency of carbamide treatment and leads to an additional yield increase.

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ORIGINAL RESEARCH PAPER

INTERRELATION OF ROTATING AGRICULTURAL LANDS WITH OUTPUT INDICATORS

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ABSTRACT

The purpose of the study was to identify and assess the interelation between the acreage dynamics, reflecting the removing of agricultural lands from rotation and their returning back, and production and economic indicators of agricultural producers. The data from the Federal State Statistics Service (Rosstat) were used as initial data. The dynamics of sown areas and other indicators related to changes in land resources and effective indicators of the agricultural sector were analysed for 72 territories of the Russian Federation. As a working hypothesis, the assumption was made that there is a significant interrelation between the dynamics of sown areas and production and economic indicators of agricultural producers. The analysis of the dynamics of sown areas, including the areas under grain and leguminous crops, in regions of the Russian Federation, as well as the dynamics of the structure of sowings of main agricultural crops, showed the presence of significant shifts both in size and in the structure of areas. It was found that productive indicators of agricultural production, in particular, crop yields, profitability of the crop industry, net financial result (profit minus loss) of the crop industry in the regions correlate with indicators reflecting the regions' share in the total size of sown areas and dynamics. Economically acreage growing is due to the increased profitability of crop production in 51 out of 71 regions. The acreage growth is accompanied by an increase in yield, and, moreover, the yield is higher in regions with large production volumes. The growth of acreage leads to improved financial results of enterprises and land productivity (defined as the ratio of the balanced financial result of the crop industry and the sown area). During 2005-2016 the increase in land productivity was observed in 52 out of 72 regions.

JEL classification: Q10, Q15

Keywords *fallow land, agriculture, land rotation, agricultural production efficiency*

1. INTRODUCTION

One of the main arguments in favor of removing lands from agricultural use is their fertility diminishing as a result of excessively intensive usage. Thus, the balance of nutrients in the soil is reduced, and, in order to avoid its further degradation, it is advisable to stop its using.

Thus, by 2017, the amount of fertilizers used per hectare of sown land has decreased by 10 times against 1990. The balance of nutrients in the soil of Chelyabinsk region since 1990 is negative. In 2017, it amounted to 131.3 thous. tons of active ingredients or 69.0 kg/ha of acreage (Zybalov, Denisov, 2018), which may be the reason for removing some lands from agricultural use.

On the other hand, when fallow lands are not used and other conditions are equal, either the load on the lands remaining in rotation increases or the production decreases. Negative consequences can be avoided by improving technology, increasing the balance of nutrients.

According to the results of studies conducted in 2003-2010 in the southern forest steppe on the experimental field of the instructional farm of Verkhneuralsk agrarian vocational school №133, it was established that the agrophysical properties of chernozem being fallow for five and eight years were improved. The content of organic matter increased, the biological activity of soil improved, which made it possible to use fallow lands in agriculture after their due treatment and applied fertilizers, ameliorants, adsorbents (Zybalov et al., 2016).

On the 1st of January 2018 the area of unused lands in Chelyabinsk region was 24.6%, 723.2 ha of lands that had been in rotation before were not used. Only since 2016, a weak tendency to reduce the area of fallow lands can be noticed (Fig. 1).

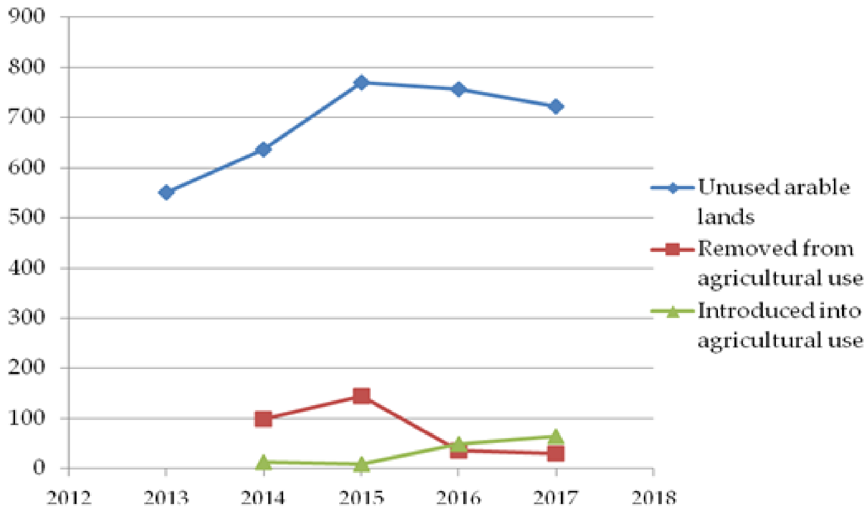

Figure 1. Dynamics of introducing unused arable lands into rotation in Chelyabinsk Region, thous. ha[8]

Source: Author

The dynamics of the area of fallow lands in Chelyabinsk Region during 2013-2017 does not make it possible to draw some firm conclusion about the tendencies, but the distribution of fallow lands becomes less uneven against the total arable land area. In particular, the variation coefficient of the share of fallow lands in the total acreage for the areas of the region decreased from 0.90 to 0.74[9].

Thus, to find the economic causes or consequences of the returning of fallow lands into rotation is of great interest. It was done based on data characterizing the main agrarian regions of Russia.

2. LITERATURE REVIEW

This article considers only the production criterion for assessing the need for acreage growth. But this is only one of several possible criteria, their detailed analysis being given in scientific works (Pullin et al. (2016)), Esmail, Geneletti (2018)). Currently, the attempts to expand agricultural lands can difficult because of urbanization processes leading to land redistribution, and not always in favor of agriculture (Schwaab et al., 2018, FAO & ITPS, 2015, Afifi et al., 2013). Therefore, the involving of agricultural lands in rotation can be one of possible ways for retaining them for production, since useless lands may

[8] According to the Federal State Budgetary Institution “Center for Chemicalization and Agricultural Radiology” Chelyabinsky”

[9] The authors’ calculations according to the information of the Federal State Budgetary Institution “Center for Chemicalization and Agricultural Radiology“ Chelyabinsky ”

be removed from agricultural use, transferred into another land category to be permanently lost for the agricultural sector of the economy.

3. METHODOLOGY

The assumption that there is a significant relationship between the acreage dynamics, production and economic indicators of agricultural producers was considered as a working hypothesis. Since the removal of land from agricultural use is often believed to be due to unproductive and unprofitable cultivation (EEA, 2005, Westhoek et al., 2013), according to changes in the acreage dynamics, the crisis in domestic agriculture can be thought to be overcome or not.

To support the hypothesis, the following tasks are sequentially solved.

1. Both the acreage dynamics including the areas occupied by grain and leguminous crops for the regions of the Russian Federation and the dynamics of the structure of main crops are analysed.

2. The indicators of agricultural production and crop yields, the profitability and balanced financial result (profit minus loss) of the crop industry for the regions of Russia are analysed.

3. The presence and significance of the correlation relationship between the analyzed indicators is found.

Materials and research methods. The data from the Federal State Statistics Service (Rosstat) were used as initial. The acreage dynamics, other indicators related to changes in land resources and effective indicators of the agricultural sector were analysed for 72 territories. The following non-cereal regions were excluded from the general coverage: Kamchatka Region, Karelia, Nenets Autonomous Okrug, Khanty-Mansi Autonomous Okrug, Yamalo-Nenets Autonomous Okrug, Sakhalin Region, Magadan Region, Chukotka Autonomous Okrug, as well as cities of federal significance and the Republic of Crimea, the latter being to ensure data comparability over the entire analyzed time interval. In 2017 the excluded regions produced less than 2.2% of the total crop production in Russia.

The processing of statistical data included calculations of descriptive statistics indicators: average, maximum and minimum values of indicators, standard deviations, variation coefficients. Dynamics of indicators was estimated by the index method. The interrelation of indicators was estimated according to the results of correlation analysis, the significance of correlation coefficients being found with the help of Student's test.

Effective indicators of agricultural production were estimated by production and financial results (yield, profitability), the data were compared due to the introduced indicator of land productivity equal to the ratio of the balanced financial result of the crop industry and the acreage.

4. EMPIRICAL FINDINGS

During 2006-2016 the area under crops in farms of all categories increased in Russia from 75,837 thous. ha to 79,993 thous. ha or by 5.5%. At the same time, there was a uniform tendency towards increasing in acreage in the regions of Russia. Acreage decreasing in the North-West and Siberian Federal Districts may be due to relatively unfavorable climatic conditions, with the result that the products of these regions are less competitive on the Russian market. In the Siberian Federal District, the increase in acreage was observed in the regions most favorable for production: Altai Territory, the Altai Republic, Khakassia and Omsk Region; in other regions there was an acreage reduction. In the North-West Federal District, the area under crops increased only in Kaliningrad and Novgorod regions. The data on the increase of the acreage compared with the area under grain crops reveal a more intensive dynamics and a greater varation of the values showing the increase of the latter. The data are shown in Table 1.

Table 1. Statistical characteristics of acreage growth indices and areas under grain and leguminous crops during 2005-2016 in 72 constituent entities of the Russian Federation

Acreage growth index	Acreage for crops	Acreage for grain and leguminous crops
Average	1.0264	1.0507
Standard error	0.0279	0.0460
Standard deviation	0.2366	0.3905
Sample variance	0.0560	0.1525
Minimum	0.5473	0.1667
Maximum	2.1057	2.7763

Source: Author

In general, the areas under grain and leguminous crops increased more noticeably, although the data on their dynamics in the regions vary widely in comparison with the total acreage.

Yield fluctuations of most crops are quite intense over the years (Table 2). The analysis of the data of yields during 1991-2017 proved an increase to be observed for most crops. To even out the effect of the weather factor and to match time intervals, the data for the successive decades during 1998-2007 and 2008-2017 were compared (the data are shown in the lower part of Table 2).

Table 2. Crop yields in Russia

Yield, center/ha	Grain crops in general	Incl. wheat	Sugar beet	Oilseeds	Potatoes
Average	19.7	20.6	275.9	11.2	146.3
Minimum	13.1	13.9	135.2	8.0	83.9
Maximum	31.0	33.2	471.6	14.6	258.3
Standard deviation	4.367	4.452	101.421	1.962	52.338
Variation coefficient	0.221	0.216	0.368	0.176	0.358
Yeild growth index in 2008-2017 in relation to 1998-2007	1.35	1.33	1.63	1.27	1.55
Growth index of production volumes in 2008-2017 in relation to 1998-2007	1.37	1.44	2.00	2.22	1.06

Sources: Urozhaynost' sel'skokhozyaystvennykh kul'tur v sel'skokhozyaystvennykh organizatsiyakh // Effektivnost' ekonomiki Rossii // Federal'naya sluzhba gosudarstvennoy statistiki http://www.gks.ru/free_doc/new_site/business/sx/uroj_2.xls Valovoy sbor sel'skokhozyaystvennykh kul'tur po kategoriyam khozyaystv (v khozyaystvakh vsekh kategoriy) // Sel'skoe khozyaystvo i balansy prodovol'stvennykh resursov Sel'skoe khozyaystvo, okhota i lesnoe khozyaystvo // Federal'naya sluzhba gosudarstvennoy statistiki http://www.gks.ru/free_doc/new_site/business/sx/m_v_1.xls, the authors' calculations

The table does not include the data on fodder crops; the dynamics of their yield is not so noticeable: the increase for different types of products over 10 years was from 1 to 12%.

With an increase in the average yield and acreage, the production of agricultural products will raise in general (the data on growth indices of production volumes during 2008-2017 against 1998-2007 are presented in the last line of Table 2). However, the analysis of the data on the gross crop yield [3] shows that there is an uneven growth in production in general. This may indicate both a structure redistribution of crops and an uneven change in the structure of production in the regions.

The analysis of the acreage structure according to the types of crops in Russia as a whole [4] proves the changes to be uneven (Table 3).

Table 3. Statistical characteristics of changes in the acreage structure according to types of crops (the averaged data for Russia)

Share in the crops structure	Grain crops in general	Incl. wheat	Sugar beet	Oilseeds	Potatoes
Average	57.2	31.4	1.2	9.9	3.0
Minimum	53.0	25.8	0.9	4.5	2.4
Maximum	61.1	36.9	1.7	15.7	3.3
Standard deviation	2.259	3.190	0.223	3.763	0.284
Variation coefficient	0.040	0.102	0.187	0.380	0.096
Growth index of the acreage share in 2008-2017 in relation to 1998-2007	1.052	1.141	1.235	1.802	0.874
Growth share index in the acreage of crops during 1996-2017	1.102	1.339	1.390	3.276	0.708

Sourses: Struktura posevnykh ploshchadey po vidam sel'skokhozyaystvennykh kul'tur (v khozyaystvakh vsekh kategoriy) // Sel'skoe khozyaystvo i balansy prodovol'stvennykh resursov Sel'skoe khozyaystvo, okhota i lesnoe khozyaystvo // Federal'naya sluzhba gosudarstvennoy statistiki http://www.gks.ru/free_doc/new_site/business/sx/struk_posev_vid1.xls, the authors' calculations

Moreover, long-term changes are even more significant (when the data compared for 10 years and 22 years) for all types of analyzed crops. This proves the fact that over time there occurs not just an increase in the area, but some redistribution in favor of some crops against others.

Changes in the crop production structure in regions and their rationality can be confirmed by analyzing the data on the financial results of agricultural organizations. If changes in financial results (balanced financial result, i.e. profit minus loss, profitability level) are more significant than changes in resource provision (land resources), then the involvement of lands in agriculture may be due to economic reasons.

In general, for the most of analyzed regions (for 57 out of 72), positive average values of crop production profitability were observed. In 51 out of 71 regions, the profitability increased in 2016 against 2005. This may favor the economic justification for the acreage growth, since along with the general tendency of increasing, the profitability of crop production raises. The positive balanced financial result of the crop industry can serve as an indirect confirmation of this thesis, as during the analyzed period it was observed in most of the regions. The number of profitable regions varied from 43 in 2010 to 55 in 2016.

To identify the nature of the interrelation between the analyzed indicators, a correlation matrix was compiled (Table 4). The data on the structure of crop production in the regions of Russia are taken from [1].

The pair correlation coefficients were calculated according to the formula:

$$r_{jk} = \frac{\sum_{i=1}^{n}(x_{ij}-\hat{x_j})(x_{ik}-\hat{x_k})}{\sqrt{\sum_{i=1}^{n}(x_{ij}-\hat{x_j})^2(x_{ik}-\hat{x_k})^2}},$$

where x_{jk} is the value of the j^{th} and k^{th} indicators for the i^{th} region, $\hat{x}_j, \hat{x}_k$ is the average value of the indicator.

The names of the indicators are given in Table 4. The significance of the indicator r_{jk} was determined with Student's test for n = 72.

Table 4. Correlation matrix for the sampling frame of the regions

Indicator name	Indicators					
	1	**2**	**3**	**4**	**5**	**6**
Acreage growth index, 2016-2005 (1)	1.0					
Regional share in crop production in 2017 (2)	0.21806	1.0				
Average yield of grain crops, 2005-2016 (3)	0.27582	0.43032	1.0			
Yield increase in grain crops during 2005-2016 (4)	0.28166	-0.11093	0.20826	1.0		
Aaverage annual profitability during 2005-2016 (5)	0.20705	0.43457	0.20220	0.06817*	1.0	
Overall change in profitability during 2005-2016 (6)	0.33140	0.32978	0.16011*	0.14768*	0.53375	1.0

Note: * - insignificant correlation coefficients (p=0,1)

Source: Author

The positive correlation between the analyzed indicators makes it possible to conclude that the acreage growth in the regions is due to production efficiency. The low significance of the correlation coefficients of financial indicators with the yield (relative values characterizing the changes over time) may be due to unfavorable market conditions, namely the financial gain caused by the yield increase may be even out by a decrease in market prices. However, this thesis requires further substantiated verification.

With an exception being the negative value of the pair correlation coefficient of the region's share in the crop production in 2017 and the increase in yield of grain crops during 2005-2016, it can be due to a more intensive increase in yield in the regions with lower production before.

The acreage growth is accompanied by yield increasing; moreover, the yield is higher in the regions with large production output. The acreage growth leads to improving financial results of plant growing producers. Land productivity also increases: this indicator was found as the ratio of the balanced financial result of the crop industry and the acreage. The increase in land productivity during 2005-2016 was observed in 52 out of 72 regions.

5. CONCLUSION

For the analyzed time period 2005-2016 in most regions of Russia there was a moderate increase in acreage. The growth rate of acreage under grain and leguminous crops doubled the growth rate of acreage under agricultural crops in general. This growth was accompanied by an increase in the yield of main agricultural crops, which ultimately led to an increase in production output in the agricultural sector of Russia. Thus, Russia's agricultural industry can be assumed to overcome the crisis of the 1990s and to be in the recovery stage.

For most regions, positive changes in the structure of production along with the extensive use of land resources have led to improved financial performance in production, i.e. the balanced financial result and profitability of crop production.

Thus, the hypothesis about the existing positive correlation between the indicators of the acreage dynamics, production and economic indicators of agricultural producers is confirmed.

The shifts in the dynamics of fallow lands in Chelyabinsk region generally agree with the all-Russian tendency. Thus, involving fallow lands in agriculture can be considerd as feasible according to the potential economic result due to increasing acreage. This result, however, requires the forecast of market prices for the main types of agricultural products, as well as considering the planned regulatory measures by the state.

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Part IV - Environmental Conflict Management: New Ways to Solve Problems

ORIGINAL RESEARCH PAPER

FLOOD IMPACT ASSESSMENT MODEL IN THE EVENT OF A HYDRAULIC STRUCTURE BREAKTHROUGH

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ABSTRACT

The article presents an algorithm for constructing the dependence of the effects of floods on the amount of work and the cost of improving the security of a hydraulic structure. Based on the conducted regression analysis, an analytical model for estimating the possible damage from flooding is built. The calculation example is given. The resulting model allows us to formulate a new scientific problem to minimize the possible damage from emergency situations associated with floods, due to the rational choice of the volume of engineering work and the necessary costs according to the "cost-effectiveness" criterion.

JEL classification: Q54, Q59

***Keywords**: regression analysis, scope of work, consequences of an emergency, efficiency, cost.*

1. INTRODUCTION

Flooding ranks first in a series of natural disasters in terms of frequency, area coverage and average annual damage. The damage from them grows from decade to decade. In the past 100 years alone, according to UNESCO, more than 10 million people have died from floods in the world. At the end of the 20th century and the beginning of the 21st century, the increasing power and frequency of floods is invited by the improper implementation of flood control measures, which lead to breakthrough of embankment dams, destruction of artificial dams, and erosion of protective embankments [1, 2, 3, 4].

During the catastrophic floods, hundreds of thousands of hectares of farmland, hundreds of settlements, dozens of cities, thousands of kilometers of roads and railways, bridges, power lines and communications, industrial facilities, residential buildings, human economic activity are paralyzed in the flood zone and destruction. Flood damage can amount to hundreds of millions of rubles. The elimination of the consequences of the floods has been carried out for several years with the involvement of the main resources of the local executive bodies, as well as of the federal budget [5, 6, 7].

Flood preventative measures can be divided into three groups.

The first includes works of forecast-analytical nature - hydrological forecasting, analysis and assessment of a possible situation. Hydrological forecast is a scientifically based prediction of the course of development, nature and scale of flooding.

The second group of preventive measures is organizational and operational ones. These include adoption by local executive authorities, territorial bodies of civil defense and emergency situations and officials of decisions on preventive measures and preparations for combating floods; development of draft administrative documents of the local administration (on the order of evacuation, protection of property of citizens, traffic, on the involvement of the population to work, sanitary-epidemic measures, etc.); authorization of specific engineering works, protection measures, etc., organization of their implementation; clarification of the plans of action of the governing bodies and forces, setting tasks for them [8, 9, 10, 11].

The third group of preventive measures is engineering and others. They are mainly based on typical methods of reducing the effects of flooding. These may include reducing the maximum flow of water in a river by redistributing runoff over time, building fencing dams (ramparts), straightening the river bed, filling in areas, shore protection and bottom strengthening works, regulating flood flow (flood) using reservoirs, using combined ways to prevent flooding. Some of these activities can be carried out only on a long-term basis, some - quickly in anticipation of the elements, and some - both long-term and operational [12, 13].

However, the existing approaches to the planning and implementation of engineering and technical measures to mitigate the effects of floods do not sufficiently allow a methodological basis for developing the scope of their implementation, considering the allocated financial resources.

Therefore, the purpose of this article is to develop such an approach that would allow one to obtain an analytical dependence of the possible consequences on the volume and resources spent on carrying out engineering and technical measures for flood prevention. This will further make it possible to substantiate management decisions on the prevention and reduction of the effects of floods on the criterion of "cost-effectiveness".

2. PROBLEM STATEMENT

To build the analytical dependence of the effects of floods on the amount of work and the cost of improving the security of a hydraulic structure, we choose multiple regression with two explanatory variables. The linear multiple regression function in this case is written as

$$\hat{y} = a + b_1 x_1 + b_2 x_2 \tag{1}$$

where x_1 is the amount of work carried out to improve the safety of hydraulic structures, the increase in the threshold gap, in meters; x_2 is the cost of the work to increase the threshold gap, in arbitrary units; $\hat{y}$ - possible consequences in case of destruction of a hydraulic structure, width of flooding, in meters.

In order to form a data table for $\boldsymbol{x_1, x_2, \hat{y}}$ we will calculate the forecast of flooded areas and assess the engineering situation. To do this, we use the technique of "Engineering situation in a catastrophic flooding from the destruction of hydraulic structures" [14]. The initial data used in the methodology are:

1. Hydrological data (type of cross-section of the river bed, drainage basin area);
2. Meteorological data (snow cover thickness and snowmelt intensity, precipitation intensity);
3. Characteristics of the object of impact;
4. Information about the terrain in the flood zone.

The task is to estimate the regression parameters based on the results of sampling observations of the variables included in the analysis. For this purpose, we use the method of least squares. We set the condition that the regression should be as consistent with empirical data as possible. The sum of the squares of the deviations of all observed values of the dependent variable y_i from the values calculated by the regression equation y_i (i.e. the sum of the squares of the residuals) should be minimal. So, the following requirement must be fulfilled:

$$S(a, b_1, b_2) = \sum_{i=1}^{n} (y_i - \hat{y}_i)^2 \to \min \qquad (2)$$

3. PROBLEM SOLUTION ALGORITHM

The procedure for solving the task will be considered on the example of the Shemkir hydroelectric complex of the Republic of Azerbaijan. The hydroelectric complex consists of a channel earthen dam, a flood plain dam, a construction and operational spillway, and a pressure station structure.

In the event of a breakthrough of the hydraulic structure under consideration, populated areas and socially significant facilities may be in the area of possible flooding.

As stated in the statement of the problem, the work to increase the gap is considered as the engineering and technical measures performed. Using the technique of "Engineering situation in a catastrophic flooding from the destruction of hydraulic structures", we obtain the values of the volume of work carried out to improve the safety of hydraulic structures, to increase the gap gaps, in meters; the cost of the work to increase the breach threshold, in arbitrary units; possible consequences in case of destruction of hydraulic structures, the width of flooding, in meters. The data obtained are recorded in a table, a fragment is presented in Table 1.

Table 1 - Fragment of the presentation of the initial data for the construction of the regression

№	Gap threshold height, м	Cost	Flood width on the left bank, m
1	0	1000	48,28
2	0,2	1020	48,27
3	0,4	1040	48,26
4	0,6	1060	48,24
5	0,8	1080	48,22
6	1	1100	48,21
7	1,2	1120	48,2
296	59	6900	3,89
297	59,2	6920	3,01
298	59,4	6940	3,01
299	59,6	6960	3,01
300	59,8	6980	3,01
301	60	7000	3,01

Source: Author

We choose the values of the regression coefficients (1) to ensure the best fit to the observations in the hope of obtaining optimal estimates for the unknown true values of the parameters. The assessment of the optimality of conformity is determined by minimizing S (2), i.e. the sum of squared deviations:

$$S = e_1^2 + \ldots + e_n^2 \tag{3}$$

where e_i, is the remainder in observation i, the difference between the actual y value in this observation and the $\hat{y}$ value predicted by the regression equation (1).

$$e_i = y_i - \hat{y}_i = y_i - a - b_1 x_{1i} - b_2 x_{2i} \tag{4}$$

Using equation (4), we can derive:

$$S = \sum e^2 = \sum (y_i - a - b_1 x_{1i} - b_2 x_{2i})^2 \tag{5}$$

Necessary conditions of the first order for a minimum, $\partial S/\partial a = 0$, $\partial S/\partial b_1 = 0$ and $\partial S/\partial b_2 = 0$, are given by the following equations:

$$\frac{\partial S}{\partial a} = -2\sum (y_i - a - b_1 x_{1i} - b_2 x_{2i}) = 0 \tag{6}$$

$$\frac{\partial S}{\partial b_1} = -2\sum x_{1i}(y_i - a - b_1 x_{1i} - b_2 x_{2i}) = 0 \tag{7}$$

$$\frac{\partial S}{\partial b_2} = -2\sum x_{2i}(y_i - a - b_1 x_{1i} - b_2 x_{2i}) = 0 \tag{8}$$

Therefore, we have three equations with three unknowns: : a, b_1 and b_2. The first equation can be easily rearranged to express the value of a through b_1 and b_2 and the observation data for x and y:

$$a = \bar{y} - b_1\overline{x_1} - b_2\overline{x_2} \tag{9}$$

Using this expression and two other equations, by some transformations, we get the following expression for b_1, defined by the var variance and cov covariance:

$$b_1 = \frac{Cov(x_1,y)Var(x_2) - Cov(x_2,y)Cov(x_1,x_2)}{Var(x_1)Var(x_2) - (Cov(x_1,x_2))^2} \tag{10}$$

A similar expression for b_2 can be obtained by permuting x_1 and x_2 in equation (10). The principles underlying the calculation of regression coefficients in cases of multiple and pair regression do not differ.

Applying the data of table 1, calculating averages, variances, covariances, independent variables x_1 and x_2, we substitute the values found in (1) - (10). Thus, we determine the analytical view of the regression model of the dependence of the effects of flooding on the amount of work and the cost of improving the security of a hydraulic structure:

$$\hat{y} = 59{,}564 - 0{,}357x_1 - 0{,}004x_2 \tag{11}$$

Multiple regression analysis allows to differentiate the influence of independent variables, while allowing for the possibility of their correlation. The regression coefficient for each variable x gives an estimate of its effect on the value of y in the case that all other variables x have no effect on it.

The correlation coefficient, which shows how interconnected the fluctuations of the values of indicators of consequences, the volume of work and costs, is 91%. The coefficient of determination was obtained equal to 84%, i.e. the resulting value is the fraction of the variance of the resultant attribute of the dependent variable (consequences of flooding), which is explained by the influence of independent variables (the amount of work and costs). Testing the Fisher criterion equal to F (2.298) = 796.54, when compared with tabular data at a significance level of 0.05, also showed a high significance of the regression model.

Thus, the resulting computational model (11), the dependence of the effects of flooding on the amount of work and the cost of improving the protection of a hydraulic structure, will further scientifically substantiate engineering and technical measures aimed at reducing the consequences from flooding in the event of a hydraulic structure failure.

Also, the resulting model allows us to formulate a new scientific problem to minimize the possible damage from emergency situations associated with flooding, due to the rational choice of the volume of engineering works and the necessary costs according to the “cost-effectiveness” criterion.

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ORIGINAL RESEARCH PAPER

ESTIMATION OF INCREASING ENVIRONMENTAL FRIENDLINESS IN AGRICULTURAL ZONES USING RECIRCULATING FILTERS

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ABSTRACT

The paper deals with the ecological aspects related to air dedusting in premises for agricultural purposes. The justification for the relevance of using recirculation filters to reduce the concentration of dust in various buildings is given. The presented analysis of literature sources helped to study theoretical and practical approaches to ensuring the air cleanliness by various means. The material balance equation for dust particles in premises, the maximum degree equation for air purification, as well as dedusting time constant with regards to dust deposition under the action of gravity were derived and solved. This paper provides the results of experimental study on air dedusting using an ion ventilation filter in test rooms (a laboratory and a living room). Comparison of calculation results related to dust reducing kinetics in test rooms with experimental data showed their divergence due to the fact, that the dust concentration is assumed to be the same in all parts of the room, and the dust emission is constant in time. To take these factors into account, the differential equation of the maximum degree for air purification in the room has been corrected. To use the proposed equation in practice, a nomogram has been developed. It makes possible to determine the number of filters, filter air flow rate depending on the volume of the room, dust concentration in the room, air exchange rate and the value of limiting degree of air purification. The field of further research related to the improvement of the developed mathematical apparatus, considering dust deposition under the action of electrostatic scattering, has been determined.

JEL classification: Q52, Q55

Keywords: *Environmental friendliness, Recirculation, Air purification, Dust concentration, Gravity of dust particles, Filter*

1. INTRODUCTION

Production, processing, transportation and storage of agricultural products in many cases are associated with the appearance of fine dust that has a negative impact on the human body. Progressive air dustiness is a characteristic of megapolises, where it is an acute environmental problem.

The pathogenesis of dust particles effects depends on the dispersion composition and fractional concentration of dust in the air and is widely discussed in world medicine. The penetration of dust particles into the lungs and respiratory tract of a person causes damage to the lung tissue, respiratory and chronic diseases. Employees of agricultural enterprises, where dust is transported under the influence of climatic factors, are at risk. The experts of the World Health Organization (WHO) are concerned with the fact, that the International Agency for Research on Cancer considers air pollution by fine suspended particles to be one of the most important causes of cancer (IARC Monographs Working Group on the Evaluation of Carcinogenic Risks to Humans on the following issues: Outdoor Air Pollution, 2016, Vol. 109; Diesel and gasoline exhausts and some nitroarenes, 2014, Vol. 105; Household use of solid fuels and high-temperature frying, 2010, Vol. 95; Indoor emissions from household combustion of coal, 2012, Vol. 100E; Tobacco smoke and involuntary smoking, 2004, Vol. 83).

It should be noted that in several countries, including Russia, it has been decided to maintain the rationing of dust particles with dimensions of not more than 2.5 microns in the air. According to the environmental doctrine of the Russian Federation, the strategic goal of the state policy in the field of ecology is the enhancement of people's quality of life and the improvement of their health. Therefore, the task of reducing the dustiness in the premises is of great importance. Achievement of this goal is formulated as a task to ensure air quality in accordance with established hygienic standards, that confirms the urgency of the task related to reducing the dustiness in rooms where people carry out their activities.

2. LITERATURE REVIEW

Currently, various means and technologies of air purification in premises are used including filtration, electrostatic precipitation, ion generation, pulsed discharge plasma in combination with a photocatalyst, etc. Researchers are trying to find effective and cost-effective ways to reduce unwanted particles, odors, impurities in the air. To accomplish these goals, some authors suggest to use electrostatic filters (Vozmilov et al., 2016) to remove fine dust. Some scientists (Winkel et al., 2016) are investigating the operation of dry filters along with a full-scale prototype electrostatic precipitator in poultry farms. Other researchers (Thomas et al., 2015; Anthony et al., 2015; Liu et al., 2017; Chen, 2018) believe that general ventilation with recirculated air or air conditioning is necessary, which also prove to be cost-effective in controlling pollution in the workplace. The use of plasma for air purification, thermal effects of non-thermal plasma and plasma catalysts (Bahri et al., 2014) and their use for removing volatile organic compounds (VOCs) is also an effective method of cleaning industrial premises. A lot of attention is paid to filtering materials (Tang et al., 2018; Wang et al., 2016) electret fibers that can effectively clean and hold fine dust on their surface. With the rapid development of a modern wireless communication system, bandpass filters based on a multimode resonator with small functions, low losses and wide bandwidth are very popular (Xiao et al., 2015; Zhan et al., 2018; Li et al., 2018). A significant number of researches is devoted to modeling and experimental effectiveness testing of fibrous filter application (Bang et al., 2014; Shou et al., 2015; Kirsh, 2015; Huang et al., 2016; Zhou et al., 2017) using various methods to determine its characteristics.

The analysis of the scientific literature in this field showed that the most common method of air purification is the use of filters of various types. The estimation of their operation is performed in accordance with the steady-state concentration of dust in the room and the time to reach it. But the most well-known methods for calculating dust concentration in a room do not consider the deposition of dust particles by gravity.

3. METHODOLOGY

To assess the effectiveness of the filters, it is proposed to consider the effect of gravity on the dust particle. Then the equation of material balance of dust particles in a limited volume from the influencing factors including the gravity has the form:

$$dq = dq_1 + dq_2 + dq_3 - dq_4 - dq_5 - dq_6, \quad (1)$$

where dq is the amount of dust particles in the air of the room during dt; dq_1 is the amount of dust particles entering the room with the incoming air; dq_2 is the amount of dust particles entering the room from a distributed source of dust; dq_3 is the amount of dust particles entering the premises from the filter; dq_4 is the amount of dust particles removed from the room with the exhaust air; dq_5 is the amount of dust particles entering the filter from the premises; dq_6 is the number of dust particles deposited in the room under the action of gravity.

Based on the material balance equation, a differential equation is compiled and solved

$$\frac{dn}{dt} = n_1 N + \frac{x}{V} + \frac{n(1-\eta_f)Q_f}{V} - nN - \frac{nQ_f}{V} - \frac{nW_g S_n}{V}, \quad (2)$$

where

$$n = \frac{a}{b}(1 - e^{-tb}) + n_o e^{-tb}, \quad (3)$$

$$a = n_1 N + \frac{x}{V}, \quad (4)$$

$$b = \frac{\eta_f Q_f}{V} + N + \frac{W_g S_n}{V}, \quad (5)$$

where n is the current value of average counting dust concentration (hereinafter is the concentration) in the air considering room volume, pcs/m^3; t is the time constant of dust removal, s; n_0 is the initial (at t=0) dust concentration, pcs/m^3; W_g is the falling velocity of a dust particle under the action of gravity, m/s; S_n is the area of the horizontal deposition surface, m^2; N is air exchange rate, x is the counting dust emission, pcs; Q_f is the air volume flow through the filter, m^3/h; η_f is the degree of air purification in the filter; n_1 is the concentration of dust in the incoming air, pcs/m^3; V is the room volume, m^3.

The formula for steady-state concentration of dust in the air of a room n_∞ is:

$$n_\infty = \frac{a}{b} = \frac{n_1 NV + x}{\eta_f Q_f + NV + W_g S_n}, \quad (6)$$

or

$$n_\infty = \frac{n_1 N + \frac{x}{V}}{\eta_f N_f + N + \frac{W_g S_n}{V}}. \quad (7)$$

The time constant of dust removal τ can be calculated by the formula:

$$\tau = \frac{1}{b} = \frac{V}{\eta_f Q_f + NV + W_g S_n}, \quad (8)$$

or

$$\tau = \frac{1}{\eta_f N_f + N + \frac{W_g S_n}{V}}. \quad (9)$$

The formulas for calculating the current and maximum degrees of air purification in the room, considering the deposition of dust under the action of gravity at any initial concentration of dust are:

$$\eta_n = 1 - \frac{n_1 NV + x}{(\eta_f Q_f + NV + W_q S_n) n_0}(1 - e^{-\frac{t}{\tau}}) - e^{-\frac{t}{\tau}}, \quad (10)$$

$$\eta_{n_\infty} = \lim_{t \to \infty} \eta_n = 1 - \frac{n_1 NV + x}{(\eta_f Q_f + NV + W_q S_n) n_0}. \quad (11)$$

To obtain formulas that help to calculate the value of the current and maximum degrees of air purification in the room, we put the value n'_∞ (it can be found from (7), setting η_f=0) instead of n_0 in (10) and (11).

Thus,

$$\eta_n = 1 - \frac{N + \frac{W_g S_n}{V}}{N + \frac{\eta_f Q_f}{V} + \frac{W_g S_n}{V}} (1 - e^{-\frac{t}{\tau}}) - e^{-\frac{t}{\tau}}, \tag{12}$$

$$\eta_{n_\infty} = \lim_{t \to \infty} \eta_n = \frac{\eta_f Q_f}{\eta_f Q_f + NV + W_g S_n}, \tag{13}$$

Formula (13) can be written in another form, for example:

$$\eta_{n\infty} = \frac{\eta_f N_f}{\eta_f N_f + N + W_g \frac{S_n}{V}}, \tag{14}$$

4. EMPIRICAL FINDINGS

The experimental verification of the obtained expressions was carried out in two test rooms: No. 1 (a living room) and No. 2 (a laboratory). The parameters and conditions of the experiment are given in Table 1. The ion ventilation filter (IVF) was used as a filter (Fain, Smirnyagin, Ivanova, 2002).

Table 1. Characteristics of test rooms and the environment for conducting an experiment on air dedusting using IVF

Indicator	Room	
	№1	№2
Floor surface area S_n, m²	20	38.8
Room volume V, m³	60	109
Dust particle density ρ, kg/m³	2000	2000
The degree of air purification in the filter η_f	0.9	0.96 (for r=0.175 μm) 0.98 (for r>0.175 μm)
Specific air volume flow through the filter N_f, 10^{-4} s^{-1}	2.25	0.925
Dynamic viscosity of air μ, 10^{-6} Ns/m²	18.1	
Molecular mean free path l, 10^{-7} m	0.942	
Kenningham amendment coefficient to Stokes A law	0.86	
Intensity of gravity g	9.81	

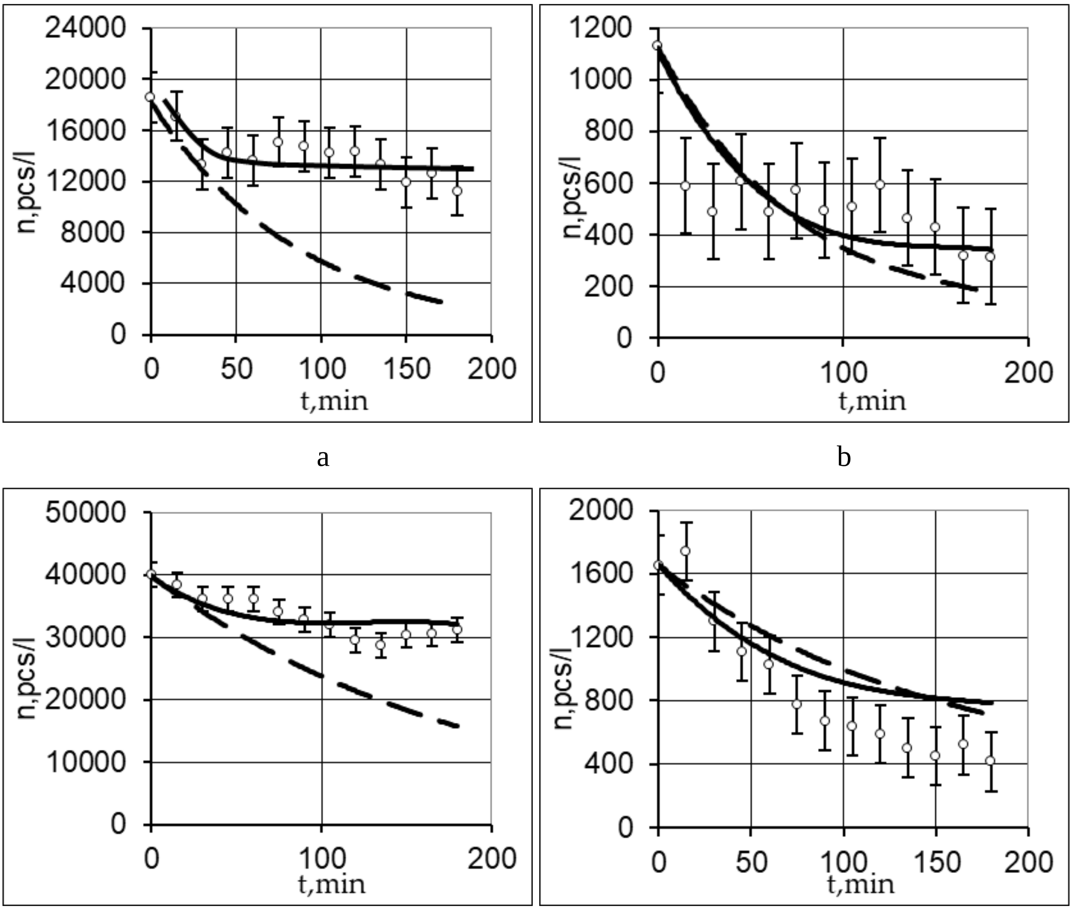
Source: Author

The specific dust emission was determined based on formula (7), where N=0 and η_f=0, as follows:

$$\frac{x}{V} = n_o W_g \frac{S_n}{V}, \tag{16}$$

where n_0 is the steady-state concentration of dust in the air of the room when the filter is not working, pcs/m^3.

The obtained experimental data were compared with the calculated values derived from the formula (7). Some results of calculations and measurements are represented by the graphs on Fig. 1.



a b

c d

Fig. 1. The kinetics of dust concentration declining in the air of the room when IVF is working:

a- room number 1, r_{mid} = 0.175 µm; b - room number 1, r_{mid} = 0.45 µm;
c - room number 2, r_{mid} = 0.175 µm; d - room number 2, r_{mid} = 0.45 µm;
- calculation by model without correction;
- calculation by model with correction;
- average values of experimental data considering the confidence interval

Source: Author

It can be seen from the graphs that there is a discrepancy between the results of calculating the dust concentration according to the theoretical model and the results of the experiment. The discrepancy averaging in time and over all five fractions of dust particles gives the values for rooms No. 1 and No. 2; they are 47% and 22%, respectively. The reasons for this discrepancy are that the dust concentration at a given time is assumed to be the same at all parts of the room, and the dust emission in the room is constant in time.

Taking this into account, it was decided to correct the mathematical model for the case of filter operation in a non-ventilated room by introducing correction coefficients C and K (C>1, K<1). The coefficient C introduced as a multiplier before the value W_g clarifies the reduction of the effective gravitational deposition rate (allowable by the model). The coefficient K introduced as a multiplier before the value $\frac{x}{V}$ considers the decrease in dust emission in the room during filter operation.

With the introduction of correction coefficients, the formulas take the following form:

$$n_\infty = \frac{K\frac{x}{V}}{\eta_f N_f + C\frac{W_g S_n}{V}}, \tag{17}$$

$$\tau = \frac{1}{\eta_f N_f + C\frac{W_g S_n}{V}} \tag{18}$$

The coefficients C and K are determined according to the experimental data conducted in room №1. The results of C and K coefficients determination are approximated by the formulas

$$C = -5{,}96 \cdot 10^{21} \cdot r^3 + 8{,}10 \cdot 10^{15} \cdot r^2 - 3{,}65 \cdot 10^9 \cdot r + 553 \tag{19}$$

and

$$K = -5{,}04 \cdot 10^{12} \cdot r^2 + 2{,}17 \cdot 10^6 \cdot r + 0{,}72\,, \tag{20}$$

applicable in the interval of $0{,}175 \cdot 10^{-6} m \le r \le 0{,}45 \cdot 10^{-6} m$.

From the graphs in Fig. 1 we can conclude that the adjusted model more accurately describes the experimental data. Inaccuracy averaging of the corrected model over time and over all five fractions of dust particles gives the values for rooms No. 1 and No. 2, they are 17% and 19%, respectively. Therefore, the adjusted mathematical model makes it possible to calculate air dedusting in the room by a recirculation filter with an inaccuracy acceptable for practical purposes and can be recommended both for design calculations and for mathematical modeling of the process.

To facilitate the use of the results obtained, we have developed a nomogram that helps to determine the number of filters, filter air flow rate depending on the volume of the room, dust concentration in the room, air exchange rate and the value of limiting degree of air purification. The nomogram is presented in Fig. 2.

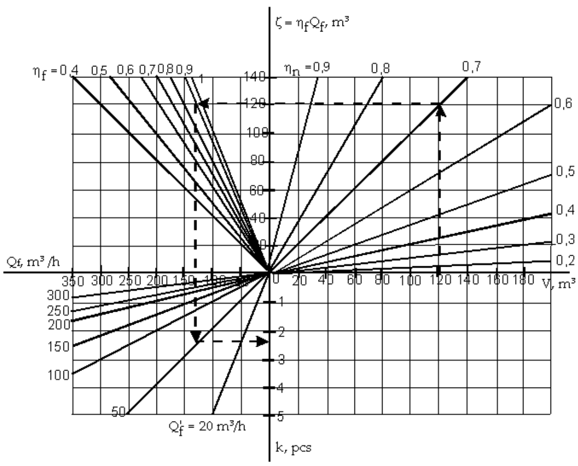


Fig. 2. Nomogram for determining the number and the parameters of filters

Source: Author

The use of the nomogram is as follows: we find the required volume of the room (premises) on the abscissa axis and draw a perpendicular to the intersection with the line corresponding to the required degree of air purification in the room. From the obtained intersection point, a horizontal line is drawn to the intersection with the straight line corresponding to the degree of air purification in the filter used. Further, from the obtained point we draw a line parallel to the ordinate axis, to the intersection with the straight line corresponding to the volume flow rate of the filter used. The ordinate of this point, rounded to the nearest whole number, corresponds to the required number of filters.

5. CONCLUSION

The most promising means of air purification from dust not only in agricultural but in industrial, business and residential areas are filters. The dedusting kinetics formula presented in this paper can consider the gravity of dust particle in designing the dust-removing system and can be used for practical calculations. The proposed nomogram makes it possible to quickly determine the number of filters and filter air flow rate to ensure normalized air purity.

In further studies related to the degree of air purification in premises, it is necessary to take into consideration other mechanisms for dust deposition. Thus, for example, during the operation of electrostatic precipitators, dust is deposited on surfaces not only under the action of gravity, but under the action of electrostatic scattering.

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ORIGINAL RESEARCH PAPER

ECONOMIC ACTIVITIES OF AGRICULTURAL ORGANIZATIONS: INEQUALITY AND INSTITUTIONS

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ABSTRACT

The work examines the change in inequality when distributing the types of economic activities of organizations of the agro-industrial complex of Chelyabinsk region in the process of institutional changes. We believe that if we consider changes in inequality in the distribution of the types of economic activities of organizations, this will allow us in a first approximation to make a conclusion of the quality of the institutional environment in which these organizations are included. We use for empirical researching of organizations Theil index, which is additively decomposable. An empirical study of organizations was conducted with the help of data before and after the Russian Federation joined the World Trade Organization. The data of 194-294 organizations of the agro-industrial complex of Chelyabinsk region during 2006-2012 and 2013-2017 are investigated. An empirical study of inequality when distributing the types of economic activities of organizations is based on the use of the all-Russian classifier of types of economic activity. The study made it possible to confirm the hypothesis about the inequality of the average values of the inequality indices of organizations and areas of Chelyabinsk region with the help of Mann-Whitney U-test. The presence of statistically significant changes in the average values of the inequality index when distributing the types of economic activities in the areas of Chelyabinsk region indicates the impact of such an institutional change as the entry of the Russian Federation into the World Trade Organization. The growth of inequality indices when distributing the types of economic activities of organizations, areas and the region, which indicates a decline in the quality of the institutional environment is established. In the future, the study will include the results of economic performance of organizations, government subsidies and grants.

JEL classification: Q10, Q13

***Keywords:** inequality, organizations, economic activity, institutions, Theil index, generalized entropy index*

1. INTRODUCTION

The role of institutions in economic changes is of interest for both theoretical and empirical analysis in the literature. This is since in all activities of organizations, the influence of institutions can be traced. (For example, works (Acemoglu & Johnson, 2005; Acemoglu, Johnson, & Robinson, 2005; Acemoglu, Johnson, Robinson, & Thaicharoen, 2003; Acemoglu, Johnson, & Robinson, 2001, 2002; Aoki, 2001; Coase, 1937; Davis, North, & Smorodin, 1971; Granovetter, 1985; Greif, 1998; Nelson, 1994; North, 1981, 1990, 1991, 2005; North, Wallis, & Weingast, 2009; Olson, 1965; Ostrom, 1990, 1998, 2000) and others).

In the literature there are three main definitions of institutions. Institutions can be understood as rules of some game, i.e. they represent a set of norms (Hurwicz, 1996; North, 1990; Ostrom, 1990). Institutions can be viewed as players in some game (Nelson, 1994). Institutions can be understood as the balance of outcomes of some game (Schotter, 1981). This definition was additionally developed based on evolutionary games (Aoki, 1998; Young, 2001) and repetitive games (Greif, 1989, 1994, 1998; Greif, Milgrom, & Weingast, 1994; Milgrom, North, & Weingast, 1990). We will stick to the definition of D. C. North (North, 1990) in this study.

We are interested in inequality changes when distributing the types of economic activities of organizations of the agro-industrial complex in Chelyabinsk region in the process of institutional changes. We examine organizations to assess the quality of the institutional environment in which they are included.

We believe that if we consider changes in inequality when distributing the types of economic activities of organizations of the agro-industrial complex in Chelyabinsk region, this will allow concluding at a first approximation about the quality of the institutional environment in which these organizations are included. We analyze the types of economic activities of 194-294 organizations from 2006 to 2017. We assume that organizations have either a high degree of inequality in distributing the economic activities in an environment with institutions of poor or high quality where organizations are included in hybrid mechanisms with Governance transactions aimed at solving problems of collective actions (Williamson, 1996, 1996, 2000). We believe further analysis of the institutional environment quality to relate to the analysis of distributing for alternative mechanisms Governance with transactions in the economy (Avdasheva & Goreiko, 2011).

The work is organized in the following way. Section 2 is devoted to the literature review on the problem of measuring inequality. Section 3 describes the data for studying inequalities when distributing the economic activities of organizations of the agro-industrial complex in Chelyabinsk region. Section 4 outlines the methods and models for studying inequalities when distributing the economic activities of organizations, territories and the region. Methods and models are based on the results of the information theory on the approach of H. Theil to the definition of inequality (Theil, 1967). Section 5 describes the results of this study in the context of institutional changes during 2006-2017. Section 6 presents conclusions.

2. LITERATURE REVIEW

Spatial and technological differences of organizations affect the distribution of economic activities. However, an important factor of inequality in distributing the types of economic activities of organizations, territories and areas is the institutional environment.

D. Acemoglu and J.A. Robinson consider the relationship of political and economic institutions. They describe the mechanism of inequality formation under their influence. Political institutions in this mechanism determine the distribution of political power in society. Political power is set by how social and economic groups solve the problem of collective actions. Economic institutions in this mechanism determine the distribution of market power and influence of using and changing technologies through endogenous innovations. Thus, the political and economic institutions of society determine economic growth and income inequality (Acemoglu & Robinson, 2015).

M. Gradstein, using a mathematical model for relationship of political and economic inequality, the quality of institutions and economic growth, shows that income inequality and the quality of institutions can mutually reinforce each other, generating different ways of development (Gradstein, 2008).

Researches by economists A. B. Atkinson (Atkinson, 1970; Atkinson & Brandolini, 2010) and S.-C. Kolm (Kolm, 1969) strongly linked inequality and welfare economics. Their researches laid the foundation for distributional analysis, as we know it today (Cowell & Kanbur, 2011).

The structure of economic systems is most often studied with the help of information statistics methods (Dragan & Isaic-Maniu, 2017). Inequality measures such as Atkinson index (Atkinson, 1970; Atkinson & Brandolini, 2010), Bonferroni index (Barcena-Martin & Silber, 2017; Giorgi & Guandalini, 2018), Gini index (Deutsch & Silber, 2007; Ogwang, 2014, 2016) and Generalized entropy index (Cowell, 1980; Foster & Shneyerov, 1999; Shorrocks, 1980, 1984; Theil, 1967) and so on were developed.

F. A. Cowell emphasizes Theil's approach to measuring inequality (Cowell, 2006). H. Theil considered inequality as a by-product of the information content of the characteristic distribution structure of the object under study (Theil, 1967). A particular advantage of this approach is that its basis for measuring inequality leads to a decomposable structure (Bosmans & Cowell, 2010; Cowell, 1980, 2006).

For empirical studies of organizations, it is necessary that the overall inequality in the distribution of their economic activities can be found from the size, average value and inequality of each subgroup. This implies that the index must be additively decomposable (Shorrocks, 1984).

An additively decomposable measure of inequality is one that can be defined as a weighted sum of inequality values calculated for the economic activities of organization subgroups, plus the contribution that is caused by differences between the average values of subgroups (Shorrocks, 1980).

Imposing requirements for additive decomposability, replicative and scale invariance leads to one class of indices — the generalized entropy indices (GE) (Shorrocks, 1984).

A. F. Shorrocks shows that the solution of the general problem of inequality decomposition is formally equivalent to Shapley value (Shapley, 1953), therefore it is called Shapley decomposition (Shorrocks, 2013).

Indeed, this procedure, according to A. F. Shorrocks, can be used in applied economics whenever we want to assess the relative importance of explanatory variables. He concludes that in all cases Shapley decomposition either replicates the current practice or provides a more satisfactory method for distributing contributions into explanatory factors (Shorrocks, 2013).

F. A. Cowell shows how classical methods for inequality decomposition can be reconciled with the regression methodology (Cowell & Fiorio, 2011).

For institutional research of organizations, various measures for comparing the ordinal categorical distributions for the features of objects under study have been developed.

J. C. Font and F. A. Cowell's work on analyzing the distributions of categorical variables showed how status interpretations can be used to solve the problem of measuring inequality without using arbitrary cardinalization of ordinal concepts, which is important for evaluating institutions and public policy (Font & Cowell, 2013). J. C. Font and F. Cowell's method is a collection of discrepancies between the actual status of each organization and some certain status checkpoint, with the maximum value being the only value that makes sense as a control point. This leads to a new set of inequality indices, which are very similar to the class of generalized entropy indices (Font & Cowell, 2013).

In the literature, as D. Gunawan and co-authors note, various measures have been developed for comparing the ordinal categorical distributions for the signs of objects (Gunawan, Griffiths, & Chotikapanich, 2018). The authors themselves proposed Bayesian inference for comparing ordinal categorical distributions (Gunawan et al., 2018).

F. A. Cowell and E. Flachalre investigated the statistical efficiency of inequality indices in the presence of extreme values in the data and showed that these indices are very sensitive to the distribution properties of signs of the objects under study to the properties of income distribution (Cowell & Flachalre, 2007). Using semi-parametric upper tail modeling techniques can significantly improve the performance of inequality indices that are sensitive to extreme values. Measures of semi-parametric inequality are less sensitive to pollution than inequality measures based on the empirical distribution function. For example, Gini index is less sensitive than Generalized entropy index to data pollution. In terms of performance, Gini index and Generalized entropy index or Atkinson index differ a little. This is true for estimation methods to use empirical distribution functions, but if semi-parametric methods are used, then the empirical advantage of Gini index is obvious (Cowell & Flachalre, 2007).

F. A. Cowell, E. Flachaire and S. Bandyopadhyay investigated the problem of comparing distribution pairs. The authors' approach to the problem is based on standard information theory results, which allow us to construct the concept of distance to characterize the discrepancy between the empirical distribution function and reference distribution (Cowell, Flachaire, & Bandyopadhyay, 2013).

T. Mehdi and T. Stengos proposed the empirical inference method for comparing the inequalities of two populations (Mehdi & Stengos, 2014). Their inference method is based on empirical probability (EL), that is, the powerful non-parametric method first proposed by A. B. Owen (Owen, 1988, 1990). The advantage of empirical credibility is that no assumptions about the underlying distribution of the data are required (Mehdi & Stengos, 2014).

Applied economics not only uses Generalized entropy index (Cowell, 1980; Foster & Shneyerov, 1999; Shorrocks, 1980, 1984; Theil, 1967), but also Bonferroni index (Barcena-Martin & Silber, 2017; Giorgi & Guandalini, 2018) and Gini index (Deutsch & Silber, 2007; Ogwang, 2014, 2016).

For additive decomposition, Gini index uses Shapley value, which considers the fact that inequality between or within groups can be viewed as remaining members, that the size of subgroups can affect inequality and there are different ways of ranking organizations when defining Gini index (Deutsch & Silber, 2007; Shorrocks, 2013).

Other decomposition methods for Gini index were proposed in the literature. For example, multidimensional decomposition (Mussard, 2004; Mussini, 2013) and the regression approach (Cowell & Fiorio, 2011) and others.

In applied economics, there is the problem of the accuracy and efficiency of inequality assessments when distributing the types of economic activities of organizations. The simple random sampling method (SRS) is used to solve this problem. Using this method is not always possible, therefore, as an alternative, it is possible to use the method of a ranked sampling set (RSS). This sampling method is a more economical method that improves the accuracy and efficiency of inequality assessments (Cowell & Flachalre, 2007).

Many studies comparing the RSS method with other sampling methods have been conducted. The RSS method of a ranked sampling set is a more efficient sampling method than the SRS method for estimating the mean value and variance of populations (Stokes, 1977, 1980; Stokes & Sager, 1988). Comparing the RSS method with other two-phase sampling methods proves the method not to require any distribution assumptions (Rad, Borzadaran, & Yari, 2018).

J. Teixido - Figueras and J. A. Duro explore the benefits of spatial analysis of distributing resources for statistical polarization measures in comparison with classical inequality measures that are developed in welfare economics (Teixido-Figueras & Duro, 2014).

In the literature, statistical polarization measures were proposed to analyze the polarization of distributing resources, which makes it possible to describe the process of clustering resources around local geographical spaces (Teixido-Figueras & Duro, 2014).

For example, ER index (Esteban & Ray, 1994) was originally proposed, with endogenously predetermined J. B. Davies and A. F. Shorrocks' groups (Davies & Shorrocks, 1989) EGR index (Esteban, Gradín, & Ray, 2007), and ZK index (Zhang & Kanbur, 2001), for which groups are given exogenously, and DER index, which is based directly on the empirical density function (Duclos, Esteban, & Ray, 2004), and so on.

3. DATA AND METHODS

The information base of the research covers 194-294 organizations of the agro-industrial complex of Chelyabinsk Region, which has been existing in its modern territorial borders since January 17, 1934. The organizations are located on the territory of 20 areas of the region, excluding 7, mainly in mining and industrial areas of Chelyabinsk region.

An empirical study of organizations, areas and regions was carried out with using data from two segments of the time scale – before and after the entry of the Russian Federation into the World Trade

Organization. The data of organizations of the agro-industrial complex of Chelyabinsk region, provided by the Ministry of Agriculture of Chelyabinsk region, for the period from 2006 to 2012 and from 2013 to 2017 are studied.

An empirical study of inequality when distributing the types of economic activities of organizations of the agro-industrial complex is based on the use of all-Russian classifier of types of economic activities, the basis for which was the statistical classification of types of economic activities in European Economic Community. The basic unit of analysis was the economic activities of organizations such as growing wheat, barley, rye, raising dairy cattle, breeding dairy cattle, producing raw cow milk, and so on. In the study, the basic units of analysis were also combined into two groups, namely, crop production and animal husbandry.

Statistical classification of the types of economic activities of organizations of the agro-industrial complex of Chelyabinsk region for during 2006-2017 allowed using Theil index, correlation analysis methods and non-parametric statistics.

4. METHODS OR MODEL

To solve the tasks, it is proposed to conduct an empirical study of the distribution of types of economic activities of organizations of the agro-industrial complex of Chelyabinsk region.

In this work, inequality indicators are found, whose properties are determined by the axioms for measuring inequality, namely: redistribution, scale independence, duplication of observations, anonymity and additivity (Cowell, 1985). All of the mentioned above requirements are satisfied by only one class of indicators — the indices of generalized entropy (GE) (Shorrocks, 1980).

Let there be many types of economic activities of organizations of the agro-industrial complex $S = \{i = 1,\dots,n\}$, each of which (i) is characterized by revenue from sales of products $Y_i > 0$ (Theil, 1967). H. Theil defines the inequality index for the given aggregate by the formula:

$$T_S = H_{\max} - H(S), \tag{1}$$

where $H(S)$ is Shannon entropy of S aggregate:

$$H(S) = -\sum_{i\in S} p_i \ln p_i = -\sum_{i\in S} \ln p_i^{p_i}, \tag{2}$$

where p_i is the ratio of the i type of economic activity of organizations of the agro-industrial complex. Then Shannon entropy quantitatively describes the uncertainty in predicting the economic activities of organizations, which is randomly taken from the data set. The equation is written with the natural logarithm; however, the base of the logarithm used in the calculation of Shannon entropy can be freely chosen (Shannon, 1948).

When all economic activities of organizations of the agro-industrial complex in the data set are equally distributed, all values of p_i are equal to $1/N$, then Shannon index takes the value $\ln(N)$. The greater the unevenness in the distribution of the types of economic activity of organizations, the greater the weighted geometric mean value of p_i and the smaller Shannon entropy value. If almost all the diversity is reduced to one type of economic activity of organizations in the data set, and other economic activities are rare, even if there are many of them, Shannon entropy approaches to zero.

Therefore, Theil entropy inequality index has the form:

$$T_S = H_{\max} - H(S) =$$
$$= \ln N - H(S) = \ln N + \sum_{i \in S} \frac{Y_i}{Y(S)} \ln \frac{Y_i}{Y(S)} . \quad (3)$$

Economic inequality is measured, therefore, by the entropy deviation from its maximum value, achieved with full equality of the shares of the types of economic activities of organizations of the agro-industrial complex in the output of the total product.

Let the set S be represented as the set V of its disjoint subsets – the groups v, which form a complete partition:

$$S = \bigcup_{v \in V} v , \quad (4)$$

and each type of economic activity of the organization is included only in one group.

For an arbitrary group $v \in V$ we denote the total revenue from the sale of the group of products of the organization as $Y(v)$ select in the entropy $H(S)$ that part which is to be in this group:

$$-\sum_{i \in v} \frac{Y_i}{Y(S)} \ln \frac{Y_i}{Y(S)} = -\frac{Y(v)}{Y(S)} \cdot \sum_{i \in v} \frac{Y_i}{Y(v)} \left[\ln \frac{Y_i}{Y(v)} + \ln \frac{Y(v)}{Y(S)} \right] =$$
$$= \frac{Y(v)}{Y(S)} \cdot \left[H(v) - \ln \frac{Y(v)}{Y(S)} \right] \qquad Y(v) = \sum_{i \in v} Y_i ; \quad (5)$$

in this ratio $H(v)$ is the entropy of the group v, considered similarly to S as a group of economic activities of the organization. Summing up (5) for all groups, we get the presentation of the index (2) in the form:

$$T_S = \ln N - \sum_{v \in V} \frac{Y(v)}{Y(S)} \cdot \left[H(v) - \ln \frac{Y(v)}{Y(S)} \right] =$$
$$= \ln N - \sum_{v \in V} \frac{Y(v)}{Y(S)} \ln N(v) + \sum_{v \in V} \frac{Y(v)}{Y(S)} \ln \frac{Y(v)}{Y(S)} + \sum_{v \in V} \frac{Y(v)}{Y(S)} \left[\ln N(v) - H(v) \right] =$$
$$= \sum_{v \in V} \frac{Y(v)}{Y(S)} \ln \frac{Y(v)/Y(S)}{N(v)/N} + \sum_{v \in V} \frac{Y(v)}{Y(S)} T_v , \quad (6)$$

here $N(v)$ is the number of types of economic activities in the group v and T_v is Theil index of an individual inequality inherent in the group v.

In this presentation of the index, the first sum is the index of group inequality, which characterizes the inequality inherent in the aggregate of groups:

$$\tilde{T}_V = \sum_{v \in V} \frac{Y(v)}{Y(S)} \ln \frac{Y(v)/Y(S)}{N(v)/N} , \quad (7)$$

and the second sum is the weighted average, according to the revenue of organizations *the index of intragroup inequality*:

$$\omega\, T_V = \sum_{v \in V} \frac{Y(v)}{Y(S)} T_v = \sum_{v \in V} \frac{Y(v)}{Y(V)} T_v \,. \qquad (8)$$

Thus, the two-step presentation consists in decomposing the index of general inequality into two components:

$$T_S = \tilde{T}_V + \omega\, T_V \,, \qquad (9)$$

if all groups consist of the same type of economic activities of the organization of the agro-industrial complex, then

$$T_v = 0 \quad \forall\, v \,, \quad \omega\, T_V = 0 \,, \quad T_S = T_V \qquad (10)$$

(Theil, 1967).

5. RESULTS

The analysis of official statistical data published by the Federal State Statistics Service of the Russian Federation made it possible to establish the gross regional product of Chelyabinsk region in 2005 prices ranging from 386,941.99 to 444,669.34 million rubles during the studied period, the production of agricultural products, hunting and forestry being from 30,607.19 to 29,751.75 million rubles. The arithmetic average of the share of agricultural, hunting and forestry products of in the gross regional product was 6.90%, which indicates the industrial character of the region (Table 1).

Table 1. Gross regional product of Chelyabinsk region *(in 2005 prices, mln. rubles)*

Year	A	B	C
2006	386941.99	30607.19	7.91
2007	438726.07	27960.80	6.37
2008	445419.71	29933.27	6.72
2009	382536.72	31578.86	8.26
2010	405507.49	25267.09	6.23
2011	431757.21	34378.46	7.96
2012	442025.15	27332.86	6.18
2013	448854.15	29043.73	6.47
2014	461319.57	29864.19	6.47
2015	458929.46	30599.37	6.67
2016	444669.34	29751.75	6.69
	431516.99	29665.23	6.90
	8274.51	712.42	0.23
	27443.44	2362.84	0.76

Notes:

A – the gross regional product, mln. rubles; B – the agricultural, hunting and forestry products, mln. rubles; C – the share of agricultural, hunting and forestry products in the gross regional product, pct.; $\overline{X}$ – mean; $S_{\overline{X}}$ – standard error of the mean; S – standard deviation.

*Sources: According to (Chelyabinsk region in figures, 2012; Chelyabinsk region in figures, 2014; Chelyabinsk region in figures, 2017)***.**

An empirical study of 194-294 organizations of the agro-industrial complex of Chelyabinsk region during 2006-2017 made it possible to estimate the inequality in the distribution of economic activities of organizations T_{S_a}, areas T_{S_b} and the region as a whole T_{S_c} with the help Theil index. The collected data of the organizations of the agro-industrial complex allowed us to confirm the hypothesis about the inequality of the average values of Theil indices of organizations, areas and regions using Mann-Whitney U-test (Table 2).

Table 2. Theil average values of organizations T_{S_a}, areas T_{S_b} and the region T_{S_c}

Period	$\bar{X}$	$S_{\bar{X}}$	N	S	L	U
			T_{S_a}			
2006 – 2009	0.9398	0.0022	4	0.0043	0.9357	0.9440
2010 – 2013	0.9508	0.0008	4	0.0016	0.9494	0.9526
2014 – 2017	0.9571	0.0008	4	0.0017	0.9549	0.9589
Total	0.9492	0.0023	12	0.0079	0.9446	0.9536
			T_{S_b}			
2006 – 2012	0.8979	0.0012	7	0.0033	0.8958	0.9005
2013 – 2017	0.9139	0.0033	5	0.0073	0.9079	0.9199
Total	0.9046	0.0028	12	0.0097	0.8997	0.9105
			T_{S_c}			
2006 – 2010	0.8871	0.0058	5	0.0130	0.8781	0.8997
2011 – 2017	0.9238	0.0024	7	0.0064	0.9192	0.9285
Total	0.9085	0.0061	12	0.0210	0.8978	0.9198
			$\Delta_{T_{S_a}-T_{S_b}}$			
2006 – 2009	0.0405	0.0008	3	0.0014	0.0391	0.0418
2010 – 2013	0.0500	0.0010	6	0.0023	0.0486	0.0520
2014 – 2017	0.0382	0.0026	3	0.0044	0.0332	0.0418
Total	0.0447	0.0018	12	0.0062	0.0413	0.0480

Notes:

$\bar{X}$ – mean; $S_{\bar{X}}$ – standard error of the mean; N – number of observations; S – standard deviation; L and U – lower and upper endpoints of the 95% confidence interval.

Sources: According to the Ministry of Agriculture of Chelyabinsk region.

High values of inequality indices when distributing economic activities of organizations T_{S_a} and areas T_{S_b} attract attention, their average values of the growth rate were 0.26 and 0.34%, 0.34 and 0.15%, 0.16 and 0.72% during the studied period, the period 2006-2012 and 2013-2017, respectively.

Thus, the presence of statistically significant changes in the average values of the inequality index when distributing the types of economic activities in the areas of Chelyabinsk region indicates the impact of such an institutional change as the entry of the Russian Federation into the World Trade Organization. This institutional change is fixed with the help of empirical data of organizations as microsystems and areas as mesosystems of the economy of Chelyabinsk region (Figure 1).

Correlation analysis of average values of inequality indices when distributing the types of economic activities of organizations T_{S_a} and areas T_{S_b} allowed us to establish a relationship, Pearson correlation coefficient between the indicators being 0.77 with significance level α equal to 0.003.

Calculations show that the distribution inequality of the types of economic activities in areas of Chelyabinsk region is characterized by high values of the index of intragroup inequality $\omega\ T_Y$, and not by values of the index of group inequality $\tilde{T}_Y$ (Table 3).

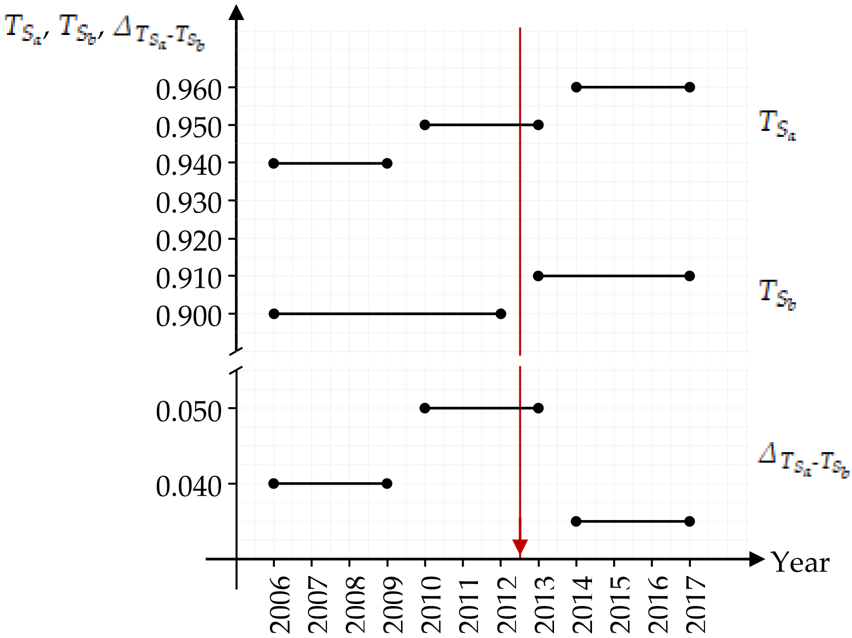

Figure 1. Structural changes in Theil indexes of organizations T_{S_a} and areas T_{S_b} of Chelyabinsk region

Note: H_1 is the hypothesis about the inequality of the average values of the indicator.

Source: Author

Table 3. Distribution of economic activities in the areas of Chelyabinsk region (the indices of group $\tilde{T}_{V}$ and intragroup ωT_{V} inequalities)

Period	$\bar{X}$	$S_{\bar{X}}$	N	S	L	U
			$\tilde{T}_{V}$			
2006 – 2012	0.1046	0.0052	7	0.0138	0.0945	0.1138
2013 – 2017	0.1323	0.0041	5	0.0091	0.1254	0.1409
Total	0.1162	0.0053	12	0.0184	0.1060	0.1257
			ωT_{V}			
2006 – 2012	0.8852	0.0021	7	0.0056	0.8815	0.8897
2013 – 2017	0.9014	0.0034	5	0.0077	0.8947	0.9078
Total	0.8919	0.0030	12	0.0104	0.8867	0.8981

Note:

"X" ¯ – mean; "S" _"X" ¯ – standard error of the mean; "N" – number of observations; "S" – standard deviation; "L" and "U" – lower and upper endpoints of the 95% confidence interval.

Sources: According to the Ministry of Agriculture of the Chelyabinsk region.

6. CONCLUSIONS

In the work, to measure inequality when distributing the types of economic activities of organizations of the agro-industrial complex of Chelyabinsk region, the approach by H. Theil was applied to the definition of inequality, used Theil index, which meets the requirements of additive decomposability and invariance.

We studied 194-294 organizations of the agro-industrial complex of Chelyabinsk region during 2006-2017 to assess the quality of the institutional environment in which they are included. We identified an increase in inequality indices when distributing the types of economic activities of organizations and regions, which indicates a decline in the quality of the institutional environment. We have revealed the growth of intragroup inequality indices, which indicates the driving of the organizations of the agro-industrial complex of Chelyabinsk region to a mono-product structure of production in one of the groups of economic activities of organizations – crop production or animal husbandry.

In the future, the work on studying the inequality when distributing the types of economic activities of organizations in Chelyabinsk region will include the results of economic performance of organizations, government subsidies and grants.

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ORIGINAL RESEARCH PAPER

THE DEVELOPMENT OF MEDIATIVE COMPETENCES IN THE FIELD OF RESOLVING ENVIRONMENTAL CONFLICTS

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Abstract

This study is concerned with considering the process of influence of conflict resolution of methodology in the field of securing environmental safety on the growth of professional competence of the heads of government organizations. The foundation of this theory is to give the description of the main point and matter of ecological safety, position and importance of it in state and public security of general system. The competence may be expressed through the participating in training game of ecological conflict resolution. Moreover, there are empirical results received by the authors of the article characterizing the influence of the methodology on the growth of professional competence of a leader and mediator in the game problem resolution.

The analysis of the empirical observation has demonstrated an obvious need to consider the ecological safety question and practical technology of ecological conflict resolution within the framework of current system of a higher education. Considering the contradiction, today, a scientific-theoretical training base of the heads of government organizations, ecologists and mediators is isolated enough and there is no common ground left; life experience has shown the actuality to master the methods described in this article. An important feature of developed technology is in teaching practice to organize and to engage in the activities during the training game. This method permits one to form professional intuition and available technology, that's a key point in resolving practical problems of conflict interaction and management.

There was reporting the research findings proved by the authors the vitality and existence for the methodology of result measurement of conflict competence evolution. The real point of this consists of three phases of state estimation of getting knowledge by students and skills in social group conflict technology resolution. The methodical investigation approach involves scientific achievement in a relevant field, the requirements of the Federal State Educational Standard of Higher Education in Russia in the training program «conflictology». Searching for this competence in our study program is represented as four basic blocks of questions describing the degree of achievement of expected results in the research by students.

Based on the results obtained the proposed conclusions were formulated and it's indicated the enrichment of study process of leader's importance of local-government organizations with theoretical and methodological approaches to environmental safety issues using meditative technologies.

JEL classification: Q50, Q57

***Keywords**: ecology, conflict, mediation, technology, local-government, public organization.*

1. INTRODUCTION

As in the whole world, state of environment in Russia today is going to have the greatest impact on the human quality of life. Besides that, this fact is significant enough in the question of stability of state and public development. Current environmental problems are defined as air pollution, groundwater and surface water pollution, and soil pollution in many regions of country.

According to the economic activity by deferent agents this process influences man's health of certain territories as well. Today, it must be carefully noted an interconnection between environmental pollution and high death rate caused by blood disorder and blood-forming organs, blood cancer, mental disorder, and other diseases of respiratory and digestive system.

It should be noted, reduction in a human population in relation to social well-being and on the other hand, increasing of death-rates caused by environmental pollution; all this is about an instant danger to every person, state and public. Firstly, this concept is the reason for necessity a more precise and coordinated legal regulation one in ensuring environmental safety in Russia. (Federal law #7-FZ, 2002)

Russia's National Security Strategy reviews that ecological safety is essential to National Security of the Russian Federation. (Federal law #390-FZ, 2010)

It's described the state as a guarantor of security of the person and property rights from internal and external threats by improving the protection of human rights and freedoms of the Russian Federation, decent quality and standard of living, sovereignty, independence, state and territorial integrity, sustainable social-economic development of the Russian Federation. (Government data and reports, 2017)

This allows us to treat environmental safety as ecological security and, accordingly, to present the essential understanding of this process as a state of protection of its vital interests of the individual, state and public from potential or real threats caused by the anthropogenic impact on the environment, as well as from natural catastrophes and man-made disasters. Such an interpretation to broaden the range of environmental safety facilities, and at the same time it's giving them the function of the subjects of this process.

Based on the approach, different types of activity of officials (legal entities), citizens (as individuals), public associations in Russia and other states can be represented as the threat to environmental safety. It can be associated with both intentional and (or) unintentional environmental impact, which had led to dangerous natural processes and phenomena.

Such an understanding of environmental safety allows us to define this process as a qualitative characteristic of social and environmental development; it presupposes the activity of its subjects in the formation of innovative approaches in the technological processes of social organization. This provides optimally solving modern environmental problems, as well as ensure the protection of the objects of this process from any environmental hazards arising from both anthropogenic and natural (natural disasters, accidents, catastrophes, etc.).

Mostly in modern scientific literature, the object-subject area of environmental safety is presented as follows:

-a person with its rights to a healthy and favorable natural environment that ensures comfortable conditions for the existence;

-a society with its material and spiritual values, which are affected by the ecology of the country and the region;

-a government as the main subject of this process, where the state and territorial integrity, sustainable social and environmental development and economics of the Russian Federation are achieved;

-The natural environment and natural resources as the source of sustainable development of Russian society, it's a necessary condition for the safe existence of citizens of the Russian Federation.

This approach to understanding of people attitude to the natural environment objectively determines the need for a clear interaction of all its structural elements (Kozyrev M.S., Medvedeva N.V., et al., 2016). Among these are government, economic, political and public organizations that stipulate a comprehensive account of the system of socio-economic, socio-political and spiritual-moral factors that are the key to solving the environmental safety problems of all its facilities (Fomicheva T., Sulyagina Ju., 2017).

An analysis of the problems of environmental safety shows that for a long time a person has developed a view that nature is inexhaustible and unlimited in its resources, that it is designed to meet human needs.

At the same time, mankind was convinced that the growth of production and the development of science reduce the spontaneous arbitrariness of nature over man and ensure the growth of its wealth.

This approach led to a predatory approach to the use of natural resources, which until then was relatively insignificant, and did not lead to radical ecological changes.

At the same time, the growth of productive forces increased the power of man over nature, expanded the possibilities in its development. But on the other hand, this process, often unregulated, chaotic was to worsen and destroyed the Earth's natural resources. And because of this process, under the influence of anthropogenic factor strengthening, the prerequisites for violation of ecological balance in nature inevitably arose. It’s determined the deep-rooted contradictions between the human aspiration to meet the growing needs for the use of natural resources and the possibilities of nature to satisfy.

Such an understanding of the problem under analysis obliges us to proceed from the fact that under modern conditions only the rational interaction between nature on the one hand, and the individual, society, state, on the other, ensures environmental safety and stability of the natural environment. (Kirillov N.P., 2018)

The coordination of the life activity of the individual and society with the requirements of the surrounding natural environment becomes the determining condition for the safe existence of mankind on Earth.

This "Ecological Doctrine of the Russian Federation" what is for; it’s defined the goals and objectives of the principles and directions of a coordinated, unified state policy in the field of environmental safety in Russia for a long-term period. The essence of this policy of the government is to improve the environment, preserving nature and natural resources are priority areas for the activities of the state and Russian society. According to this document, the environment should be a single element in the system of socio-economic relations of the triune "personality-society-government" system as a combining component of the national asset. Implementation of this requirement is possible only if the triune system is carefully respected to the environment.

The creation of the special protected areas of Russia (literally “Specially Protected Natural Arias”) is the main mechanism for the realization of such a treatment. These areas are pieces of land, water surface and air space, where natural complexes and objects are located. Designated complexes and facilities have a special nature protection, scientific, cultural, aesthetic, recreational and health value.

It’s withdrawn from practical use totally or particularly by decisions of public authorities; a special protection regime is established for them.

The peculiarity of the natural reserves designed by government institutions is that on the territory there can be areas excluding direct human interference. But, at the same time, activities aimed at ensuring the functioning of the state natural reserve and the activities of citizens living on its territory, for the sake of conservation of which a state nature reserve was created, are allowed on specially designated sites excluding particularly valuable ecological systems and subjects. (Kirillov N.P., 2009)

This sphere of activity is conducted in accordance with the approved individual position on this government nature reserve.

Also, it should be noted that this problem is important not just in Russia, but also, it’s relevant in world practice. Thus, according to the report of the Sixth Global Environment Outlook (GEO-6), supported by the United Nations Environment Program Live (UNEP), the creation of specially protected natural areas is one of the keys and most effective responses to the degradation of natural habitats and their fragmentation, and prevents the reduction and loss of biological diversity.

The lack of identical mechanisms for interaction between representatives of local self-government bodies, big business, authorities, public representatives, reveals the presence of obvious contradictions, which gave rise to the problem of our study. This problem is obvious and consists of the inadequacy of the mechanisms for the settlement of environmental conflicts among the state administration bodies, its territories and with public organizations. The development and approbation of one of these mechanisms was the goal of the scientific work carried out. (Usanov V. E., et al., 2009)

The problems and contradictions described provides reason enough to formation of the object base for research and a scientific study. Thus, the object of our analysis is the specific competence of the heads of state organizations that contribute to the settlement of conflicts in the sphere of environmental security. The proposed methodology for conducting an organizational and business game can concentrate the attention of managers on topical issues of environmental safety and providing techniques for resolving conflicts in this area.

The authors also found that the scientific and theoretical basis for studying and resolving such conflicts today is quite slender and is represented in several educational complexes. However, the authors' interest in the creation and testing of organizational and activity games was determined by two positions. The first is that the main authors and potential participants in their conflicts in the sphere of environmental safety have no the opportunity to be trained of the practice in resolving social conflicts. The second one describes the situation when the trainees, potential participants in such conflicts soon, in the process of training have insufficiently necessary practices of a real conflict logical nature.

As it will be discussed below, gambling practices are cannot replace the theoretical course of professional training, but they contribute to the formation of professional intuition and technological equipment of managers, which is very important in resolving applied questions of conflict interaction and management.

The main advantage of gaming techniques is that the proposed scenarios are such an objective reality, but not a product of any abstract generalization. They simulate real communication dependencies in the environment and receive output in each scenario. As a result, students get free creative analysis and searching of several variants to the problem solution by comparing different scenarios and acting on a strictly defined algorithm. This methodological approach allows the creation of a new generalized knowledge, contributes to the getting of important professional competencies (A.V. Soroko, V.V. Bondaletov, et al., 2018).

In addition, the research and development works were to study the influence of the teaching methodology on the regulation of environmental conflicts on the development of professional qualities of a manager and conflictologist, to master the basic competence of technologies for resolving group social conflicts with environmental characteristics, particularly, to demonstrate the importance in a number of cases preservation of a neutral position in the conflict of the representative of the authority. (Krever, V.G., et al., 2008)

2. METHODOLOGY

As the plot of the game can be taken the history of any environmental conflict that has gained public resonance and characterized by the participation of several parties, among which there must necessarily be representatives of government and civil society.

The plot of the game described by the authors is based about a real environmental conflict taking place in one of the regions of Russia. In this region, the Government and the Governor decided to cooperate with a large Russian financial and industrial group to build a large dairy in the small town of the region. Driving of the dairy factory will provide more than 700 workplaces for the residents of the region. The dairy factory project is patronized by a member of the Federation Council of the Federal Assembly, as well as the Plenipotentiary Representative of the President in this region. The governor of the region within the framework of the annual report was reported to the President of the Russian Federation on the factory development as the most important strategic management for the social and economic development of the region.

Within the construction of the factory, it is planned to organize an intake draws water on the local river. This intake must provide water to the factory under construction and several villages in the neighboring district. An independent environmental research center, with the participation of specialists from one of the Russian universities, carried out an examination of the project and determined that the organization of a water intake creates the risk of dehumidification in the area of a unique lianas forest.

In turn, it will mean irreversible changes in the flora and fauna of a unique natural object.

An alternative option for providing the factory with water is the construction of a technical water pipe with a water intake from a larger river. The construction of this water pipeline increases the cost of the project for a significant amount for this and the region as a total amounting to 50 billion rubles.

At the same time, in the same area with the support of civil activists a group of local entrepreneurs is developing a project for the development of local tourism. Their idea is to build a hotel on the riverbank and organize excursions to the protected lianas forest to historical sites - ancient cult structures of ancestors living in a small ethnic group.

In connection with the assumed damage to the ecology of the region in defense of the forest, a group of civil activists, among them students and university lecturers, local entrepreneurs and a group of active citizens, argued against the project of a water intake. At the same time, student bloggers created their online program to protect the lianas forest. The manifested organizers of public resistance several times carried out picketing of the building aria. Also support for the protest movement was organized on the Moscow information Internet portal. There were published articles on the struggle of the residents of the region against the construction of water intake.

In a straight line with the President of Russia, one of the residents of the district was asked about the problem of their lianas forest.

Nevertheless, after a time the construction of the plant continued. Plans for water intake on the river have not been canceled. Moreover, the district police department for combating economic crime conducted unscheduled inspections of economic activities, accompanied by the arrest of documents and office equipment in companies of entrepreneurs - activists for the lianas forest control.

There was a series of response publications in the local district newspaper condemning the actions of defenders of the forest and threatening to stop the construction of the enterprise. As a reaction to the articles, discontent of the residents of the district, waiting for workplaces in the new plant, taxes to the budget of the district began to grow.

The authors of the article monitored news and research sources and they found this problem is quite often encountered in the public and political life of the state. Such conflicts are very acute because of the large number of political and economic factors and forces involved in them. This assumption allows to make a conclusion that the administration of local self-government needs to management development communicative skills, conflict literacy and rethinking the meditative functions of government bodies in the context of carrying out their tasks while moderating social interaction in a conflict situation (Maksudov R.R, et al., 2017).

In the current practice, it should be noticed that it is not possible to give a full-fledged conflict logical education to many officials. However, such significant requirements to the competencies of administrative employees that cause the problem can be found by inculcating purposeful skills through the method of training games (Gulyaeva AE, Maslikov VA 2017). In the process of the training game participants get the material for reflection, think it over and then fix it with immediate practical solutions. At the same time, their decisions receive an immediate answer and develop effective reflective thinking.

The idea of the training game based on these purposes is to simulate a meeting between the representative of the Civic Chamber of the Russian Federation, who came from Moscow to sort out the situation. Participants of this training game are offered a choice of roles, which in many respects are typical for conflicts of this kind.

These roles can be divided into several groups:

-Environmental team – opponents of water intake construction: an over the hill assistant professor of the ecology department in the local university; a student, blogger-activist; elderly - a professor of history, local historian, a representative of a small ethnic group, not interested in any financial compensation in the project.

-Local businessmen who are opponents of water withdrawal construction but having of material interest because of the loss of a unique forest damages their tourist and hotel business.

-Representatives of local authorities supporting the construction of water intake for various reasons: the head of the district and deputies of the State Duma, deputy of the district council. All of them are interested in the appearance of new workplaces.

Vice-governor, representing the interests of the region in attracting investment in the region from a large financial and industrial group. Journalist of a local newspaper which supports the interests of the authorities.

-Investor's representative of the central holding company.

-Persons directly related to the conflict, but for various reasons, maintaining neutrality: the head of the local police station; deputy of the State Duma from the area, interested in the votes of potential voters.

In more detail these roles are distributed depending on the number of participants. In the most complete version, the training game developers offer the following detailing of the roles of the participants:

“An expert-ecologist”, a man, 55 years old, a candidate of biological sciences, assistant professor of the ecology department of Krasnopol'sk federal university, ecologist-activist, he was the first who drew attention to the problems of the Jaura forest, lives in the regional center.

"Blogger activist", a woman, a fourth-year student at the Faculty of Biology of the local university, a blogger, a civil activist, the leader of a student protest group opposing the construction of a water intake (15 people), lives in the regional center.

"Historian-Elder statesman", a man, 78 years old, retired, professor-historian, local historian, native and honorary resident of the district, stands against the construction of water intake, lives in the regional center.

"Leader of entrepreneurs", a man, 38 years old, entrepreneur, owner of car service center and restaurant "Kavkaz", informal leader of the business community of the district, who is against the construction of water intake (7 people), lives in the area under consideration.

"Entrepreneur", a man, 45 years old, an entrepreneur, an owner of the tourist camp "Jaurka", the initiator of the construction of the tourist complex "Our Forest", lives in the district.

"Head of the local administration", a man, 50 years old, an entrepreneur in the past who has interests in the oil business, supports the construction of water intake, lives in the district.

"Businessman from the city-center," a man, 48, a representative of the financial and industrial group "Kavkazprom", lives in Moscow.

"A deputy from the city-center," a 58-year-old man, a deputy of the State Duma of the Federal Assembly of the Russian Federation from the district (a member of the leading political party), formerly a district resident, a former CEO and a major shareholder in a distillery, remains neutral and calls for listening to the opinion of the population.

"Vice-governor", a woman of 48 years old, a vice-governor of social policy of the region, where the district is located; Supports the position of the authorities regarding the construction of water intake, lives in the regional center.

"Local deputy", a 45-year-old man, a deputy of the regional Duma from an opposition political party, stands for the construction of a water intake, as he believes that the plant will give new workplaces and provide employment for the residents of the region,

"Head of the municipality", a woman of 59 years old, the head of the Council of Deputies of the region, stands for the construction of a water intake, lives in the district.

"Police officer," a 35-year-old man, the chief of the police department of the district, has a long personal animosity to the "Leader of Entrepreneurs", a resident of the district, who does not express himself publicly about the construction of the water intake.

"Journalist", a 48-year-old woman, a journalist of the newspaper "Native Land", the author of articles condemning defenders of the forest, lives in the district.

"Communist", a woman, 75 years old, a member of an opposition political party, leader of a group of citizens (30 people) supporting the construction of a water intake, lives in the district.

During the training game, its participants are making their decisions in the current game situation, and if there is no a way to resolve the conflict, then at least outline a plan of measures to resolve it. Participants can "think out" their role, give it an emotional color and develop skills of reflective thinking. (Ostrovsky A.N., et al., 2017)

In the process of the training game, the role of the representative of the Public Chamber is assumed by the host of the game, who in fact, acts as a mediator of the conflict, declaring the principles of voluntariness of the parties to the conflict in the discussion and confidentiality of the information that can be voiced by the parties in the process of discussion. During the discussion of the conflict, he maintains neutrality, does not pass his judgments, moderates the communication of participants in the training game, stopping attempts of mutual insults and incorrect communication, demonstrating the techniques of active listening (Federal Law of July 27, 2010 # 193-FZ "On Alternative Dispute Resolution Procedure” (mediation procedure).

The duration of the training game is around from 1.5 to 2.5 hours.

At the first stage of the training game, "representative of the Public Chamber" has separate meetings with all parties of the conflict. The objectives of the separate meetings are: 1) identification of the general principles of the forthcoming mediation procedure; 2) hearing and clarifying the positions of the parties regarding the conflict; 3) getting the sanction of the parties to participate in the mediation procedure; 4) forming issues for general discussion proposed by a party of the conflict; the forthcoming mediation procedure.

In the training game situation, all participants of the game and observers should see a demonstration of the neutral position of the moderator of the conflict resolution, its impartiality, equidistance from all sides of the conflict. In real conditions, these separate meetings should be held confidentially.

At the second stage of the game, there is a group discussion of the problem situation on the pre-formed agenda of the discussion, consisting of questions previously formulated by the parties to the conflict.

At this stage, an important element is realized that fixes the main targets – the training game is reflexed, at least according to double structural focusing.

The significance of this stage of the training game was noted by many scientists. The famous Russian philosopher M.M. Bakhtin believed that understanding the subject of scientific research means "to understand my obligation to him, to understand his attitude to me, and therefore my responsible part." The act demonstrates the participation of thinking in the world. An act is an action that becomes and is realized in a reflective course of consciousness based on a distinctly expressed "I am a conception" of a person. The true sense is borne of objectivity, of value and creative experiences but not of words (Bahtin M.M, 1986).

An another eminent Russian scientist G.P. Shchedrovitsky gave considerable prominence to no less important role in the organization of the process of reflection during the conduct of organizational and activity games : "Both the processes of self-organization and the processes of self-development in organizational and activity games are provided primarily through reflection and a special organization of reflexive processes for all participants" (G.P Shchedrovitsky, 2005).

This philosophical concept is the basis of the second stage of the training game, which is based on the importance to fix the acquired skills of productive interaction and the resolution of environmental conflicts. This stage is based on the reflection of its participants on the issues being worked out, the conflict model and the socio-psychological mechanisms for overcoming it.

With the consent of the students with several discussions' moderators conducted an audio recording of the discussion. The first group of discourse was devoted to assessing the relevance of the training game, then a reflection of its results took place. Reflecting on the ways to achieve the intended outcome, the students noted the most important aspects of social interaction, taking into account the different psychological characteristics of the participants in the dialogue and fixed the mandatory steps in achieving a mutually acceptable result.

Later, with the help of the moderator, the thinking activity of the players is directed to the search for parallels of the plot of the game with the modern social problems of their region. Particularly, the most relevant points of application of such technologies are the sphere of interaction between local and state management with public organizations.

3. RESULTS

The experience of such games shows some phenomena repeating at each session, pretending to a regularity:

-Updating of "rapid-blowing" local social conflicts and previous resentments of representatives of residents against each other. Particularly, in each game the past of local businessmen "comes back" when they have earned the first capital not always honestly in a difficult period for the formation of business in Russia. Such a claim deprives businessmen of the right to authority in terms of assessing the criteria for fairness. In addition, there are reproaches against journalists and deputies being residents interested in the ecological well-being of the region, are forced to be conformists and adopt a position of power.

-Rapprochement of a large non-resident business, without worries about the ecological well-being of the region.

-Verbalization of the feeling of infringement of the positions of a small ethnic group by its representative.

-Reproaches to the highest power in the region that is unable to hear citizens.

In addition, the moderation of the discussion is putting the ordinary civil activists as a member of the Public Chamber for a while in equal status with representatives of the authorities and big business, who have higher power and social status. This balancing of the position corresponds to the principle of mediation of "equality of parties", which creates a "cooperation" atmosphere, that is another meditative principle and the key to the success of the conflict resolution procedure. In addition, fallowing this principle allows not demonizing civil activists, whose position can be constructive, patriotic and not contradictory to government and public values.

In general, these positions form a structural lattice of the conflict, give clarity to the leading elements of this structure. Such a model assumes predictable subjects and corresponding conflict logical tools.

As a rule, the result of the first stage of the game is the development of a joint action plan for the construction of an alternative water intake that does not damage the forest, the priority objectives of which are:

-Involving of all project participants in the problem solution considering the interests of all parties of the conflict.

-Including of all artificially marginalized participants of the conflict (civil activists - environmentalists and local businessmen) in the working group on the productive settlement of the conflict situation.

-Understanding the importance of supporting the project (including financial support) from local business.

-An application to the Government of the Russian Federation on co-financing the construction of an alternative water intake.

Separate attention deserves a general assessment of the satisfaction with participation in the training game. In this part, the most valuable remarks were fixed in the understanding of the importance to resolve any social conflict with technologies for a productive search for a compromise aimed at strategic long-term projects, rather than on one-time system of benefits. In the list of basic priorities that have received special significance, the mediator's competencies turned out to be a symbol of trust and a measure of justice. This understanding provides clarity in the role and importance of skills and abilities, acquired both directly by the mediator and by all participants of the training game. On the one hand, the approach represented to conflict resolution demonstrates the effectiveness of the principles of facilitation as a management technology when working with a group; on the other, the principles of mediation based on the neutrality and independence of the mediator, which provides a space for negotiations on the way out of the current conflict situation.

As a result, at the end of the training game "Environmental Conflict" for government and municipal employees, civil activists, members of public councils and students, the direction of "state and municipal government" and "conflictology" training was:

-to show the features of formation and development of group social conflicts;

-to demonstrate the difficulties and opportunities allow the person to resolve the conflict situation;

-to demonstrate the advantages of mediation in other forms of conflict interaction;

-to equip people with techniques for organizing communication and understanding in conditions of complex mental work requiring collective and team forms - psychotechnics, sociotechnics, sign engineering systems.

-to provide students with technologies for conflict resolution from the perspective of mobilizing the resources of the communities themselves to solve their pressing social problems.

In addition to the achievements described above and the acquired skills, all participants in the training game "Environmental Conflict" with the observation method are recorded obvious latent qualities. To such qualities, moderators and consultants refer to the knowledge of solidarity skills, cohesion, collective responsibility and individual attrition, and the ability to adequately assess the various forms of relationships.

4. DISCUSSION

Since the purpose of the study was not just the description of the technology of the training game, but also the study of the impact of the implementation of this methodology on the development of the professional qualities of the conflictologist, the authors of this study measured incoming and outgoing knowledge and attitudes from participants in the training game from among the students of conflictological areas of study.

The methodology for assessing the measurement of the dynamics of changes in the confrontational competencies of trainees consists of a three-stage assessment of the degree where the students get the knowledge and skills of technologies for resolving group social conflicts based on traditional Russian practices of local self-government. Such an assessment took place in the form of a questionnaire. The questionnaires were not large, which did not take up much time during the game.

The first phase of the conflictological competence studying with students was held before the starting of training. The second questionnaire was held after the first stage of the game. And the third measurement was taken at the end of the event, being a part of the final self-analysis stage of the trainees.

The methodology of studying the competences described is based on the subject matter "Conflictology". This program consists of several blocks of competences the students must get in studying process. There are four elementary blocks with questions as reproduction of these competences in the program of the researching. These questions describing the degree of results achieved by trainees. This knowledge was checked by such types of questions:

General professional consistency

1. Standards of ethical codes for employees?
2. The concept of the Russian Federation Ecological code project?
3. Ethical codes of several public organizations?
4. Mediative practice in serious ecological conflict resolution?
5. The proposed structure of participants in a major environmental conflict.

Technological

1. Competences and functions of mediator in practice of public-administrative conflict resolution
2. Comparative characteristic to the diagnostic technology and conflict resolution in using “focus-group” and “round table discussion” (meeting) methods.
3. The technological principles in the forming social programs that allow to reduce the level of conflict in social communities.
4. The ecological conflict diagnostic algorithm
5. The ecological conflict resolution algorithm

Information and analytical

1. Comparative characteristics of the resolution of major environmental conflicts with the practice of litigation.
2. Basic methods of analyzing information in resolving major environmental conflicts.
3. The main socio-cultural factors in the development of major environmental conflicts.
4. Main socio-economic factors in the development of major environmental conflicts.
5. The main socio-political factors in the development of major environmental conflicts.

Research

1. The nature of the development of major environmental conflicts, their structure and features of the dynamics of the course.
2. Modern theoretical approaches to the settlement of socio-political conflicts.
3. Regularities of conflict and peaceful interaction in the sphere of environmental security.

4. Categories and hierarchy of issues to be considered in resolving major environmental conflicts.
5. Possible alternative technologies for the prevention, resolution and management of major environmental conflicts.

Organizational management

1. The main requirements for the mediator in the process of organization and managing the resolution of major environmental conflicts.
2. Management activities in the preparation of activities to resolve major environmental conflicts.
3. Methods for ensuring control over the situation in the resolution of major environmental conflicts at the stage of escalation.
4. The methods of self-regulation in resolving major environmental conflicts?
5. The methods for reducing the level of conflict in resolving environmental conflicts.

Each of the five questions in these blocks, all of it goes from zero to two points; it gives a possibility to the respondent to get from zero to ten points in the sum for each section and in the amount of up to fifty. In addition, there were several variations of answering to each question in the sections. For example, the question "Name the principles of technology to develop social programs that reduce the level of conflict in social communities" provided options: no answer - 0 points, 1-2 variants – 1 point, 3 or more variants-2 points. The analysis of the competences obtained in three sectors allows to identify the strengths and weaknesses of the game methodology, to direct the efforts to enrich it in case of such need.

In addition, after processing the empirical data obtained as a result of the processing of questionnaires of the participants in the training game "Environmental Conflict", it was possible to reveal the indicators of the influence of training in conflict resolution technologies on this sphere in the formation of the conflictological competencies of trainees. These results are presented in the diagram.

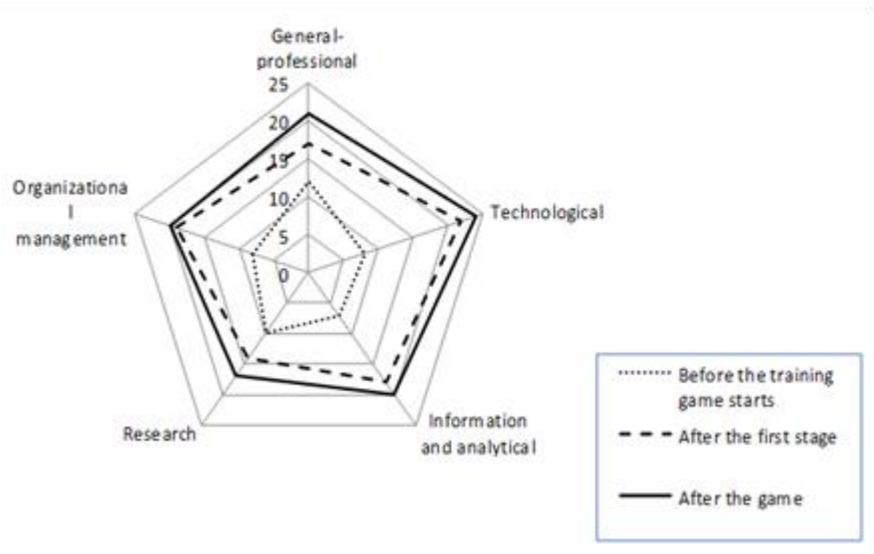

Diagram 1. The results of the influence of teaching the technologies of the settlement of environmental conflicts on the formation of the conflictological competencies of students.
Source: Author

Operationalized concepts were classified into five basic blocks, corresponding to the planned results of training students in the field of training "conflictology." The diagram shows the amount of points scored by the players, divided by the number of players – the average size of the formation of the required competence for the twelve groups that have been trained.

The empirical characteristics presented on the diagram also make it possible to conclude that the analysis of the competencies obtained in the five basic blocks allows to identify the strengths and weaknesses of the training methodology, to direct efforts to enrich it in case if it’s necessary. As practice has shown, such additional details in each new are always required. These details can significantly increase the effect of infection and involvement of players if they rely on local, relevant to the audience sensational events.

It should be noted that in different studying groups the average coefficient of each stage of game training was different, however, the general tendency of this coefficient change did not change significantly. In general, there is a noticeable interest of trainees not just in studying effective techniques for the regulation of social conflicts in the sphere of environmental safety based on the use of training technologies, but also on the theory, history and methodology of meditative practices.

It should also be noted that generally these training technologies, and the game "Environmental conflict", it’s such additional forms of professional development in particular, but it’s not resolving issues of full professional competence. The goal of the training is to actualize the demand for knowledge, and skills available to participants and consolidate them in a methodological connection. That is, the active role of the player allows to understand and appreciate what is impossible in other conditions of the educational process.

In other words, it is impossible to count on the possibility of a full replacement of the traditional educational process with playing techniques, trainings, coaching. However, it is obvious that playing technologies provide an excellent opportunity for the development of professional intuition and technological equipment, that is very important in resolving practical issues of conflict interaction and management. And the possibility of watching yourself, reflecting, which manifests itself throughout the training game and is fixed separately in the second part of the game, allows to make corrections to your thinking stereotypes and habits of situational behavior. If as a result of the training game it will be possible to convince players to internalize the techniques of reflexive control of their actions, to make them as the norm, then self-monitoring work can become the norm. In the meantime, such work necessarily improves the professional and communicative qualities of a person due to the fact that it’s no longer needs to search for behavioral patterns, he hones this pattern independently in interaction with environmental factors. Thus, a person independently developed and launched a mechanism of personal development based on reflexive analysis (Baynova M.S., et al., 2017).

This additional interpretation of the results justifies the cumulative effect of all training technologies, and the "Environmental conflict" in particular.

However, despite the obvious positive effects and acquired positive skills in resolving environmental conflicts and establishing healthy communication links between state and local government bodies, it should be noted that at present the bank of data on the most significant cases of environmental conflicts in the current conditions of the development of society and the government, there is no hierarchy and a universal classification of such phenomena, a modular set of specific conflictological tools, is not calculated as a positive, and, probably, a negative latent effect from the conduct of such organizational and activity games. Therefore, this direction still remains quite capacious for a variety of sociological, psychological and conflictological studies (Fomicheva T., et al., 2017).

5. CONCLUSIONS

In conclusion, it should be noted that a thorough familiarization with the problems of environmental safety has made it possible to create an organizational and activity game that is approximate to real standard situations. Based on this training game throughout the year, classes are held with a number of officials, students of specialized areas of training, some leaders of public associations.

The main objective of the described method is to realize the importance of environmental safety in the life of modern society, to acquire optimal skills for settling conflicts that are unavoidable for the modern social and economic order in the sphere of environmental safety, and to form the thinking of an effective leader.

Representatives of the administrative structures participating in the game often note the effect of reflection, expressed for them by the fact that they see their actions through the eyes of the other participants of the game, understand the real, rather than superficial and contrived qualities of all participants in the training game. Leaders, due to the temporary transformation of the personality in the process of the training game, organically take the usual directive style that does not allow them to notice the important factors of the conflict, but the style of a constructive dialogue or, in the worst case, neutral one. Such mechanisms of interaction, subject to their adoption and consolidation, develop into a constructive managerial mindset, allowing to bypass the acute aspects of social conflicts.

In addition, the importance to feel all the trainees benefit from the neutral status of the person who resolves the conflict, to assess the importance of acquiring mediatory qualities in order to resolve contradictions and preserve public confidence is the main task of the training (Maksudov R.R., et al., 2017, Ostrovsky A.N, Skladchikova E.S. 2017).

The feedback received from the participants of the training game, as well as the results of the measurements of the competent development of the players, allow us to draw conclusions about the achievement of the main goals of the game and about the positive effect in the development of the planned knowledge and competencies, and also to achieve increasingly important standards in the development of participants competences. At the same time, all new discoveries, both in the field of methodological features of collectives and in the field of specific problems of environmental safety, allow improving the method of playing the "Environmental conflict", including the creation of its new scenarios, taking into account the specific socio-economic situation of modern Russia and the current problems of social interaction , caused by a variety of conflictants. Features of the training game in a variety of groups of students depending on their age and professional status may be the subject of further research in the field of the introduction of training technology in the process of professional training and retraining of specialists in management. An important task of such games is the initiation of the transformation of established behavioral patterns of management specialists in accordance with the changing system of public relations in the country with the approbation of data on new approaches to dealing with conflict situations in the game and subsequent reflection.

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