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KEY AREAS OF THE AGRICULTURAL SCIENCE DEVELOPMENT IN RUSSIA IN THE CONTEXT OF GLOBAL TRENDS AND CHALLENGES

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EXECUTIVE SUMMARY

The modern Russian agrifood industry is one of the most steadily developing sectors of the national economy. The production of several goods shows historical records. Russia has a very strong position in the world export of agricultural raw commodities and low degree processing products from one side and localizing import dependence on certain products' groups, our country remains critically dependent on the means of their production from the other side. It is obvious that this state of affairs is not only an Achilles' heel in ensuring national

sustainability of food systems, but also hinders the growth of global competitiveness even within the current technological order.

The vectors of further scientific and technical development of the Russian food systems should be:

- Strengthening its own fundamental basis for productivity growth: breeding technologies and improving the genetics in combination with technologies for ensuring this potential best realization (feed additives, fertilizers, plant protection products and animal health,

and other so-called "package" solutions).

- The introduction of digital technologies and cross-platform solutions in agriculture, which is necessary to reduce the lag behind the leading countries in terms of labor productivity, increase productivity and reduce food losses.

- Diversification of the produced range of food products with priorities for high-margin segments of healthy, functional and personalized nutrition, deep processing of agricultural commodities.

- The support of the closed farming systems (including "urban farming") that are independent of external climatic and biological factors. Existing technologies allow us to eliminate the factor of seasonality and make it possible to obtain fresh, safe and affordable high-value products (berries, herbs, vegetables) anywhere in our country.

- Development of the agricultural waste recycling sector: the current situation in the field of waste generation and disposal is becoming critical in many regions of Russia. Meanwhile, the existing technologies in the world prove the possibility of their efficient processing into various products with high added value.

As one of the world's largest agricultural powers, Russia has a gap behind its competitors in terms of the scientific products quality. This is due to the lack of efficiency of agricultural science financing, as well as the imbalance of their structure.

An increasingly acute problem of the Russian food systems transition to the innovative path is the reduction of human resources. This trend is typical both for the scientific sector, where it is expressed in the number of researchers decrease, an aging staff (which threatens the continuity

in the established scientific schools and the viability of research teams) and for the agriculture as a whole.

This report examines critical areas of scientific research in Russia, which, according to the experts who participated in its preparation, will create "windows of opportunity" for increasing competitiveness in the situation of the transition of the world food systems from conventional agriculture to Agriculture 4.0. This period is key for ensuring further economic growth in Russia.

INTRODUCTION

Current world food systems are entering a fundamentally new stage of technological development, which is called Agriculture 4.0 and based on the introduction of "smart" solutions (robotics, "precision" agriculture, IoT (Internet of Things)), biotechnologies and alternative sources of raw materials.

The scientific potential elaboration and innovative solutions introduction are becoming critical to ensure competitiveness and further progressive development of the Russian agrifood sector.

The next decade of the Russian agrifood sector will be determined by the impact of the following trends:

- transition to a new technological mode: in the future, the key factor in food production will be technologies to increase productivity and prevent losses;

- changes in value chains: value added will increasingly be concentrated in knowledge-intensive sectors (genetics and breeding, IT (Information technology) sector, industrial design and engineering);

- the growing influence of large integrator companies, which are

the engines of the innovative technologies' introduction;

- the demand shift from the traditional food to the products corresponding to the values of new generations, who prefer ready-to-eat food, improved and predetermined properties products and increasing importance not only to their "benefits and safety", but also to their origin, sustainability technologies and production ethics;
- strengthening sustainability and product safety factors: increasing the number and strengthening of relevant standards and certification systems;
- transition to the knowledge economy: the process of digital transformation and the growing robotization will radically change the employment structure.

In parallel with these trends, there are a number of challenges in the Russian agrifood sector, a timely response to which will allow domestic producers to enter new markets for products and technologies. Among the economic challenges, we can highlight the growing demand for food against the background of a slowdown in production growth with a simultaneous reduction in resources, the concentration of the population in large cities, which leads to an aggravation of the problem of urbanized areas uninterrupted supply with food, as well as large-scale food waste and loss.

Despite the high level of the country's basic resources (fertile soils, fresh water) availability and the average low negative effects of global warming, the development of the Russian agrifood sector is increasingly influenced by natural and climatic challenges and the subsequent

decline in the agro-climatic potential of the planet; the reduction of natural breed and variety diversity in agriculture; the degradation of agricultural land, which threatens the sustainable development of the rural sector. All future areas of scientific research having a key impact on the sustainable growth of the national agrifood sector should be based on the climate change needs¹.

Technological challenges include spreading the principles of sustainable agrifood production and food consumption.

Agrifood production directly interacts with the environment, which creates environmental challenges: the loss of biological productivity of the world's oceans and NNN-fishing (nonlegal, nonregulated, nonreported fishing); the growth of animal waste; the destruction of ecosystems as a result of the use of chemical plant protection products.

It is important to consider the value challenges in modern Russia among which we can highlight the growing popularity of a healthy lifestyle, the personalized diet; public resistance to the technologies of genetic engineering modification and cloning; the strengthening of public activity against cruelty to animals.

Social challenges such as the stratification of the population in terms of income and access to healthy food products and the lag in the development between the rural areas and cities have a significant impact on the development of the Russian agrifood sector.

The answer to these challenges should be the creation and implementation of innovative technologies in production. Thus, we can identify the following priority areas for the development of agricultural science in Russia in the context of the

¹ Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty / V. Masson-Delmotte et al. IPCC, 2018.

national refraction of global trends and challenges.

1. BIOTECHNOLOGIES

The high relevance of biotechnology in the modern scientific and technological landscape of the Russian agrifood sector is determined by its ability to respond to the global challenges of our time, especially ensuring food security and environmental problems. In the conditions of man-made environmental pollution, soil degradation, and the growing number of chronic diseases of the country's population caused by the unfavorable environmental situation the importance of biotechnologies is increasing more and more.

The biotechnologies researches meet all the requirements of Russia's sustainable development in terms of ensuring food security, obtaining high quality, environmentally friendly products, processing agricultural waste, and restoring soil fertility. The driver of the development of biotechnologies in agriculture is the increasingly growing trends of maintaining a healthy lifestyle of Russian residents, responsible consumption and caring for the environment.

Currently, in Russia, the practice of processing waste into bio-products has become most widespread mainly in the production of solid biofuels (waste from crop production and woodworking) and feed protein (waste from pulp and paper and alcohol production, brewing and grain processing).

In addition, biotechnologies play an important role in the prevention and treatment of the infectious animal diseases. Without biotech, Russian

agrifood production will continue to be highly cost-effective and lose out in the competitiveness of its products on world markets. Currently the Russian market of biotechnologies in comparison to the European markets is in a nascent state and its largest segments are biotechnological feed additives, immunobiological preparations and biologics for crop production (the fastest growing segment). At the same time the import dependence in this market is very high – 83%. Therefore, it is necessary to develop our own agrobiotechnologies in the following key areas:

1.1. Technologies for breeding plant varieties that are resistant to pests and adverse environmental factors. For example, the selection methods based on the use of molecular markers, new-generation varieties and hybrids are created that are resistant to drought, diseases, herbicides, and insect pests².

1.2. Biological protection products, microbiological fertilizers and plant growth regulators that reduce the residues of the active substance in the final product, reduce the environmental burden on ecosystems and ensure the long-term competitiveness of the sector.

1.3. Biological products and feed additives in livestock. Development of production of feed protein and functional additives to improve feed quality and increase productivity in livestock, as well as technologies that reduce the use of feed antibiotics.

1.4. Technologies for processing animal waste. With the help of bacteria, the processing of organic waste can significantly speed up and reduce the cost of creating organic fertilizers, reduce environmental damage from agricultural production. Microbiological conversion

² Springer N., Schmitz R. Exploiting Induced and Natural Epigenetic Variation for Crop Improvement // Nature Reviews Genetics. 2017. Vol. 18. P. 563–575. DOI: <https://doi.org/10.1038/nrg.2017.45>

allows you to process various waste products into feed protein with improved qualities.

1.5. Biological products for livestock. Creation of immunobiological medicines for veterinary use using local strains of microorganisms isolated in Russia.

1.6. Technologies of soil bioremediation and biofertilization. The introduction of bacteria into the soil can significantly improve their quality and productivity.

1.7. Technologies of deep processing of feedstock for the production of bioplastics.

2. PRECISION AGRICULTURE

The significant lag behind the leading countries in terms of productivity and their relatively high volatility (primarily in crop production), the need to ensure the global competitiveness of the Russian agrifood sector and reduce food losses requires the activation of the transition to a new technological stage, including the introduction of "smart" technologies that make agriculture more accurate and controlled, focused on making decisions based on the needs of individual animals or plants.

In crop production, the use of precision farming technologies allows you to optimize the consumption of fertilizers and plant protection products and increase crop yields. In livestock, RFID (Radio Frequency Identification) technologies make it possible to obtain the maximum amount of information about the livestock population, including its accounting, movement, feeding, vaccination, etc.³ Given the limited resources available, the use of digital technologies is essential to improve the

efficiency of agrifood production. The main areas of digitalization of the Russian agrifood sector include:

2.1. Development of precision farming technologies based on IoT (Internet of Things). Obtaining real-time data on plants, animals, machinery, soil, and air allows you to make more informed decisions about the production⁴.

2.2. Technologies of digital systems that operate with "big data" and allow you to make more informed decisions that take into account weather forecasts, the probability of diseases, the state of soils and plants, yield estimates, and many others within a single model. They also allow us to design agricultural systems based on the principles of biologization, resource conservation, and environmental and sanitary-epidemiological safety.

2.3. Technologies of automated agricultural machinery and integrated management systems based on a combination of sensor (IoT) technologies, telematics, robotics and artificial intelligence.

3. SELECTION AND GENETICS IN CROP PRODUCTION AND LIVESTOCK

The recent discoveries in the field of genome research and the introduction of post-genomic technologies are already radically changing the face of world agriculture and creating new factors of competitiveness.

Russia lags far behind the leading countries in the field of both research and implementation of modern technologies of genetics and breeding.

This determines a high degree of dependence on foreign genetic material,

³ Ustundag A., Cevikcan E. Industry 4.0: Managing the Digital Transformation. Springer Series in Advanced Manufacturing. DOI: 10.1007/978-3-319-57870-5_1

⁴ Marchiol L. Nanotechnology in Agriculture: New Opportunities and Perspectives. 2018. September 19. DOI: 10.5772/intechopen.74425

which threatens the risks of reducing the global competitiveness of the Russian agricultural sector.

Russia's import dependence on corn seeds reached 62%, sunflower – 73%, sugar beet – 98%. Import dependence on breeding material of cattle and poultry is also high. When creating new genetic lines of meat breeds, only imported breeding genetic material is used.

Strengthening of selection and genetic research in these industries is one of the most priority areas of their development. The main topics of research work in this field include:

3.1. Creation of databases of genetic resources that form the basis of knowledge about hereditary variability and are a reference for the identification of new mutations and a source of valuable source material for breeding.

3.2. Development and implementation of genomic assessment tools and creation of Russian varieties and hybrids, pure lines of highly productive animal breeds that correspond to the real economic and agro-climatic conditions of the agrifood sector.

3.3. Methods of accelerated selection (marker-oriented, microclonal reproduction in vitro), which significantly reduce the time of breeding of new varieties and hybrids of plants.

3.4. Technologies for breeding plant varieties that are resistant to pests and adverse environmental factors. With the help of biotechnological innovations, for example, selection methods based on the use of molecular markers, new-generation varieties and hybrids are created that are resistant to drought, diseases, herbicides, and insect pests.

4. FOOD PROCESSING TECHNOLOGIES

Popularization of healthy food has become one of the strategic national tasks

of Russia. In the period from 2010 to 2018, the number of people suffering from obesity in Russia almost doubled and exceeded 2 million people (1.4 % of the population). At the same time, the highest specific rate of obesity is observed in the cohorts of children (0-14 years) and adolescents (15-17 years) of the population: 375 and 763 per 100 thousand, respectively (for comparison, it is 304 per 100 thousand for the entire population). In the period from 2010 to 2020, the number of patients diagnosed with diabetes increased by 61% to 5.1 million people. 63% of deaths in Russia are associated with diseases arising from poor nutrition.

At the same time, the transition to a healthy diet in Russia is favored by the current socio-demographic structure: a high level of urbanization (up to 75%), the share of the educated population (over 60 % have a tertiary education), the level of income in the largest urban agglomerations comparable to most countries in Eastern Europe. The results of sociological research show not only the rapidly growing interest of Russian consumers in healthy food, but also a significant proportion of the population, which is already guided by the relevant principles in the choice of products.

The following areas of scientific research are critical from the point of view of further development of food systems in Russia:

4.1. Biotechnologies for the production of food additives, enzyme products based on methods of microbial synthesis, including the use of mutant and genetically modified microorganisms; the creation of innovative domestic starter cultures, probiotic and starter cultures for the food

industry; medical and biological studies of their safety⁵.

4.2. Creation of mass consumption products enriched with essential nutrients, functional and specialized (therapeutic and preventive) food products that allow correcting violations of the nutritional status, preventing the occurrence of certain diseases, promoting the growth and development of children, slowing down the aging of the body.

4.3. New sources of protein derived from the biomass of microorganisms based on biotechnologies that allow the conversion of low-value waste into protein products and components with high added value. Scientific support for a comprehensive sanitary and epidemiological assessment of the quality and safety of sources of their production, as well as assessment of the impact of these products and secondary products of their processing on the human environment, including microbiological and toxicological-hygienic studies

4.4. Development of food engineering to create a new generation of probiotic products designed to maintain and preserve the normal human microbiota, to promote the formation of a healthy food market in Russia.

4.5. Technologies for the production of synthetic food products with high protein value from non-traditional natural food raw materials. Development of methods for deep processing of raw materials of plant and animal origin, based on microbial synthesis and biocatalysis. Biotechnological methods implementation for low-waste and resource-saving production, such as processing of food industry waste, recycling of food packaging, including non-food products.

4.6. Biotechnologies for the organic agriculture and obtaining organic food products, taking into consideration the requirements and restrictions imposed on the use of fertilizers, plant protection products, veterinary drugs.

A separate sector of the agrifood sector of Russia is the fishing industry. Russia has rich aquatic biological resources and is one of the world leaders in terms of fish and seafood exports. The share of exports from the volume of production in physical terms over the past five years has varied from 38.9% to 41.0%. Fish products as a carrier of animal protein with a unique set of amino acids, fatty acids and vitamins, which are not found in such an amount and variety either in cereals, meat, or other products, take a leading place in ensuring a balanced diet and a healthy diet. Marine pharmacology and biotechnological methods of aquaculture are the most promising areas of research and development in this industry for Russia.

5. AQUACULTURE

The reduction of fish stocks and their species diversity due to overfishing and water pollution are problems that in the near future may become a threat to food security both for Russia and for many other countries of the world⁶. Therefore, the main principles of national legislation in this area have become the priority of the preservation of aquatic biological resources before their use – the precautionary principle of the use of aquatic biological resources and the assignment of a quota of biological water resources to enterprises. The Russian fishing industry has received guarantees of the initial production resource. Therefore,

⁵ Ordovas J.M. et al. Personalised Nutrition and Health // BMJ. 2018.

⁶ Barang M. et al. Impacts of Climate Change on Marine Ecosystem Production in Societies Dependent on Fisheries // Nature Climate Change. 2014. Vol. 4. P. 211– 216.

to preserve the aquatic biological resources of our country, it is necessary to develop aquaculture in the following areas:

5.1. Development of recycled aquaculture (fish farming in completely closed controlled conditions). Water recycling in aquaculture farms can ensure high and stable production of aquaculture products with a lower risk of disease. At the same time, modern methods of recycling significantly reduce the adverse impact on the environment compared to traditional methods of fish farming.

5.2. Creation of specialized feed for aquaculture with high levels of protein, lipids, metabolic energy and vitamins, as well as resistant in aggressive aquatic environments.

6. REDUCING FOOD WASTE AND LOSSES METHODS

Reducing food waste and losses plays an important role in the development of sustainable food systems around the world. However, Russia has not yet formed a general conceptual view of this problem; the dangers associated with food waste and loss, which go beyond environmental pollution or contamination, are not on the agenda. In the country, there is no cooperation between the government, science and business regarding the food waste and loss, which is why there are practically no scientific developments in this direction; existing solutions or technologies to reduce food waste and loss are local, small in scale, and are not supported by the government or society as a whole⁷.

In addition, there are no reliable statistics on the volume of food waste and loss in Russia. There is a problem of data discrepancy: according to official statistics, the volume of food waste and losses in

Russia is 0.6% of food production on average; the expert community considers these indicators to be underestimated tenfold and points out that in Russia as a whole, the situation with food waste and losses is no better than the global average, 30-40% of the total production.

Unfortunately, in Russia, this problem is poorly studied and the focus is mainly on the disposal of food waste, rather than ways to reduce losses and waste in the process of production, processing and transportation. In this regard, it is necessary to conduct research in the following areas:

6.1. Development of methods for calculating the food waste and losses throughout the entire food supply chain.

6.2. A survey of the food supply chains themselves to identify and classify the main causes of food waste and losses at all stages, as well as to develop methods for reducing them.

6.3. Development of innovative methods for storing fruit products in a controlled atmosphere.

6.4. Study of the use of methods of ionizing radiation treatment of agricultural raw materials to improve their shelf life and quality.

In addition, it is necessary to identify barriers to the introduction of advanced technologies, including restrictions present in the regulatory framework, as well as issues of costs and payback for the use of these technologies within a particular enterprise.

7. CLOSED FARMING SYSTEMS

Russia has huge resources: our country accounts for about 10 % of the global arable land fund, and it is one of the world leaders in terms of fresh water reserves. However, these resources are distributed

⁷ Global Food Losses and Food Waste. – Extent, Causes and Prevention. Rome: FAO, 2011.

across the country: a significant part of the agricultural area has low fertility, is located in the zone of risky farming. In turn, the main reserves of fresh water are concentrated in the northern part of the country, which is not suitable for agricultural development, while the southern agricultural regions face the threat of a shortage of water for irrigation.

In addition, Russia is a country with a high level of urbanization (up to 75%), while almost 25% of Russians live in cities with a population of more than 1 million people. The largest urban agglomerations are located at a considerable distance from the key centers of agricultural production and are increasingly competing with local centers for land and water resources⁸. Another 2.4 million people live in the Arctic zone, which is dependent on external food supplies. Providing residents of megacities and remote regions with food products now requires the involvement of significant logistics resources, creates an additional environmental burden, and makes a significant contribution to the volume of food losses.

The transition to agricultural production in closed systems, independent of external agroclimatic factors, is one of the most relevant and promising directions for the development of agricultural science also in the context of Russia's Arctic ambitions and the implementation of long-term space programs.

7.1. Vertical farms – creation and improvement of crop production technologies in vertically arranged automated complexes with artificial lighting, heating and air conditioning, closed water circulation and sterile air. Vertical farm technologies will increase the availability of high-quality fresh produce in cities and remote areas, eliminate the

seasonal factor, as well as significantly reduce the environmental burden and ensure local food security.

7.2. Non-ground crop production – hydroponics, aquaponics, aeroponics, as well as advanced technologies derived from them (including bioponics, hyponics). Technologies of non-ground crop production allow a) to complete the transition of vertical farms to closed systems that do not use traditional agricultural resources; b) to level the weight and size restrictions – to receive products on autonomous objects: ships, Arctic stations, spacecraft, etc.

7.3. Robotic "smart" greenhouses – technologies for integrated monitoring and management of microclimate, lighting, fertigation, and plant protection. Also, automation of processes and manipulations with plants. Technologies allow you to: a) increase productivity and reduce the costs associated with the use of manual labor; b) improve the quality of decision-making; c) increase the level of availability of products for end users.

7.4. Construction of specialized greenhouse complexes adapted to permafrost conditions to provide fresh food to the population of the Far North of Russia.

8. DEEP PROCESSING OF AGRICULTURAL AND FISHERY FEEDSTOCK

To increase the sustainability of the Russian agrifood sector, it is very important to increase the depth of processing of agricultural feedstock, where there is still a significant gap with global agricultural producers.

The need for the development of deep processing of grain is caused by record harvests of grain crops in Russia, which in

⁸ World Urbanization Prospects: The 2018 Revision (ST/ESA/SER.A/420) / United Nations, Department of Economic and Social Affairs, Population Division. N. Y.: United Nations, 2019.

recent years have led to the fact that production volumes are increasing faster than their consumption in related industries. Every year, about 40% of the country's grain reserves remain unused, which requires expanding the areas of its domestic use, strengthening the potential opportunities for entering international markets.

In addition, the intensive development of livestock in Russia in recent years has provided a significant increase in demand for feed amino acids, which the domestic deep processing industry is not able to meet.

On the scale of the world market of fish and other products from aquatic biological resources, the fisheries complex retains the role of one of the key suppliers of feedstock of the most valuable and popular types of aquatic biological resources. The main buyers of domestic fish and other products from aquatic biological resources are processing enterprises located in the countries of the Asia-Pacific region and the European Union. The products produced for final consumption in some cases go to the final consumer without indicating the Russian origin of the fish. Thus, Russian suppliers of fish products are deprived of competitive influence on the final sales price and do not participate in the formation of market demand, and also do not receive a significant part of the added value in terms of deep processing, distribution and marketing of fish and other products from aquatic biological resources. Therefore, within the framework of deep processing of fishery feedstock, the main task is to introduce modern biotechnological methods into the practice of fish processing enterprises that can provide cost-effective production of a wide range of food ingredients and

valuable food products with high added value from hydrobionts. The production of fish meal and fat, fish feed and fish oil deep processing products have the highest growth rates in the global fish industry, due to the need to meet the growing mass demand for protein-containing products.

The priorities in research and development in this industry for Russia are:

8.1. Deep processing of agricultural feedstock for the production of feed amino acids, glucose and glucose-fructose syrups, starch.

8.2. Deep processing of low-value products of processing of hydrobionts of the fishing industry into products with a high content of free amino acids and lower peptides that have good functional and nutritional properties for use in medicine, microbiology, food and feed industry. Extraction of fish oil from secondary feedstock to create functional food products based on it.

The implementation of these directions will allow for the transition from feedstock export-oriented production to the production of products with a deep degree of processing for both domestic consumption and export.

9. SUSTAINABLE DEVELOPMENT OF AGRICULTURAL PRODUCTION AND RURAL AREAS

In order to prevent the destructive consequences of the aggressive intensification of agricultural production in Russia, it is necessary now to translate it into the principles of sustainable development, which are based on the optimal use of limited natural resources, the creation of a "green" economy and the preservation of vast rural areas of our country⁹.

⁹ Dietz T. et al. Governance of the Bioeconomy: A Global Comparative Study of National Bioeconomy Strategies // Sustainability. 2018. Vol. 10. Iss. 9. DOI: <https://doi.org/10.3390/su10093190>

To minimize the negative impact of aggressive intensification on the environment, it is necessary to develop research and development in the following areas:

9.1. Technologies of organic agriculture, including methods of minimal impact on the soil, mechanical and biological weed control, the use of sideral fertilizers and biological products, ensuring a closed cycle of agricultural production "crop production-livestock-crop production".

9.2. Integrated plant protection, safe for the environment and reducing harm to the human organism. Its goal is to maintain a balance between the economic efficiency of production and the environment.

9.3. Soil protection and resource-saving agriculture, which is based on the principles of zero tillage, diversification of crop rotation by various types of crops.

9.4. Biological reclamation technologies for increasing soil fertility, preventing water and wind erosion with the help of grass and woody vegetation.

9.5. Development of bioremediation – a complex of methods for cleaning water, soil and atmosphere using the metabolic potential of biological objects.

9.6. Development of models for restoring biodiversity and soil productivity

9.7. Technologies of adaptive landscape system of agriculture.

10. VETERINARY AND PHYTOSANITARY CONTROL

In the context of globalization and the expansion of commodity turnover between Russia and other countries, the system of veterinary and phytosanitary control, the purpose of which is to prevent harmful introduced organisms from entering the

country, is becoming increasingly important. The problem is aggravated by the negative effect of climate warming, against which pests and pathogens of plants and animals are beginning to spread more and more actively beyond their natural habitats¹⁰. The increased risks of epizootic and epiphytotic situations for Russia are associated with the vast territories located in the European and Asian parts of the continent.

The costs of combating them and the resulting food losses can cause significant harm to Russian agriculture and public well-being.

In Russia, about 40 million cases of infectious diseases are registered annually among farm animals, while economic losses from diseases amount to 30%, and the amount of damage is more than \$200 million.

10.1. Blockchain technologies for tracking the entire path of food production, processing and sale.

10.2. Creation of phytosanitary and veterinary databases and digital platforms for analyzing and predicting the spread of animal and plant diseases.

10.3. Development of systems for monitoring, diagnosis and prevention of plant and animal diseases.

11. TECHNOLOGIES OF THE LOGGING INDUSTRY

Technologies of the logging industry, which are extremely necessary for Russia, which has more than 20% of the world's forest reserve. The forest complex occupies an important place in the country's economy, due to the performance of important environmental protection and environmental-forming

¹⁰ Clapper J.R. Worldwide Threat Assessment of the US Intelligence Community / U.S. Intelligence Community Worldwide Threat Assessment. 2011. February 10.

functions. The forest is one of the most valuable renewable natural resources. Such a global significance of the Russian forest multiplies the country's responsibility for its conservation and reproduction, especially since it is an ecological framework for our entire planet, a colossal resource for the economy, for economic growth, for improving the well-being and health of our citizens. To do this, it is necessary to develop research and development aimed at improving the efficiency of forest plantation management, preserving and reproducing forest genetic resources, and protecting forests from various adverse factors:

11.1. Technologies for the protection of forests from fires, pests, diseases and other adverse factors. The use of biological means of protection will help to contain the spread of new dangerous pests and phytopathogens of phytophages in the forests, which negatively affect fire safety in the forests.

11.2. Technologies for predicting the spread and dynamics of the most dangerous pest foci using remote monitoring systems.

11.3. Selection of the main forest-forming species, aimed at accelerating growth, breeding new hybrids and varieties, creating biotechnological forms of trees with specified characteristics, micro-planar reproduction of genetically valuable tree forms.

11.4. Technologies for processing larch and dry wood, technologies for multi-layer and alternative molding in the production of paper and cardboard, research of the properties of wood-based materials for their use as building materials, development and introduction of new wood-based materials through deep chemical and mechanical processing of feedstock.

The only way to preserve and increase forest wealth is through the sustainable management of forests, preserving their biological diversity, productivity, resilience, viability, and ability to perform important environmental, economic, and social functions at the local, national, and global levels in the present and future.

CONCLUSIONS

The range of key areas for the agricultural science development in Russia is very wide and varied, which is due to the presence of a huge potential, both natural and climatic and human capital of our country. The main goal of all presented research areas will be to provide the population of Russia and the whole world with high quality food products.

We should look and think one-step ahead, so as not to miss the unique “windows of opportunity” for the industry that arise when changing technological patterns.

It is necessary to overcome the idea of agriculture as a very conservative industry of traditional products and technologies, to surpass isolationism in the field of scientific and technological development. The current tasks of catching up development and strengthening food security should evolve into a higher-order goal – the transition to innovative development, building an effective system for generating new original ideas and supporting their transformation into specific solutions, products, and technologies. The scientific and technological development of the Russia's agrifood sector in the future will be based on sustainability combined with innovations. Economic, social and environmental efficiency of agribusiness is possible only with the introduction of innovative technologies.

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