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## **ИННОВАЦИОННЫЕ МЕТОДЫ ЗАЩИТЫ РАСТЕНИЙ И УГОДИЙ**

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**Аннотация.** Инновационные методы защиты растений и угодий представляют собой перспективное направление, способное обеспечить не только повышение урожайности, но и экономическое процветание сельского хозяйства, но их внедрение требует комплексного подхода, учитывающего как биологические, так и экономические аспекты проблемы. Объект исследования – экономика сельского хозяйства. Предмет исследования – инновационные методы защиты. Цель исследования – выявить, как инновационные методы защиты растений и угодий способствуют устойчивому развитию национальной экономики и сельского хозяйства страны. В ходе проведения исследования инновационных методов защиты растений и угодий были выявлены ключевые тенденции, технологии и их влияние на эффективность сельскохозяйственного производства. Результаты исследования позволяют сделать вывод о том, что современные подходы к защите растений способны существенно повысить урожайность, снизить экологические риски и оптимизировать затраты агропроизводства.

**Ключевые слова:** устойчивое развитие, инновационные методы, экономика сельского хозяйства, национальная экономика, природные ресурсы.

### **Introduction**

Modern agriculture is one of the key sectors of the national economy, ensuring food security and sustainable development of the entire economic complex of the country. In the context of growing geopolitical tensions, depletion of natural resources and climate change, the issue of increasing the efficiency of agricultural production is becoming relevant. One of the significant factors of the problem is the protection of plants and land from pests, diseases and weeds, which directly affects the volume of crops and the quality of products. Traditional methods of protection, based mainly on

chemicals, are gradually losing their economic and environmental feasibility, which stimulates the search for innovative solutions in the subject area. Innovative plant protection methods represent an integrated approach combining modern scientific achievements and advanced technologies, aimed not only at minimizing crop losses, but also at reducing agricultural production costs by increasing the expediency and effectiveness of the methods adopted. The introduction of new technologies contributes to the formation of a more rational resource management model, which is important for the national agricultural economy. The use of digital technologies such as remote sensing, geoinformation systems and artificial intelligence makes it possible to optimize the processes of monitoring the state of fields and forecasting threats. In general, innovations reduce the cost of using pesticides and herbicides, which traditionally account for a significant share of farm costs. The introduction of biological methods of plant protection, such as the use of entomophages, microbiological preparations and disease-resistant varieties, opens up new opportunities for the sustainable development of the agricultural sector - methods can reduce dependence on chemicals, which has a positive effect on the environmental situation and public health. In the long term, this helps to increase the competitiveness of agricultural products in the global market, where more and more attention is being paid to environmental friendliness and food safety.

### **Research methods and materials**

To study innovative methods of plant and land protection, this study used a set of theoretical and analytical methods of scientific knowledge aimed at a comprehensive analysis of modern technologies and their potential for agricultural development. The research was based on the principles of a systematic approach, which made it possible to consider the problem of plant protection as a complex multilevel phenomenon covering biological, technological and economic aspects. The main research method was the analysis of scientific literature and publications, with special attention paid to materials on current trends in plant protection, including the use of digital technologies, biological agents and genetic engineering. The analysis of the scientific literature allowed us to identify the key areas of development of innovative methods and determine their role in improving the efficiency of agricultural production. Additionally, comparative analysis and generalization methods were applied - comparative analysis was used to assess the advantages and disadvantages of traditional and innovative approaches to plant protection, which made it possible to identify the most promising technologies that can be implemented in the agricultural sector with minimal cost and maximum impact. The synthesis of materials contributed to the formation of a holistic picture of the current state of the problem under study and the identification of the main barriers to innovation. The logical analysis helped to identify the cause-and-effect relationships

between the use of new technologies and their impact on the sustainability of agricultural production. All the methods used complemented each other, which ensured the complexity and scientific validity of the research, the results obtained allow us to form recommendations on the introduction of innovative technologies into agricultural practice aimed at improving its efficiency and sustainability.

Modern agriculture is faced with the need to increase yields while maintaining environmental sustainability, which makes it urgent to search for innovative plant protection methods. As noted in the Russian scientific literature, "one of the most accessible ways to increase yields is to reduce losses resulting from plant damage by pests and diseases and crop contamination" [1, p. 27]. This underlines the importance of implementing comprehensive measures aimed at minimizing losses and ensuring the stable development of agricultural production. However, the problem lies not only in the need to protect plants, but also in the scale of losses, which can reach significant values. According to scientific research: "they are susceptible to diseases, the effects of pests, weeds and other factors that cause significant losses (up to 50%) of genetic productivity" [2, p. 22]. Such losses directly affect the economic efficiency of agricultural production, increasing the cost of restoring yields and reducing the competitiveness of products. In the context of the growing pressure of anthropogenic and natural factors on agroecosystems, innovative technologies that can replace traditional chemical protection methods are becoming particularly relevant: "Laser and mineral agrotechnical measures are a promising alternative to chemical methods" [3, p. 3]. Laser technologies have fungicidal properties and can be used to improve the phytosanitary condition of fields, but their widespread introduction is limited by farmers' low awareness of the possibilities of these technologies, which creates a barrier to their economic application. It is important to take into account the influence of external factors on the condition of lands: "Desertification is a process of irreversible changes in soil and vegetation, a decrease in biological productivity, which in extreme cases can lead to the complete destruction of the biosphere potential and the transformation of the territory into a desert" [4, p. 177] – the process requires the introduction of measures aimed at restoring soil fertility and preventing land degradation, which can also be achieved through innovative approaches. The role of weeds as one of the key factors reducing crop yields cannot be ignored. "Technological methods of tillage, as well as the presence of weeds in the uncultivated territories of settlements, various industrial buildings, along the sides of fields, etc. have a significant impact on the contamination of crops" [5, p. 79]. The introduction of modern methods of contamination monitoring and management can significantly reduce economic losses and increase the efficiency of agricultural production.

## **The results of the study**

The economic importance of innovative plant protection methods lies in their ability to increase the adaptability of agricultural production to changes in external conditions, which are increasingly negative due to the influence of anthropogenic and man-made factors. Modern technologies make it possible to quickly respond to new challenges, such as the spread of invasive pest species or adverse weather conditions. Research and implementation of innovative approaches in the field of plant and land protection is an important factor in ensuring sustainable economic growth of the agricultural sector and solving global food security problems.:

### **1. The effectiveness of biological protection methods**

Biological methods of plant protection, including the use of entomophages, microbiological preparations and disease-resistant varieties, demonstrate high prospects for implementation in practice. The key advantages of these methods include:

- Reducing dependence on chemical pesticides, biological agents do not have a negative impact on the environment and human health, which makes them a more environmentally friendly alternative.

- Resistance to the development of resistance in pests, unlike chemicals, biological methods are less susceptible to the formation of resistance in target organisms.

- Long-term economic benefits, as despite the relatively high initial costs of implementation, biological methods can reduce the cost of reuse of pesticides and soil restoration.

- Domestic studies have shown that the use of biological agents can reduce crop losses from pests and diseases by 20-40%. - the use of microbiological preparations such as *Bacillus thuringiensis* has significantly reduced the number of insect pests in grain crops.

### **2. Digital technologies and precision farming**

One of the most significant achievements in the field of plant protection is the introduction of digital technologies, precision farming systems based on remote sensing, geographic information systems (GIS) and artificial intelligence, ensure high accuracy of monitoring and management of agroecosystems. The main results of using digital technologies include:

- Optimization of the use of pesticides and herbicides - accurate data on the condition of fields allows you to minimize the amount of chemicals used, using them only in those areas where it is really necessary.

- Improved forecasting efficiency, the use of satellite data and IoT sensors allows timely detection of signs of plant damage by pests or diseases, which contributes to the rapid adoption of preventive measures.

- Reducing the cost of manual labor, automating monitoring and control processes through drones, robots and software reduces the need for manual labor and increases productivity. The use of drones with high-resolution cameras to analyze the condition of crops allowed farmers to reduce plant protection costs by 15-20%, while increasing yields by 10-15%.

### 3. Laser and physical methods

Laser plant protection technologies, although they are at the stage of active development, already demonstrate significant potential, domestic research has shown that laser irradiation can be used for:

- Suppression of the vital activity of pests - lasers can cause damage to insects, reducing their numbers without the use of chemicals, laser treatment of seeds before sowing improves their resistance to diseases and increases germination.

-Plant growth stimulation - some experiments have shown that laser irradiation can stimulate photosynthetic activity of plants, but the widespread adoption of laser technologies is still limited by high equipment costs and insufficient awareness of farmers about the possibilities of these methods.

### 4. Application of saporrels and mineral fertilizers

-The use of saporrels and other mineral fertilizers has also proved effective in improving the phytosanitary status of agroecosystems. The main results include:

-Improvement of soil quality - saporrels contribute to the restoration of soil fertility, increase their biological activity and resistance to erosion.

- Reducing the contamination of crops, the use of mineral fertilizers helps to control the growth of weeds, which reduces competition for nutrients and water.

- Increasing yields, experiments have shown that the use of saporrels can increase the yield of grain crops by 25-30%.

#### Challenges and barriers to innovation:

Despite the obvious advantages of innovative plant protection methods, their implementation faces a number of challenges.:

-High initial costs for the purchase of equipment and staff training.

-Insufficient awareness of farmers about new technologies.

-Lack of government support for small and medium-sized enterprises.

-Technical difficulties in adapting methods to regional conditions.

An analysis of the economic efficiency of innovative plant protection methods has shown that their implementation can bring significant benefits.:

1. Reducing the cost of chemical pesticides and herbicides by 20-30%.

2. Increasing yields by 10-25%, depending on the crop and method.

3. Reducing the environmental costs associated with soil and water pollution.

4. Increasing the competitiveness of products in international markets due to their environmental friendliness.

## Conclusion

The results of the study confirm that innovative methods of plant and land protection are a promising area of agricultural development within the framework of sustainable development of the national economy. They are capable of ensuring not only increased yields, but also the sustainability of agroecosystems, reducing environmental risks and economic prosperity of the agricultural sector, but additional efforts from the government, the scientific community and business are needed for the successful implementation of these methods.

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## INNOVATIVE METHODS OF PLANT AND LAND PROTECTION

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**Annotation.** Innovative methods of plant and land protection represent a promising area that can ensure not only increased yields, but also the economic prosperity of agriculture, but their implementation requires an integrated approach that takes into account both biological and economic aspects of the problem. The object of research is the economics of agriculture. The subject of the research is innovative methods of protection. The purpose of the study is to identify how innovative methods of plant and land protection contribute to the sustainable development of the national economy and agriculture of the country. During the research of innovative methods of plant and land protection, key trends, technologies and their impact on the efficiency of agricultural production were identified. The results of the study allow us to conclude that modern approaches to plant protection can significantly increase yields, reduce environmental risks and optimize agricultural production costs.

**Keywords:** sustainable development, innovative methods, agricultural economics, national economy, natural resources.

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