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# INNOVATIVE TECHNOLOGIES OF USING MINERAL FERTILIZERS IN AGRICULTURE

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**Abstract**
In the article, the use of innovative technologies in the use of mineral fertilizers in agriculture and the impact on crop productivity have been studied, projects on the production of mineral fertilizers in economic sectors are reflected.

**Keywords:** Biotechnology, intensive, suspension, export, cluster, biological fertilizer, innovative technology, agrochemistry, trace elements, uni-agro, biomineral, mobile laboratory, biohumos, bacterial fertilizers.

## Introduction

In global practice, the role and importance of the agricultural sector in ensuring the food security of the population is increasing day by day. In particular, it is an urgent issue to rationally use the resources and opportunities available in our country, to ensure the guaranteed supply of agricultural products to the population, to further increase productivity and efficiency, and to introduce scientific achievements and modern innovative approaches to the sector.

In his Address to the Oliy Majlis of the Republic of Uzbekistan on December 29, 2020, the President of the Republic of Uzbekistan stated, "the factor that will yield the fastest results in reducing poverty and increasing the incomes of the rural population is a sharp increase in productivity and efficiency in agriculture".

It will be a priority to increase the income from each hectare of land from the current average of 2,000 dollars to at least 5,000 dollars. "We need to widely introduce the most advanced technologies, water-saving and biotechnologies, and achievements in the field of seed production, science, and innovation into agriculture," he emphasized.

The introduction of modern innovative approaches to increase production in the agriculture of our republic has risen to the level of state policy. In particular, the Resolution of the President of the Republic of Uzbekistan No. PD-307 of July 6, 2022 “On organizational measures for the implementation of the innovative development strategy of the Republic of Uzbekistan for 2022-2026” was adopted. According to this resolution, in 2022-2026, it was determined that organizations in economic sectors

will implement projects to develop the production of large-scale scientific and innovative products based on new developments and technologies.

In particular, a program was approved for the implementation of 14 innovative projects based on modern technologies aimed at applying innovative technologies for the use of mineral fertilizers in agriculture, as well as 26 projects for the introduction of new developments and technologies related to mineral fertilizers by scientific and higher educational institutions, including all sectors of the economy.

Also, projects have been identified for the production of mineral fertilizers based on innovative technologies in 2022-2026 by research institutions engaged in mineral fertilizers, large manufacturing enterprises currently operating as locomotives in Uzbekistan, and private entrepreneurs. (Table 1).

**Table 1. Implementation of projects for the production of mineral fertilizers based on innovative technologies in economic sectors in 2022-2026**

| T/p | Projects | Implementing organization | Amount, million soums | Funding sources |
|---|---|---|---|---|
| ***commercialization of innovative developments and start-up projects*** | | | | |
| 1 | "On the basis of local non-traditional agro-ores, soil fertility, improvement of its reclamation condition, increase of crop productivity in the cotton, wheat, polyz, horticultural complex, production of water-saving mineral fertilizer "Agrobentofos". | «MS-OLTINSOY AGROFOS» LLC | 1 385 | Funds allocated within the framework of state scientific programs |
| 2 | Production of new environmentally friendly bacterial fertilizers of the "TERIA" series to increase the productivity of saline and degraded soils and the yield of agricultural crops. | «INNOVATION-IDEAS» LLC | 801 | Funds allocated within the framework of state scientific programs |
| ***specific priority projects to be implemented to launch the production of new innovative products*** | | | | |
| 3 | Creating innovative agrotechnology for fertilizing cotton with NPK ratios that are adapted to global climate change. | Research Institute of Soil Science and Agrochemistry | 1 930 | State budget funds allocated to scientific projects |
| 4 | Creation of a technology for the production of water-saving hydrogels modified with complex fertilizers based on local raw materials. | Tashkent Scientific Research Institute of Chemical Technology | 530 | Network funds |
| 5 | To organize the production of NPK mineral fertilizers of various compositions in crystalline form, 100% soluble in water. | «Фарғона азот» JSC | 1 200 | Network funds |
| ***"driver" innovative projects implemented in economic sectors*** | | | | |

| T/p | Projects | Implementing organization | Amount, million soums | Funding sources |
|---|---|---|---|---|
| 6 | Creation of granulated calcium chloride, calcium carbonate, table salt, mineral fertilizer based on the technology of waste disposal in the environment in an innovative way. | «JV "Kungirot Soda Plant" LLC | 15 680 | Network funds |
| 7 | Production of bio-organic fertilizers based on the technology of biological processing of Angren hydroelectric waste. | «Ўзкимёсаноат» JSC | 2 240 | Network funds |
| 8 | Production of new biofertilizers based on biopesticides and bioadditives for agricultural pests. | «Ўзкимёсаноат» JSC | 112 000 | Network funds |

Specifically, in the field of introducing innovative technologies for the application of mineral fertilizers in agricultural production, the activities of 8 new innovative academic enterprises specializing in the production of scientific-scale products (goods and services) under scientific organizations and higher educational institutions in promising areas of innovative activity in 2022-2024 were approved. (Table 2).

It is planned to allocate 1,900 million soums within the framework of state scientific programs and 1,915 million soums from initiative enterprises and entrepreneurs to create new innovative academic enterprises at scientific organizations and higher educational institutions in promising areas of innovative activity in the development of agriculture.

This, in turn, plays an important role in developing new technologies for innovative mineral fertilizers for agricultural enterprises, accelerating the production and implementation of organo-mineral fertilizers rich in microelements, and, on this basis, in the use of agrochemical services based on innovative technologies.

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**Table 2. In 2022-2024, new innovative academic enterprises specializing in the production of scientific products (goods and services) in promising areas of innovative activity will be established at scientific organizations and higher educational institutions**

| T/p | Name of scientific and higher education institutions | Name of innovative enterprises | Innovative Enterprises | Funding sources, mln. soum | |
|---|---|---|---|---|---|
| | | | | State scientific programs | Initiator |
| 1 | Institute of Genetics and Plant Experimental Biology | «Organic o'rmon» LLC | Production of nitrogen-based microbiological biopreparation for forestry | - | 50 |
| 2 | Institute of Microbiology | «Micro-world» LLC | Production of complex biopreparations for plants based on local waste | 500 | 1 000 |
| 3 | Research Institute of Soil Science and Agrochemistry | "Soil Clinic" LLC | Providing prompt recommendations to land users on the implementation of agrochemical and agro-ameliorative measures on the soils of their land plots | 100 | 100 |
| 4 | Scientific-research institute of agro-technologies of cotton breeding, breeding and cultivation | « Agrochemistry and general analysis» | Determining the level of soil nutrient supply by determining the amount of humus, total nitrogen, phosphorus, potassium and nitrate nitrogen, mobile phosphorus and exchangeable potassium in the soil, and the soil environment. | - | 320 |
| 5 | Grain and Rice Scientific and Production Association | «Biogumus» LLC | Production of vermicompost (biohumus) based on the processing of agricultural and livestock products by the red California worm | - | 200 |
| 6 | Bukhara Institute of Engineering and Technology | «Muxammadali bio Ziroat» LLC | Production of "Microfertilizers" concentrate for greenhouses | - | 60 |
| 7 | Namangan Institute of Engineering and Construction | Agrobiotechnology Transfer LLC | Establishing a soil clinic mobile laboratory service | - | 35 |
| 8 | Ministry of Innovative Development | «Chust Innovation Pro» LLC | Establishing a soil clinic mobile laboratory service | 1 300 | 150 |
| **Total Funding Amounts** | | | | **1 900** | **1 915** |

The result of the implementation of this decision in practice shows that there is an impetus to the growth and expansion of the activities of enterprises based on innovative technologies in various sectors of the economy.

In the current era, when attention is paid to the innovative development of agriculture and the use of modern intensive technologies and methods suitable for the products of each of its branches, it is necessary to effectively switch from complex and mineral fertilizers containing various microfertilizers and fundamentally improve the system. Today, in our republic, several international (joint venture) and local enterprises are implementing mineral fertilizers created on the basis of innovative technologies, as well as modern agrochemical services. In the course of the research, some of them were studied to affect the production efficiency of agricultural enterprises. (Table 3).

**Table 3. The state of implementation of innovative technologies affecting the efficiency of the use of mineral fertilizers in agriculture**

| T/p | Innovative name of enterprises | Innovative Enterprises Direction | Innovative efficiency results |
|---|---|---|---|
| 1 | "Soil clinic" mobile laboratory in Chust innovation area | Determining the amelioration status of the soil, nutrient supply, and other agrochemical indicators in the field at various stages of crop vegetation using mobile laboratories. | 1. The ability to analyze the soil of plots of land of farms, clusters, peasant farms, etc. in the field itself and give relevant practical recommendations.<br>2. It is possible to correctly determine the timing of planting, watering, tillage, and stratify the application of mineral fertilizers according to the availability of soil and crop requirements..<br>3. Conducting rapid analyses and measurements in greenhouses to create optimal conditions for the normal growth and development of crops. |
| 2 | Tashkent Research Institute of Chemical Technology | Development of new generation nanomaterials and hydrogels that will eliminate salt and sand migration in the Aral Sea regions, increase soil fertility, and help save water. Currently, the hydrogel product is made on the basis of local raw materials available in our Republic, its price is 8 times cheaper compared to imported similar products, and it does not differ in terms of properties. It holds 200-300 times its own weight in rainwater, and 200-250 times more water in most areas, depending on the amount of various salts in the soil. | 1. Ишлаб чиқарилган гидрогеллар it is ecologically harmless, due to the long preservation of moisture in the areas where hydrogel is used and the soil does not harden, irrigations are reduced by 30-40% and the number of agrotechnical treatments is reduced by 20-30%.<br>2. The application process does not require special complex technologies.<br>3. Hydrogel ensures preservation of moisture, mineral fertilizers and trace elements around the roots for 3-5 years.<br>4. As a result, the plant germinates quickly, does not dry up in the absence of water, increases productivity and resistance to diseases.<br>5. Mixing the hydrogel with mineral fertilizers makes it easier to apply to the soil. |
| 3 | Islamic Republic of Iran Sodour Ahrah Shargh (Knowledge based company) | Production of organic fertilizers and nano biostimulants based on chelated (a form easily absorbed by plants) | 1. Nano-fertilizers increase cotton yield up to 70-80 t/h in desert and steppe regions.<br>2. High economic efficiency is achieved in the maintenance of tomato crops grown in innovative greenhouses. |
| 4 | Korean innovative company "Nacle" | Innovative biomineral fertilizer production | 1. A total of 100 tons of biomineral fertilizer worth 15.3 billion soums was delivered to 1,048 farms in Namangan, Navoi, Fergana, Kashkadarya and Tashkent regions on a trial basis under a contract.<br>2. As a result, 30-40% economic efficiency was achieved due to the use of biomineral fertilizer. |
| 5 | “IFODA Agro Chemical Protection” LLC | Production of more than 50 types of new generation fertilizers in chelated forms, containing all the substances and microelements necessary for plants | 1. 50 highly qualified agronomists provide free agronomic services.<br>2. There are about 100 trade branches in the regions with more than 30 thousand farmers in the republic.<br>3. The use of liquid fertilizer compounds (stimulators) in plant nutrition leads to additional efficiency gains for the farmer. |

Also, with the implementation of innovative technologies for the effective use of mineral fertilizers, the use of mineral fertilizers in the form of liquid fertilizers, slow-release fertilizers or granular fertilizers that slowly decompose in the soil, fully concentrated and multi-component fertilizers, that is, complex fertilizers, is increasingly expanding.

It is very important to develop the technology for the production and use of mineral fertilizers, increasing the concentration of nitrogen, phosphorus, and potassium in their composition, the growing demand for complex fertilizers, and the greater differentiation of the composition of these fertilizers for different soils and crops.

The results of the above-mentioned indicators were also observed during monographic studies. Accordingly, we can see that in 2022, at the Angor Sardorbek Daler farm in Angor district, high cotton yields were achieved as a result of the use of Ento NPK liquid fertilizer, a foliar fertilizer produced by IFODA Agro Kimyo Himoya LLC, in suspension, in cotton cultivation using mineral fertilizers. (Table 4).

**Table 4. Analysis of the effect of mineral fertilizers on the productivity of the use of liquid fertilizers in the cultivation of cotton in 2022 at the farm "Angor Sardorbek Daler" in Angor district**

| № | Indicators | Unit of measurement | Application | |
|---|---|---|---|---|
| | | | mineral fertilizer | liquid fertilizer |
| 1 | Cotton field | hectare | 11 | |
| 2 | Productivity | c/ hectare | 38,6 | 43,1 |
| 3 | Gross profit | C | 424,6 | 474,1 |
| 4 | Mineral fertilizer (in physical form) | kg/ hectare | 530 | x |
| | nitrogen | kg/ hectare | 425 | x |
| | phosphorus | kg/ hectare | 105 | x |
| | potassium | kg/ hectare | - | x |
| 5 | Ento NPK liquid fertilizer | l/hectare | x | 5 |
| 6 | Average cotton yield obtained in addition to mineral fertilizer | c/hectare | 8,75 | 4,5 |
| | | | 13,25 | |
| 7 | Additional total cotton yield accounted for by fertilizer | c | 96,3 | 49,5 |
| | | | 145,8 | |

According to the analysis of the effective use of mineral fertilizers in cotton production at the Angor Sardorbek Daler farm, the average cotton yield obtained additionally due to mineral fertilizers on an 11-hectare cotton field was 8.75 c/ha, while the cotton yield was 38.6 c/ha. In addition to mineral fertilizers, Ento NPK liquid NPK fertilizer was used as a suspension, achieving an additional yield of 4.5 c/ha. As a result, the total cotton yield was 43.1 c/ha per hectare.

Ento NPK liquid fertilizer is a fertilizer containing nitrogen, phosphorus, and potassium (total nitrogen 7%, urea nitrogen 2.9%, nitrate nitrogen 2.1%, ammonium nitrogen 2.0%, total phosphorus 5%, total potassium 8%). This type of fertilizer provides essential nutrients for crop growth, ensures healthy and good crop

development, increases soil fertility while preserving the beneficial properties of the soil, and at the same time allows for high yields.

In the current era, when attention is paid to the innovative development of agriculture and the use of modern intensive technologies and methods suitable for the products of each of its branches, the analysis shows that the changes occurring as a result of imbalances between the demand and supply of mineral fertilizers require a fundamental improvement of the system of using mineral fertilizers in agriculture.

In this regard, the agrochemical service system is one of the urgent issues that requires serious attention, as today's agricultural production is not up to the required level, and the provision of agrochemical services to agriculture, that is, mineral fertilizers, is not effective.

Of course, this can be done by moving agriculture and, accordingly, its service enterprises to the path of innovative development. Without government support, it is difficult for one, or even a few, farms or service enterprises to carry out these processes. Because:

-farms and service providers currently do not have the opportunity to participate in commissioning research and innovative ideas or in financing research;

- economic entities themselves cannot conduct research and finance research in the development of advanced innovative technologies;

- agricultural producers and service providers lack the knowledge to use new innovative technologies, and they are forced to use the services of scientists and specialists;

- the low importance of implementing innovative technologies, the fact that agriculture belongs to a low-income sector is also caused by the characteristics of capital circulation in the sector.

The main reason for this is the seasonal nature of agricultural production, the long growing season, and the limited duration of the production period, which is limited to one or two harvests per year.

However, we all know that, like other industries, it is profitable due to the rapid turnover of financial funds. This situation sharply limits the possibilities of attracting investments and applying innovative technologies due to the seasonality of the production process in agriculture.

Also, today, insufficient guarantee of the right to use land, lack of clear land allocation mechanisms, and other reasons are evident as factors preventing the rational use of land and natural resources, environmental protection, and increasing the volume of export of agricultural products.

In particular, agricultural land owned by farms is used inefficiently in terms of maintaining and increasing soil fertility. Soil fertility is constantly decreasing, salinization and land degradation are occurring.

The main reasons for this are:

- land ownership rights are not well protected, land can be taken away at any time. Therefore, landowners have no incentive to make long-term investments in caring for the land and increasing its productivity. As a result, land is used intensively for short-term profit;
- the indicators of the plan for the cultivation of crops on the basis of the state order force farmers to intensively use the land and reduce the possibilities of crop rotation;
- there are no transparent and rational mechanisms for selecting effective landowners and redistributing land in favor of effective landowners. Land owned by farmers has been removed from the market, the right to use it cannot be resold or pledged, and the possibilities for secondary leasing are limited.
- Land allocation and redistribution are not based on market principles, but rather on the whims of officials. The mechanisms for land allocation and redistribution are not transparent;
- significant state intervention in the agricultural production process remains, the mandatory state order system (cotton-grain) still exists in practice, farmers' land use rights are limited and insufficiently protected.
- this leads to many negative consequences and casts doubt on the prospects for implementing agrarian reforms;
-agricultural clusters are widely used, although the legislation does not define clusters as a form of land use.

At the same time, the state has delegated the authority to force farmers to grow crops on the basis of state orders, namely to clusters, and at the same time, coercion can be applied not only to cotton and grain, but also to other crops (fruits and vegetables). In addition, in some cases, by introducing stronger agrotechnologies than before, clusters are highly limiting the freedom of activity of the farmers attached to them;

- the land of the farmers attached to the clusters is not considered the property of the clusters and is not considered by them as a valuable asset. Therefore, they have no incentive to make long-term investments to maintain or improve the productivity and quality of the land. Nevertheless, they are interested in maximizing the use of this land;
-emphasis on increasing production volume encourages agricultural clusters to increase productivity by excessive use of chemical fertilizers and pest control agents without regard to soil conditions and crop rotation practices. Uncontrolled use of

chemicals and pesticides deprives the soil and beneficial microorganisms of their natural habitat. In addition, the water used for irrigation and soil washing is being polluted;

- the use of biological fertilizers does not give adequate short-term results, and the demand for them is decreasing. The fact that the number of biological laboratories in the republic, which was more than 1000, decreased to 600 during the activity of the clusters indicates that the demand for them has decreased;

-degradation and pollution of the soil, water pollution is occurring not only directly in the fields of cotton and grain cultivation, but also in all other irrigated lands. The soil is losing important trace elements: mobile phosphorus (93 percent below the norm), exchangeable potassium (68.3 percent below the norm), humus (70.3 percent below the norm);

- mineral fertilizers are hardly used based on agrochemical map. As a result:

- the amount of mineral fertilizers used is higher or lower than the established scientifically based standards;

- the maximum permissible residue limit (MPC) of nitrates in agricultural products is high;

-export barriers arise, as products with high MPC are not accepted in many countries.

It is clear that restoring soil quality, creating new plant varieties, restoring biodiversity and traditional agricultural varieties of fruits and vegetables, rational use of natural resources such as land and water, and the correct use of agricultural technology and biological fertilizers require knowledge, investments, changes in land use culture, and a careful attitude towards the land from land users. This will be possible only if the farmers have achieved economic independence and have solid guarantees of the right to use the land.

Increasing ownership of land by farmers allows them to produce exportable and quality products and use mineral fertilizers based on innovative technologies. At the same time, the participation of enterprises directly providing services in the application of mineral fertilizers in the agricultural production process requires constant financial support and encouragement from the state in the formation of a modern material and technical base, the introduction of scientific and technical achievements and advanced innovative technologies.

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