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WAYS TO USE RESOURCES RATIONALLY IN AGRICULTURE

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Abstract:
This article analyzes the essence of agriculture in sustainable economic development and the main aspects of rational use of resources in it, considers its main types. Also, the specific features of modern technologies in agriculture are studied. At the end of the work, conclusions and recommendations on the topic are formulated.

Keywords: Agriculture, resource efficiency, energy efficiency, food security, farming, water conservation, sustainable development, modern technologies.

INTRODUCTION

In the context of rapid global population growth and climate change, agriculture faces two important challenges: ensuring food security for the population and conserving limited natural resources. According to data for 2024, global surface temperatures have increased by 1.55°C compared to pre-industrial times, making it the warmest year in 175 years of observation [1]. Such climate changes are leading to water scarcity, soil degradation, and reduced agricultural productivity. Currently, water used in agriculture accounts for about 70 percent of total water resources. By 2030, half of the world's population may experience severe water shortages, so the efficient use of water resources is of global importance [2]. The rational use of resources in agriculture not only increases economic efficiency, but also serves to protect the environment and ensure sustainable development for future generations.

It is known that the agricultural sector is one of the important sectors of the economy, playing a key role in ensuring food security of the population and increasing export potential. The rational use of resources is an urgent issue not only for economic efficiency, but also for environmental sustainability. Therefore, the relevance of the topic is manifested as one of the priority areas of the agrarian policy of our country.

MATERIALS AND METHODS

The study was conducted based on the latest scientific articles, reports of international organizations, and statistical data on ways to rationally use resources in agriculture. The research is based on the methodology of secondary data analysis.

RESULTS OF STUDIES

According to the Food and Agriculture Organization of the United Nations (FAO), sustainable agriculture should meet the needs of present and future generations, while ensuring profitability, environmental health, and social and economic justice [3]. A sustainable agricultural system is based on four key principles: economic viability, social responsibility, environmental sustainability, and technological innovation.

The Food and Agriculture Organization of the United Nations' Sustainable Food Production Framework states that everyone should have access to nutritious food and that natural resource management should ensure that ecosystem services are maintained. This approach should take into account the views of farmers, pastoralists, fishers and other rural people.

The UN Water Data Report 2024 notes that water use efficiency in agriculture has increased by 40 percent since 2015 [4]. This increase has been driven by increases in gross value added in the sectors or by reductions in water use in sectors across regions and countries.

ANALYSIS AND RESULTS

The main goal of agrarian policy in Uzbekistan is to modernize agriculture, ensure food security, and produce products that are competitive in international markets. A number of priority tasks for the development of the agricultural sector in our country are being implemented step by step. In particular, in accordance with the Government Resolution "On measures to develop the agro-industrial complex and digitalization system in agriculture of the Republic of Uzbekistan", a strategy for the development of "Smart Agriculture" technologies has been adopted. Its main areas are the introduction of digital and geoinformation technologies in the use of agricultural land; the management and use of water resources through the application of modern computer technologies; the introduction of automated management technologies in the organization of intensive gardens and the cultivation of horticultural products; the introduction of automated, computerized intellectual technologies in greenhouse farms; the introduction of modern technologies in the processes of storage and processing of agricultural products [5].

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The Resolution of the President of the Republic of Uzbekistan "On Approval of the Strategy for the Development of Artificial Intelligence Technologies until 2030" also indicates several key tasks for the development of the agro-industrial complex [6]. According to it:

- development of technologies for monitoring the state of soil and agricultural crops based on remote sensing of the earth, as well as the operation of agricultural machinery, including combines, based on global positioning systems;
- increasing the productivity of agricultural crops, facilitating decision-making in the field based on artificial intelligence;
- creating the possibility of online monitoring of the growth, (reproduction) and volume of agricultural crops and livestock, poultry, fish and other plant and animal species;
- it is planned to carry out work such as determining the amount of water in the ground, the volume of crops, and using artificial intelligence to provide recommendations on saving water resources and mineral fertilizers.

Agriculture 4.0 is the application of the technologies of the fourth industrial revolution to the agricultural sector. This includes IoT (Internet of Things), big data, artificial intelligence, cloud technologies, and blockchain. Digitalization helps farms to use resources more efficiently, increase productivity, and ensure economic efficiency [7].

Smart agriculture includes the following technologies:

• GPS (Global Positioning System) and automatic control systems;
• Sensor technologies and IoT (Internet Of Things) devices;
• Satellite monitoring and drones;
• Data analytics and artificial intelligence;
• Robotic machinery and equipment.

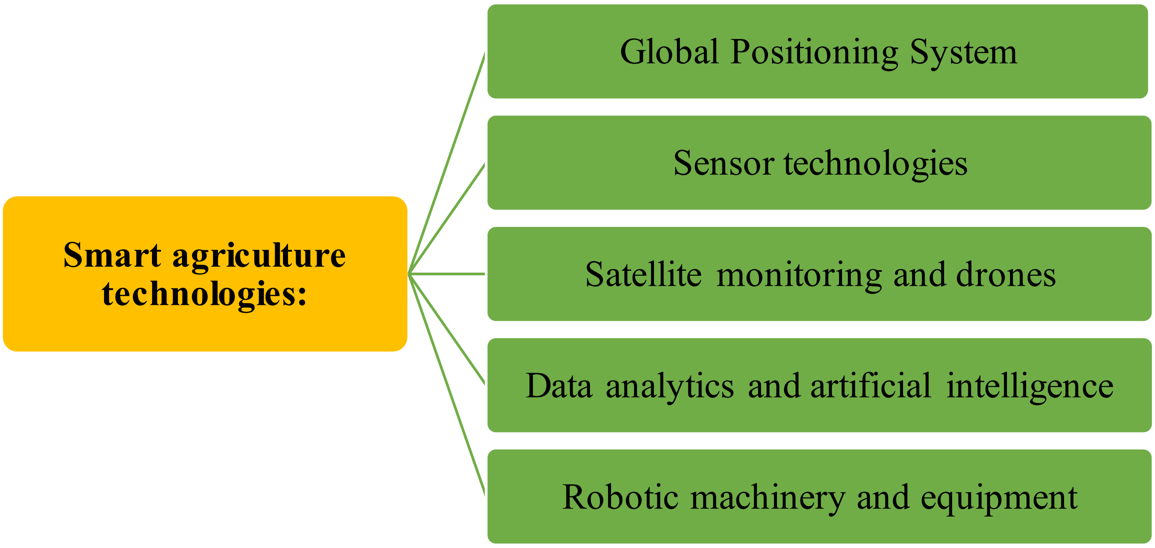

Figure 1. Smart agriculture technologies

Research from 2024 shows that farming systems are integrating drones, artificial intelligence, GPS (Global Positioning System), and satellites. These technologies allow for monitoring plant health, optimizing resource use, and managing environmental conditions.

The most important areas of resource efficiency are related to land, water, labor, and technology. For example, drip irrigation systems can reduce water consumption by 30–50 percent. Agrotechnical measures can also increase yields by 20–30 percent. Today, innovative technologies such as organic farming, genetically modified varieties, artificial intelligence, and the use of drones are being implemented. They allow not only to increase productivity, but also to save resources [8].

Diversification of cropping systems, crop rotation, land reclamation and anti-erosion measures are important in the rational use of land resources. Water resources are the most consumed resource in agriculture in our country, and their conservation and reuse are necessary for both the economy and the environment. Through land reclamation, the efficiency of saline lands is being restored and productivity is increasing [9].

In addition, it is necessary to adhere to hygiene rules, improve storage and packaging technologies to ensure food safety. Investments in agriculture by the World

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Bank and international organizations are helping to introduce modern equipment and technologies to the sector.

Recent analyses have shown that modern irrigation technologies have significantly reduced water consumption:

- drip irrigation systems have saved 30-50% water, increased productivity by 15-25%, and increased the efficiency of mineral fertilizers by 40% [10];
- sprinkler irrigation has saved 15-25% water, reduced surface irrigation by 85-95%, and reduced labor costs by 30%;
- subsurface drip irrigation has saved 40-60% water, minimizing evaporation losses [11].

According to the United Nations' annual report on world water resources development, water efficiency in agriculture increased by 40% between 2015 and 2024. Regional results varied, with developed countries seeing a 45-50% improvement, developing countries seeing a 25-35% increase, and Africa seeing a 20-25% change.

The effectiveness of the technologies during the analyzed period was as follows:

- Seed sowing accuracy through GPS (Global Positioning System) and automatic control was 98-99 percent, fuel savings were 15-20 percent, and rework was reduced by 10-15 percent;
- Field monitoring speed through drones and satellites was 100 hectares/hour, early detection of diseases and pests was improved by 35 percent, fertilizers and pesticides were saved by 20-30 percent;
- Real-time soil moisture status was continuously monitored through IoT (Internet Of Things) sensors, water consumption was optimized by 25-40 percent, and productivity increased by 15-30 percent [11];
- With the help of artificial intelligence and data analysis, the accuracy of crop forecasts is 85-95 percent, decision-making is 10 times faster, and resources are optimally coordinated.

Regenerative agriculture is a method of preserving and rehabilitating food and farming systems that focuses on restoring topsoil, increasing biodiversity, improving water cycles, enhancing ecosystem services, increasing resilience to climate change, and strengthening the health and vitality of agricultural soils.

According to 2025 data, the regenerative agriculture approach is yielding the following results [12]:

- soil regeneration indicators: organic matter content increased by 2-4 percent in 5 years, soil microorganisms were activated by 50-70 percent, soil water retention capacity increased by 25-35 percent, and erosion resistance was significantly improved.
- environmental benefits: biodiversity increased by 40-60 percent, pesticide consumption decreased by 50-70 percent.

Energy efficiency during the period under review was as follows:

- Use of solar and wind energy in agriculture: electricity saved by 40-70 percent, CO_2 emissions reduced by 30-50 percent; high long-term economic efficiency achieved;
- Energy-efficient equipment: modern tractors save 20-30 percent fuel;
- LED (Light Emitting Diode) lighting: saves 60-80 percent energy;
- Greenhouse climate control: saves 25-40 percent energy.

A number of economic and environmental benefits are being achieved through the rational use of resources in agriculture. However, there are also a number of problems related to this area. The main problems include the following:

1. High initial costs due to the high cost of modern technologies.
2. There is a shortage of personnel due to the lack of qualified specialists.
3. There is a risk of cyber threats to data security.
4. Significant differences occur due to the uneven development of technological regions.
5. Lack of capital among small farmers limits their financial capabilities.

The following can be recommended as solutions to existing problems in the rational use of resources in agriculture:

1. State support: it is necessary to encourage the efficient use of agricultural resources through the use of subsidies and preferential loans, grants for innovations, and tax incentives.
2. Education and training: it is possible to inform many people about industry news through organizing trainings and seminars, creating exhibition areas, and distance learning platforms.
3. Cooperation and partnership: cooperation through the joint purchase of technologies, experience exchange platforms, and assistance in uniting farmers will have a significant impact on increasing resource efficiency.
4. Phased implementation: starting with small projects, expanding successful experiences, minimizing risks and increasing efficiency.

CONCLUSION AND SUGGESTIONS

In general, the rational use of resources in agriculture is a key factor in ensuring global economic stability, strengthening food security and maintaining ecological balance. The study has drawn the following main conclusions:

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1. Analysis of the effective use of water resources shows that over the past decade, the efficiency of water consumption in agriculture has increased by 40 percent. Modern irrigation technologies (drip irrigation, sprinkler irrigation) have allowed for 30-60 percent water savings and increased productivity by 15-25 percent.
2. The smart agriculture market was worth $14.40 billion in 2024 and is expected to grow to $23.38 billion by 2029 (at a CAGR of 10.2%). With the help of GPS, drones, IoT sensors, and artificial intelligence, fertilizer and pesticide use has been reduced by 20-30 percent, while yields have increased by 15-30 percent.
3. The regenerative agriculture approach increases soil organic matter by 2-4 percent in 5 years, improves soil water retention by 25-35 percent, and helps absorb 0.5-1 ton/hectare of CO_2 per year.
4. Using renewable energy sources (solar, wind) can reduce electricity consumption by 40-70 percent. Modern energy-efficient equipment reduces fuel costs by 20-30 percent.
5. Investments in modern technologies pay for themselves within 3-5 years. Operating costs are reduced by 20-35 percent, and annual income increases by 15-25 percent. Return on investment (ROI) is 25-40 percent.

The following proposals can be put forward for the rational use of resources in agriculture:
- widespread introduction of innovative technologies in resource management;
- development of state programs aimed at encouraging resource-saving technologies;
- creation of a system of subsidies and preferential loans for the introduction of modern technologies;
- introduction of mechanisms to support environmentally friendly farming;
- modernization of a modern irrigation network;
- improvement of Internet and communication services in rural areas.

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