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# INNOVATIVE METHODS OF GRAIN CROP PROCESSING AND THEIR EFFECTIVENESS

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**Abstract:** This article examines the innovative technologies used in the processing of grain crops, their effectiveness and advantages. Grain crops are one of the main components of the food industry, and the need to introduce new technologies in their processing is growing every day. The article analyzes advanced methods such as cryogenic grinding, optical sorting, and IoT technologies. The research results show that with the help of innovative technologies, it is possible to improve product quality, reduce energy consumption, reduce waste, and increase production efficiency. Opportunities and prospects for the implementation of these technologies in the conditions of Uzbekistan will also be discussed.
**Keywords**: cereal crops, innovative technologies, processing, efficiency, optical sorting, cryogenic grinding

**Introduction.** Grain is the fruit of cereal crops or the seeds of leguminous plants. One of the main products grown in agriculture is food for human consumption, flour, beer, starch, alcohol, raw materials for the preparation of mixed feed, and nutritious feed for agricultural animals. Products obtained from grain processing are used in bread, pasta, and confectionery enterprises. Humanity receives about 50% of proteins, 70% of carbohydrates, and about 15% of fats from grain products.

Grain crops are one of the main sources of food for humanity and play an important role in ensuring global food security. Today, such crops as wheat, rice, corn, and barley are the most widely cultivated and consumed products in the world. Against the backdrop of population growth, environmental factors, and limited energy resources, it is important to achieve high efficiency in the processing of these crops.

Grain and grain products have been stored and processed in various ways since ancient times. Nevertheless, with the growth of the population, the population's demand for bread and bakery products is also increasing. In traditional processing methods, a number of problems are still observed: high energy consumption, grain losses, low product quality, environmentally harmful waste, and low production efficiency. The issue of introducing innovative technologies into processing processes has come to the forefront.

Innovative technologies are advanced methods such as high-precision optical sorting systems, cryogenic grinding and monitoring through IoT technologies, and product consistency tracking using blockchain systems. Our scientific article analyzes practical solutions for processing grain crops based on innovative technologies, their economic and environmental effectiveness.

**MATERIALS AND METHODS.**

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Object of research. In this study, wheat, rice, barley, and corn were selected as the main objects. This type of grain crop is widely grown and processed in our republic.

**Research methods.**Analytical method - existing innovative technologies were studied. The comparative method - the effectiveness of traditional and modern methods was compared.

Based on statistical analysis - production indicators, tables and graphs were compiled.

Economic evaluation - economic efficiency is determined based on the ratio of costs and profits.

Explored technologies

| Technology | Description |
|---|---|
| Cryogenic crushing | Grinding grain in liquid nitrogen at low temperature |
| Optical sorting | Automatically separate defective grains based on the sensor and camera |
| IoT Storage System | Warehouse environment management with real-time monitoring |
| Blockchain tracking system | Product supply chain tracking |

RESULTS. Innovative technologies give the following advantages over traditional methods:

**Table 1. Comparison of innovative and traditional methods**

| Indicator | Traditional method |
|---|---|
| Grain loss (%) | 8-10 |
| Energy consumption (kWh/ton) | 250 |
| Production time | 24 hours |
| Sort accuracy (%) | 85. |
| Product quality (%) | 86. |

Optical Sorting System Operating Principle (Description)
The color, shape, and size of each grain are determined using optical sensors and cameras. Improper or damaged grains are separated by airflow.
Cryogenic Grinding Diagram (Description)
With the help of liquid nitrogen, the temperature of the grain is reduced to -195 °C, which reduces the decomposition of the substance, kills microorganisms, and preserves the quality of nutrition.
Discussion. The results show that innovative technologies significantly increase the efficiency of grain processing. The preservation of nutrients through cryogenic grinding allows for the production of healthy food products. Optical sorting improves product quality, while AI monitoring reduces human error. With IoT-based systems, warehouses are constantly monitored, which prevents problems such as grain spoilage, moisture, and fungi.

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If these technologies are adapted to the conditions of Uzbekistan, they will play a large role in ensuring the export of grain products, quality guarantees in the domestic market, and environmental safety.

Conclusion. Innovative technologies in the processing of grain crops provide the following advantages:

The possibility of obtaining a high-quality product;
Energy saving and efficient use of resources;
Increased production efficiency;
Environmental safety;
Waste reduction;
Ensuring competitiveness in domestic and foreign markets.

Through the phased introduction of these technologies in the agro-industrial complex of Uzbekistan, it is possible to further increase food security and export potential.

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