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Organic Agriculture Logistics Concept and Organizational-Economic Foundations of Using Technological Paradigms

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Abstract: The article develops the main features of logistics in organic agriculture, and the priority areas of optimizing the management of material, financial, information and service flows and reducing costs based on the implementation of the logistics concept in the organic sector are theoretically and scientifically substantiated. Also, the organizational and economic foundations of the use of technological paradigms in organic agriculture are highlighted

Keywords: Concept, organic agriculture, traditional agriculture, flow management, costs, optimization, technological paradigm, economic efficiency.

1. Introduction

At the current stage of economic development, with the growing economic ties between enterprises in the agricultural sector, the need to introduce logistics in managing commodity and material flows arises. The logistics concept is a system of views aimed at improving the economic activity of an enterprise or group of enterprises through optimizing the management of material, financial, information, and service flows. The logistics approach manages material, information, financial, and service flows, which helps reduce production and sales costs and increase the competitiveness of enterprises. The President of the Republic of Uzbekistan Sh.M. Mirziyoyev stated: "...the factor that gives the fastest results in reducing poverty and increasing the income of the rural population is the sharp increase in productivity and efficiency in agriculture. ...we must widely introduce light technologies, water-saving and biotechnologies, achievements in seed production, science, and innovation into agriculture" [1].

The insufficient development of logistics infrastructure in the country's regions and the imperfection of managing the organic agriculture sector cause serious damage to the economy and the population, reducing the competitiveness of agricultural products. Logistics in organic agriculture optimizes resource and product flows, ensures timely delivery of equipment and raw materials, efficient inventory management (from seeds to finished products), reduces losses and costs, and improves customer service, which is crucial for increasing product quality and adhering to organic production principles.

Research Methods. The study used methods such as logical reasoning, analysis and synthesis, grouping, expert evaluation, and monographic observation.

Degree of Topic Study. D.V. Stankevich believes that "logistics in organic agriculture is a symbiosis of ecological principles, technological innovations, and social responsibility"

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[2]. D.Y. Murev notes that “the logistics ecosystem, as a special type of logistics system, is formed on the basis of digital platforms connecting information flows between logistics market participants and all stakeholders in the supply chain” [3]. S.A. Gusev, D.A. Krasnikova, and V.V. Lozovaya emphasize that “...one of the main factors in organizing production and applying logistics approaches is achieving the benefits of using the logistics concept, and flexible production is the ability to change machine settings from hours to minutes” [4]. V.L.

Furthermore, the global transition toward Industry 4.0, digital ecosystems, smart farming, and IoT-based monitoring systems creates new opportunities for developing logistics in organic agriculture. The introduction of “smart” technologies improves the accuracy of forecasting demand, optimizes supply chains, increases traceability, and reduces production and service costs. At the same time, these technologies ensure compliance with strict organic standards, improve administrative processes, and support the certification requirements of organic products.

Therefore, studying logistics processes in organic agriculture and developing an integrated organizational-economic framework for using technological paradigms is of scientific and practical importance. It contributes to ensuring sustainable development of agriculture, increasing the competitiveness of organic products, and strengthening the economic resilience of rural regions.

2. Materials and Methods

Yeroxin in his research states that “various approaches are used to increase the efficiency and productivity of the agro-industrial complex, most of which lead to negative environmental consequences. The government is taking measures to reduce the negative impact of agricultural intensification on the environment and quality of life. The development of logistics infrastructure plays an important role in this process”.

Based on the above, it is appropriate to note that implementing logistics approaches in organic agriculture ensures the optimization of managing material, financial, information, and service flows and reducing costs in the phases of production, distribution, exchange, and consumption of products.

3. Results

Currently, the rural population does not have the opportunity to transport small volumes of raw materials and semi-finished products on a large scale or access trade and processing markets. There is a gap between producers and consumers, which naturally leads to a decrease in motivation for targeted activities in modern farms, a reduction in livestock herds and crop areas, or their complete disappearance [5].

Solutions to this problem can be achieved by increasing the economic literacy of the population, explaining the feasibility of managing agricultural enterprises and creating production and consumer cooperatives, developing an innovative model for supply chains tailored to each specific situation in the agro-industrial complex, considering the distance of the settlement from points of sale and processing of agricultural raw materials, the availability of transport, natural conditions, and the feasibility of producing or growing certain crops, plant varieties, or animal species.

Organic agriculture differs from traditional agriculture in several characteristics. It prohibits the use of synthetic substances, requires special technologies for soil treatment to prevent pollution, and demands strict procedures for transporting and storing products. It also adheres to resource circulation principles, uses bio-waste as fertilizer, and complicates supply chain planning. Therefore, organic production is regulated by strict rules that create specific logistics requirements. Every stage of the supply chain (from farmer to retail shelf) must be documented, increasing administrative burden [6]. These factors make organic product logistics 20-30% more expensive than traditional product logistics [7].



Figure 1. Structure of Logistics Costs (as % of sales volume)

The main goal of agrologistics is to deliver products in the required quantity and quality, on time, with minimal costs in production, sales, after-sales services, as well as in transporting, receiving, processing, and transmitting information.

The organizational aspects of managing logistics processes in organic agriculture are presented in Table 1.

Table 1. Management of Logistics Processes in Organic Agriculture

No	Logistics process	Logistical purpose	Logistical task
1	Inventory management:	Purchase optimization: Save: Excess Minimize reserves : Route planning:	Organizing timely procurement of high-quality organic seeds, fertilizers and plant protection products, etc. Creating optimal storage conditions for organic products to prevent deterioration of quality and contamination . Avoid large inventories that could be damaged or lead to loss. Optimization of delivery routes for equipment, raw materials and finished products.
2	Transport logistics	On-time delivery: Specialized transport: Coordination of operations	Ensuring the prompt and timely delivery of raw materials and equipment to the workplace and products to the consumer, especially during seasonal periods. Use of refrigerated transport for perishable organic products. Linking field work with transportation and warehouse operations.
3	Information logistics:	Supply chain transparency: Information management:	Tracking the movement of products from the field to the end consumer. Efficiently organize requirements, resource availability, and order fulfillment processes
4	Production process management	Coordination of work: Preventing downtime:	Integrating logistics operations with agricultural cycles. Eliminate equipment downtime through timely delivery of components and resources.
5	Customer service	Quality Assurance:	Ensuring that products reach consumers in good quality (correct) condition

Meeting the demand: Delivering orders to customers quickly and on time.

Key features of the organic sector: In organic agriculture, logistics must maintain product integrity and quality, prevent contamination, and respond quickly to changes in demand, which directly affects consumer confidence and business success.

Achieving logistics goals, according to their importance, requires solving three groups of tasks: global, general, and local:

Global tasks: logistics modeling of agricultural enterprise systems, developing conditions for the reliability of bringing goods to and from the enterprise, selling finished products for the organization, ensuring supply chain design [8].

General tasks: developing a system for accounting logistics costs, coordinating the activities of agricultural enterprise divisions or processing industry enterprises, and developing a logistics development strategy for the enterprise.

Local tasks: selecting a logistics or commercial intermediary in forming the logistics chain, determining the optimal number of serviced warehouses in the region, choosing a location for a retail outlet or warehouse, and selecting the type of transport vehicle.

Table 2. Main Aspects of Logistics in Organic Agriculture

Supply chain management	Transparency and tracking : Blockchain and RFID technologies working of release every one stage record to reach help gives , this and organic status confirmation for very important [8]. Small farmer farms Cooperation : Farmers to cooperatives combine logistics expenses reduces and to the markets to enter improves .
Transportation	Minimize carbon footprint by optimizing routes and using electric vehicles (e-mobility) . Separate transportation of inorganic products to avoid mixing with them .
Storage and processing	Specialized warehouses with temperature and humidity control. Separate storage areas for organic and inorganic products.
Certification and documentation	Automate data collection for audits (e.g. IoT-based platforms). Training farmers on standard requirements.
Digital technologies	Using Big Data to forecast demand and manage inventory .

Optimizing supply chains in organic agriculture can be achieved through network localization and the introduction of “smart agriculture technologies.”

The technological paradigm emerged in the 1960s based on technologies related to the development of information and computers. The theoretical foundation of this paradigm is a systemic approach.

“Smart” agriculture technologies are based on the “Internet of Things” (IoT) – a system of various “smart devices” that automate management and control processes and minimize human involvement through mutual influence and data exchange between various devices and machines. Areas of applying IoT technologies in organic agriculture include: smart farming; smart farms; smart greenhouses; raw material management; storage of agricultural products; management of agricultural transport; “Big Data,” and others [9].

The use of information technologies has enabled the automation of logistics functions and operations, as well as the collection and processing of information.

As a practical example of using the technological paradigm, the MRP (Manufacturing Resource Planning) system is used for internal company planning, inventory management, and purchasing material resources. After it became clear that an analytical approach could

not solve all problems in the distribution of goods, businesses and economic systems transitioned to automating business processes to introduce precision.

Reducing the distance between organic producers and consumers lowers the carbon footprint. For example, in Germany, 60% of organic products are sold through regional cooperatives [10]. The technology applied by IBM Food Trust enables tracking of each product. In Costa Rica, the AgroChain system automates the auditing of organic bananas, reducing inspection time by 40%. In the Netherlands, Greendish introduced electric trucks with solar panels for vegetable delivery, reducing CO₂ emissions by 35%. In Sweden, a combination of rail and road transport reduces dependence on fossil fuels. In the storage and processing sector, smart warehouse technologies are actively introduced: IoT sensors monitor temperature, humidity, and CO₂ levels, preventing product spoilage [11].

According to the Japanese Ministry of Agriculture, the number of farmers in the country decreased by 56% to 1.82 million people, with their average age increasing from 59 to 67 years during the same period, as rural youth prefer to work in cities with higher wages. To address this issue, the Japanese Ministry of Agriculture adopted a “smart” agriculture policy in 2014, aimed at developing robotics and information technologies to increase farm productivity. For example, Kubota developed autonomous tractors and spraying drones costing nearly 11 million yen, and Seven-Eleven opened its first automated farm. The “smart” agriculture market in Japan grew by 14% to 14.7 billion yen and is expected to nearly double to 33.5 billion yen in the next five years [12]. In Japan, the Smart Agri Storage system reduced organic rice losses by 15%. In recent years, biodegradable packaging has become a modern trend. Ecovative uses mushroom mycelium to create packaging that decomposes in 30 days, aligning with circular economy principles. Digital audit platforms are used in certification and regulatory systems. The EcoCert Mobile app allows farmers to upload crop and processing data in real time, accelerating the certification process.

In several countries, government subsidies are allocated for the application of digital technologies; for example, in India, attention is focused on increasing farmers' knowledge, particularly through the introduction of Agri Value Added Services mobile applications that provide information on weather, product prices, the best technologies for growing crops, and other matters. In India, the Paramparagat Krishi Vikas Yojana program covers 50% of the certification costs for small farmers [13]. The Israeli government supports the country's agriculture, providing subsidies of up to 40% of the costs for farmers to purchase and implement new technologies. The Republic of Korea has unique experience in innovative agricultural development, which can be useful for developing countries in ensuring food security and forming an innovative agrarian system. In Taiwan, an Internet portal was created to provide urban private buyers and wholesale buyers, as well as processors, with access to purchasing new organic products [14]. In the European Union, the ECOCERES electronic certification system ensures quick confirmation of compliance with standards, while in the United States, Organic Valley uses blockchain to track dairy products from farm to store.

When implementing logistics principles in organic agriculture, companies face economic and social challenges such as high production costs and unequal market access. Organic product logistics requires investments in specialized infrastructure.

Building biodegradable packaging lines is significantly more expensive than traditional ones. One solution to this problem is public-private partnerships. For example, in Canada, the Organic Cluster program funds research on logistics innovations. In African and Asian countries, small farmers often struggle to obtain expensive certifications. Specialized platforms enable them to access international markets through collective certification [15].

The opportunities for using logistics tools in organic agriculture are extensive. Machine learning algorithms can analyze data on weather, soil conditions, and demand to optimize delivery routes and production volumes. In many countries, farms use autonomous drones to monitor crop ripening and plan harvesting times.

Currently, special attention is paid to producing alternative fuel vehicles that can be used for transporting organic products. The synthesis of logistics and organic agriculture creates a foundation for reducing waste, using renewable resources, and minimizing harmful emissions to promote responsible consumption, all of which align with sustainable development goals. Logistics in organic agriculture is a symbiosis of ecological principles, technological innovations, and social responsibility.

Despite high costs, the introduction of digital platforms, green transport, and localized supply chains expands the capacity of organic production. Inclusive and sustainable systems created through cooperation between the state, business entities, and the scientific community serve as the key factor for success.

4. Conclusion

Today, in our country, priority is given to ensuring economic efficiency in production and service sectors based on the application of the logistics concept and digital technologies. In this regard, a number of decrees and resolutions of the President have been adopted. Sector specialists predict that due to logistics systems and digital transformations in agriculture, by 2030, the sector's total income will increase by nearly 60%, and food security will be achieved in the country.

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