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SMART SOLUTIONS FOR SMALLHOLDER DAIRY FARMS: A MODEL FOR KARAKALPAKSTAN

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Abstract:
This article examines the relevance of smart solutions for smallholder dairy farms in Karakalpakstan. With many producers facing limited resources and poor market access, technologies such as mobile apps, portable cooling units, and digital monitoring systems offer practical tools for improving productivity and quality. The article emphasizes the need for integrated approaches to ensure sustainable development in the region's dairy sector.

Keywords: Karakalpakstan, smallholder dairy farms, smart agriculture, milk production, innovation, digital solutions, portable cooling systems, livestock monitoring, rural development

Milk and dairy products are one of the most important sources of nutrients for the human body, they contain an abundance of proteins, calcium, phosphorus, vitamins and minerals. These substances play a decisive role in the proper growth of the body of children and young people, the strengthening of bone structure, the active functioning of the immune system and the maintenance of general health. Also, for older populations, regular consumption of dairy products is important in the Prevention of cardiovascular disease, osteoporosis and many other diseases. It follows that increasing the volume of milk production in the country, improving its quality and providing the population with affordable, natural products in sufficient quantities is one of the priorities not only in economic, but also in terms of social and health.

In the Republic of Karakalpakstan, agriculture occupies an important place in the socio-economic development of the population, including the dairy sector, which is strategically important as a source of food supply, employment and income of the population. The process of milk production in the area largely corresponds to the contribution of peasant personal subsidiary farms. This is also confirmed by the fact

that almost 92% of the total volume of milk produced in 2024 corresponds precisely to the contribution of these farms (Fig-1). These farms operate on a small scale, usually relying on family labor and being oriented towards meeting the local market need.

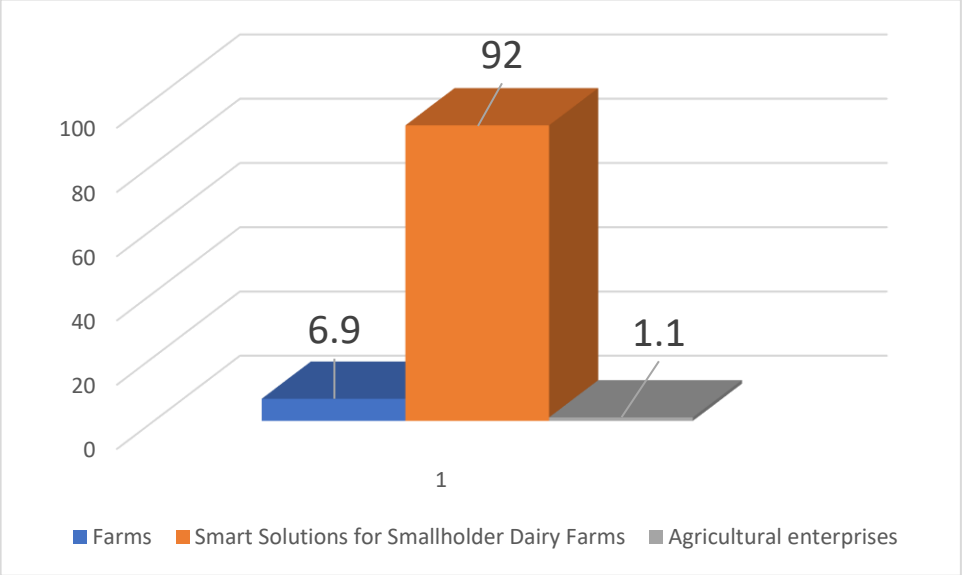

Figure -1. Distribution of milk production by agricultural enterprise

At the same time, the fact that these farms are not adequately equipped technologically, lack of modern production and management systems, limited market opportunities, low logistics and cooling infrastructure, and high levels of dependence on financial resources negatively affect their efficiency. In such conditions, the volume of dairy products is limited, and maintaining quality becomes a complex task. Therefore, in Karakalpakstan, the introduction of innovative approaches to improving the efficiency of small farms — namely, digitalization, automation, touch monitoring, co-operationalization and the use of digital platforms- is gaining relevance. These solutions not only optimize production, but also make it possible to ensure marketability, improve product quality and competitiveness, while stabilizing the income of farmers and farmers [1].

For the effective and sustainable development of the dairy sector, it is necessary to switch from traditional methods of work to modern, technological solutions. Today's farmers and farmers should have opportunities such as automated systems, digital management, data analysis and efficient use of infrastructure to grow a competitive,

quality and high-yield product. Especially in the conditions of small farms, inexpensive, easy-to-use and modular smart solutions are the most optimal way to develop them technologically. The following will consider the main directions of these solutions.

The main directions of Smart solutions

1. Automated milk shopping systems. Convenient and inexpensive automated shopping equipment designed for small farms will relieve labor and improve the quality of milk.
2. Touch control and health monitoring. Early diagnostics are provided by sensors to monitor the movement, feed consumption and health of livestock.
3. Digital management platforms. It facilitates monitoring of milk yield, feed balance and veterinary services through special mobile applications for farmers.
4. Merger into cooperatives. In order for small farms to be competitive in the market, it is necessary to combine them in a cooperative system and use infrastructure together.

The relatively large number of small farms and farmers in the Republic of Karakalpakstan, the natural and regulatory limitations of land resources, as well as the presence of problems with logistics in the implementation of markets — makes the issue of the introduction of Smart solutions in the territory very relevant. The fact that the population lives mainly in rural areas, the infrastructure is not fully formed and the uncertain distribution of resources limits the independent efficient operation of smallholdings. Therefore, energy — efficient and technically simple, but effective technological solutions adapted to local conditions — especially mobile applications, portable milk cooling equipment, touch controls-are considered among the most optimal and practical solutions for them [2].

An integrated approach like this-that is, the support of the chain from production to market access with Smart technologies — increases the economic efficiency of farms, improves the quality of products and becomes one of the main factors of sustainable development. At the same time, such an approach also makes it possible to make information-based management decisions. Smart technologies ensure that small farmers are competitive in modern market conditions, bringing them from traditional working styles to technological transformation.

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