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PROSPECTS FOR IMPLEMENTING INNOVATIVE TECHNOLOGY IN ENTERPRISES WITHIN THE AGRO-INDUSTRIAL COMPLEX

Sergey Vladimirovich DOKHOLYAN[1], Rustam Alievich YALMAEV[2], Marina Viktorovna POSTNOVA[3], Ilgizya Muzyakievna DOLGOVA[3], Ramazan Abdulmuminovich NABIYEV[4]

[1]Institute of Social and Economic Researches of the Dagestan Russian Academy of Sciences Scientific Center, 75 Yaragskogo Street, Makhachkala, 367030, Russian Federation, Phone/Fax: (8722)67-58-77; E-mail: sergsvd@mail.ru
[2]Chechen State University, 17 Dudayev Blvd., 366007, Grozny, Russian Federation, Phone/Fax: 8 (871) 221-23-38; Email: r.yalmaev@chesu.ru
[3]Ulyanovsk State Agricultural Academy named after P.A. Stolypin, 1 Novy Venets Boulevard, Ulyanovsk, 432017, Russian Federation, Phone/Fax: +7 (8422) 55-95-35; E-mail: pmv@ugsha.ru, dolgovaim@mail.ru
[4]Astrakhan State Technical University, Tatishcheva Street, 16, Astrakhan, 414056, Russian Federation, Phone/Fax: (8512) 61-41-19; E-mail: nabiev56@list.ru

Corresponding author: sergsvd@mail.ru

Abstract

The ability to ensure the competitiveness of enterprises within the agro-industrial complex is largely determined by their strategic orientation toward the conduct of innovation activity. Based on the findings from a theoretical analysis, this paper cites the need for implementing innovative technology as a major factor for boosts in the competitiveness of enterprises within the agro-industrial complex. The paper employs the findings from an expert survey to provide an insight into the current state of affairs with regard to the implementation of innovative technology in the Russian agricultural sector. The authors have analyzed some of the key characteristics of innovative agricultural technology. The paper describes some of the key issues in and prospects for implementing innovative agricultural technology in the agro-industrial sector. The authors have formulated a set of proposals aimed at enhancing the implementation of technological innovation in enterprises within the agro-industrial complex.

Key words**:** *innovation, innovation activity, innovative technology, innovation policy, enterprises within the agro-industrial complex*

INTRODUCTION

Innovations may be viewed as an economic category that reflects a collection of changes to technologies, certain processes, style of management, or HR policy, as well as methods for achieving this kind of changes that facilitate the implementation of innovations [2, p.23].

Innovations in the agro-industrial complex (hereinafter 'AIC') are normally the result of dynamic interaction among numerous agents engaged in the growing, processing, packaging, distributing, and consuming or further processing of agro-industrial output. Accordingly, these agents operate in various spheres, like metrology, safety standards, molecular genetics, intellectual property, resource economics, food chemistry, logistics, etc. To enable the emergence of innovations, interaction among these groups of persons must be open and predicated on the most relevant knowledge.

The findings from a study conducted by a group of researchers [9] provide convincing proof that agricultural enterprises' innovation activity is one of the most flexible indicators of their competitiveness. With that said, it has been noted that "the close interrelationship between innovativeness and competitiveness is characterized by naturally determined cyclic dynamics. A decline in a manufacturer's innovation activity may cause it to lose some of its positions in the market,

its production apparatus to quickly become outmoded, and the business to fall into a state of investment-technological and economic recession. On the contrary, galvanizing innovation activity facilitates the technical-technological refreshment of production and helps boost economic efficiency and competitiveness" [9]. It is worth noting that a key condition for galvanizing innovation activity is the creation of innovation programs focused on coordinating organizational issues and creating and implementing innovative products.

Based on projections by the United Nations, by 2050 the size of the planet's population will have reached 9.7 billion people, which may require significant boosts in production volume within the agricultural sector. It will be impossible to maintain such growth rates via extensive measures. Objectives of this magnitude require intensifying the development of both the technological and resource factors, which can be possible only through the implementation of innovations [3].

Scholars I.S. Sandu, V.G. Savenko, and Kh.N. Gasanova have cited the following among the key areas for implementing innovations in the AIC:

(i)ensuring the development and implementation of new technology in crop farming and livestock farming;

(ii)ensuring a better focus on refreshing the sector's technical-technological potential;

(iii)ensuring the training and retraining of professionals capable of making maximally effective use of machinery, equipment, and technology [7, p.32].

With that said, it may be noted that it is implementation of innovative technology that is becoming today a dominant form of innovation activity in AIC enterprises, which may require researching it more thoroughly within the setting of the agricultural sector specifically [4, p.9].

The authors suggest construing innovative technology in the AIC as a systematized composite of knowledge, information, and technological and organizational solutions which determine the way to carry out whole new and enhanced operations in the agricultural sector dealing both with the production and sale of agricultural output and with the conduct of management in the sector.

The study's purpose is to explore the current situation with and identify some of the prospects for implementing innovative technology in the Russian agricultural sector.

The study's hypothesis is as follows: determining the current situation with, the key benefits of employing, and the potential for adapting innovative agricultural technology in Russian conditions will help formulate a set of recommendations for the agricultural sector to help drive its progressive development.

The study's results attest that its objectives have been achieved.

MATERIALS AND METHODS

To achieve the study's objectives, the authors employed the expert survey method for the purpose of gaining a thematic insight into (and identifying some of the future prospects for) the implementation of innovative technology by enterprises within the AIC.

The authors' expert survey engaged members of the management team at 23 companies operating within the AIC (75 respondents in total). These experts were asked a set of questions relating to the quantitative and qualitative characteristics of the innovative technologies implemented in their enterprises over the last five years.

The field survey aimed to estimate the number of innovative projects implemented by agricultural enterprises over the past five years, the possibilities of using and the problems of adapting modern innovative technologies in crop production, as well as the latest technical and technological solutions in animal husbandry.

When processing the survey results, the introduced innovative technologies were divided into three groups based on the category of innovation: product-related, production-related, and organizational-managerial technologies. After this, according to the specified distribution, the share of each category of innovation and technology introduced in relation to the total number of

projects was calculated based on the following formula:
specific weight = (indicator of a separate column (category of innovation, type of innovative technologies) / total number of projects) * 100.

RESULTS AND DISCUSSIONS

The findings from the authors' survey of members of the management team at a group of enterprises within the AIC provided insight into some of the quantitative characteristics of innovative technologies (subject structure of innovative technologies) implemented by AIC enterprises over the last five years (the number of projects) (Table 1).

Table 1. Thematic Breakdown of Innovation Technologies Implemented by Enterprises within the AIC

Innovation category	Varieties of innovative technology	Number of projects	Relative share in total projects, %
Product-related	Ways to grow new (enhanced and modified) plant varieties	45	7.6
	Technology for growing productive and cost-effective livestock breeds	20	3.4
	Technology for growing ecofriendly products	9	1.5
	Total for the group	74	12.5
Production-related	Soil preparation technology	58	9.8
	Industrial technology related to arable farming and livestock farming	11	1.9
	Technology related to the use of fertilizers and crop protection agents	320	53.9
	Resource-saving technology	15	2.5
	Total for the group	404	68.1
Organizational-managerial	Production cooperation and integration	45	7.6
	Technology related to maintenance support and resource provision	40	6.7
	Technology related to organizing and motivating work	25	4.2
	Innovation-consulting systems	5	0.9
	Total for the group	115	19.4
Total		**593**	**593**

Source: Compiled by the authors based on the findings from an expert survey conducted by them.

An assessment of a set of vectors for the innovation-driven development of Russia's AIC enterprises indicates that the overwhelming majority of innovative technology implementation projects carried out over the last five years are accounted for by those dealing with production technology (68.1%), among which the greatest number of projects deal with implementing new methods for and ways of utilizing fertilizers and plant protection agents (53.9% of the total number of implemented projects). Significantly fewer innovations are related to new tillage technologies (9.8%). The introduction of resource-saving technologies and industrial technologies of agriculture and livestock has a small weight (2.5% and 1.9%, respectively).
Organizational and managerial innovations are in second place with a significant lag in specific weight in the total number of projects (19.4%). Among them, the leading innovations are related to production cooperation and integration, as well as technical maintenance and resource provision (7.6% and 6.7%, respectively).
Unfortunately, product innovations have the smallest share in the total number of projects (12.5%). These innovations are associated with the selection of new plant varieties and animal species and the cultivation of environmentally safe products (7.6%, 3.4% and 1.5%, respectively). This, in our opinion, together with production innovations, may be of the greatest interest in term of improving the efficiency of agricultural production.
Below is a detailed discussion of these product- and production-related innovations in crop farming and livestock farming in Russia.
As noted by the experts, most of the latest technical-technological solutions implemented in crop farming in Russia deal with selection work and genetic engineering, organic arable farming, micro-irrigation, space information technology, and nanotechnology (Table 2).
The most common way to boost crop farming production volumes today is implementing the achievements of selection work and genetic engineering. However, traditional selection requires significant time expenditure, significant cross-breeding effort, and vast selection material, so it is being supplanted by marker-based selection, whereby a focus on certain genes makes it possible to control them during the course of selection, which

helps ensure reliable and efficient selection procedures, while reducing the time it may take to create new varieties [6].

Table 2. Characteristics of the Use of Cutting-Edge Innovative Technology in Crop Farming

Potential for use	Adaptation issues
Selection	
– enhancing varieties' properties; – boosting crops' resistance to soil-climatic conditions and pests; – ensuring considerable increases in crop yield; – obtaining elite variety seeds	– lack of equipment; – lack of funding; – lack of technology for creating initial selection material
Genetic engineering	
– plants' resistance to yield loss, diseases, and pests; – improving the quality of produce and boosting crop yield; – boosting plant tolerance to herbicides; – enabling plants to produce pesticides of their own; – reducing the time it takes to maintain and process the produce; – ensuring savings on the costs of growing genetically modified organisms (GMO)	– lack of regulatory support; – toxicity of GMO products; – emergence of cancerogenic and mutagenic effects; – accumulation of herbicides; – declines in produce's nutritious properties; – harmful effect on human health – immune system suppression, allergic reactions, tissue mutations, etc.
Organic arable farming	
– eliminating the need for pesticides and fertilizers; – reducing the harmful impact of agricultural production on the environment; – dropping GMO	– lack of regulatory support; – lack of state subsidies; – produce certification issues; – lack of biological crop protection agents
Micro-irrigation	
– ensuring the optimum levels of crop water status in dry conditions; – ensuring the economic use of irrigation water, power, and fertilizers; – preventing soil erosion; – potential for reclaiming lands that are hardly suitable for crop cultivation; – potential for the concurrent conduct of agrotechnical works	– considerable irrigation-related construction costs; – lack of and scarce upgrades to sprinkling machinery; – high likelihood of sprinkler heads getting clogged and equipment getting damaged
IT technology	
– determining actual acreages; – forecasting crop yield and loss; – determining the level of use of material-technical resources; – potential for exposing unaccounted-for produce and resources	– need for considerable financial investment; – need for significant R&D effort; – need for a highly-skilled workforce
Nanotechnology	
– facilitating greater crop yield; – employing low-toxicity nanomaterials; – facilitating accelerated plant photosynthesis; – strengthening plants' protective properties	– lack of knowledge about the mode of action of nanotechnology and the characteristics of nanomaterials; – nanoproduct certification issues

Source: Compiled by the authors based on the findings from an expert survey conducted by them.

Of special popularity is technology related to genetic engineering and the use of genetically modified organisms (GMO). Methods of genetic engineering, cell biology, and DNA technology make it possible to transfer genetic material into plants from microorganisms, fungi, and animals. Extracting genes and incorporating them into the genome of existing plant varieties makes it possible to impart to them a set of new attributes, like resistance to pests and herbicides; tolerance to adverse soil-climatic conditions; ability to synthesize bio-pesticides; ability to neutralize toxic substances in soil and water; etc. [10]. However, researchers have yet to establish precisely these products' ultimate effect on living organisms which consume them – this effect may be felt for decades, affecting their life activity in adverse ways.

In this regard, many nations are exhibiting a growing interest in turning out agricultural eco-products, which are grown with a focus on minimum soil cultivation and giving up on the use of GMO and plant protection agents [1].

Organic agriculture implies giving up on the use of mineral fertilizers and pesticides, as well as stimulating soil's biological activity. The progressive development of Russia's agricultural sector has been impeded by various issues of a social, institutional-legal, and financial-economic nature, despite, as pointed out by some of the experts, an aspiration on the part of many of the domestic business entities to keep to the principles of organic arable farming in agricultural production.

According to one of the experts, "today the development of arable farming tends to be characterized by a focus on creating the conditions for sustainable management of soil's condition. In this respect, a key focus is on land irrigation and drainage, which may help minimize the dependence of agricultural production on the conditions of natural moisture supply".

However, as noted by some of the experts, due to insufficient government support for land improvement programs, the use of

outmoded irrigation systems, and the high costs of installing the latest irrigation machinery there currently are no plans to implement micro-irrigation systems widely in enterprises within the AIC.

Table 3. The Latest Technical-Technological Solutions in Livestock Farming

Potential for use	Adaptation issues
Biotechnology	
– preserving the livestock gene pool; – improving livestock health; – enhancing the quality of livestock farming products; – improving livestock productivity using selective breeding methods	– need to conduct R&D and engage highly skilled personnel; – emergence of undesired mutations; – reduced reproductive capacity; – infection transmission risk
Selection-and-breeding work	
– enhancing existing and creating new livestock breeds (hybrids); – improving livestock's productive features; – utilizing the genetic potential of the best breeds	– poor development of selection-and-breeding work; – need to attract financial resources; – need to prepare research personnel
Feeding systems	
– ensuring the effective use of various feeding modes; – reducing feed loss; – ensuring continuous access to feed using a state-of-the-art feed supply system; – increasing liveweight gain; – ensuring the accuracy of portioning and dispensing the feed	– need to attract investment; – need for skilled personnel capable of managing the feeding process; – feed dispensation process being highly automated; – significant financial costs
Technical-technological support	
– improving the conditions in which livestock is raised; – improving working conditions; – reducing the costs of producing a unit of output; – improving the quality of livestock output; – ensuring the economic use of resources	– high equipment upgrade and modernization costs; – need to import cutting-edge livestock maintenance and feeding technology; – need to improve the characteristics of materials used for equipment
Resource-saving technology	
– reducing capital expenditure and production costs; – ensuring the specialization of works related to raising and keeping livestock; – boosting livestock's reproductive capacity; – ensuring the effective organization of livestock rest and feed activities; – ensuring the effective use of waste transportation and disposal systems	– need for state support and incentivization; – need to attract investment in order to reequip livestock farming complexes and poultry farms; – implementation of mechanisms for automating and computerizing the production process; – use of robotics; – need to retrain personnel

Source: Compiled by the authors based on the findings from an expert survey conducted by them.

Employing the achievements of the space industry is becoming one of the most expedient ways of amplifying the development of agricultural production. This is quite relevant in present-day conditions, since, as per the experts, the use of vast areas for agricultural purposes suggests the need to continually stay updated on the current situation with resources, ensure the effective use of natural-resource potential and material-technical resources, forecast crop yield, and implement the latest land-use systems and information agritechnology, which may require developing and implementing relevant innovative information technology.

Scientific-technical progress has also provided a major impetus for the development of nanotechnology, which, in the view of one of the experts, is "present in all spheres of agriculture, including machinery and fertilizer systems".

Another sector within agriculture that is stimulating business entities to modernize, get equipped better technologically, and produce cutting-edge technical solutions is livestock farming (Table 3).

The key areas for implementing innovative technologies in livestock farming include the following [5] (also see Table 3):

-biotechnology (employing methods of cell biology and genetic engineering to boost the animals' reproductive function). The findings from research are used to improve the animals' health, enhance the quality of livestock farming output, better protect the environment, and preserve the gene pool. Biotechnologies make it possible to identify animals that are genetically resistant to various diseases and utilize them as part of the selection process;

-selection-and-breeding work (aimed at enhancing the animals' breed qualities via the intensive use of highly productive pedigreed breeders). The efficiency of breeding work is closely associated with the focus on reproduction, main herd refreshment rates, the ability to provide high-quality genetic material, and the capacity to have in place a domestic market for breeding resources that, going forward, will fully accommodate the national need and be export-oriented;

-feeding systems. The latest feeding standards must factor in the animals' need for energy,

dry solids, proteins, carbohydrates, fiber, fat, microelements, carotene, vitamins, etc. [8]. This implies designing different feeding modes to fit the needs of particular breeds to ensure accurate portioning. This technology helps increase liveweight gain. However, as noted by the experts, the implementation of intensive feeding systems is impeded by the need for significant funding, which is required to modernize and automate the production processes;

-technical-technological support, which implies upgrades to the technological base of AIC enterprises via the installation of the latest equipment for keeping livestock, e.g. latched or nonlatched fences for pens and feed tables; combined pens; common watering points; stall arrangements; feed dispensation and distribution systems; cutting-edge milking machinery etc.;

-resource-saving technologies, which imply an orientation toward the implementation of fully automated processes, the use of robotics, the creation of a sustainable feed base, and the raising of high-yielding livestock. A proper focus on this should have a positive effect on profit margins within the livestock farming sector and provide a basis for the innovation-driven development of the agricultural sector.

On the whole, in implementing innovative technology, AIC enterprises may need to be guided by the following approaches: identifying a set of priority areas that require an innovation-focused approach; reducing the number of management levels with a view to speeding up innovation processes; optimizing the timeframes for working out and rationalizing innovative projects.

Along with a set of positive features that an enterprise acquires in the course of implementing innovative projects, there are also certain negative considerations that may hinder making effective managerial decisions, namely:

-increased levels of uncertainty regarding the end result with respect to timeframes, expenditure, return on investment, or product or service quality, which may require amplifying the risk management function in innovation management;

-increased levels of risk, which may require searching for a good investor;

-accumulation of various issues, resolving which may require making a set of organizational changes in the company.

CONCLUSIONS

Summarizing the above makes it possible to draw the conclusion that implementing innovative technology is a key objective for any enterprise, being a promising area for development which helps create a favorable environment for the effective use of the company's resource potential and stewardship of its competitiveness.

It may be worth viewing innovation-driven development in enterprises within the AIC as a systematized composite of knowledge, information, technological and organizational solutions, quantitative and qualitative changes in productive forces, economic relationships, and the outcomes of companies' business activity based on the implementation of innovations, strategies for innovation-driven development in companies aimed at fostering sustainable development, a set of targets for the company's development based on the implementation of innovations, methods and key activities for the conduct of innovation activity, and mechanisms for fostering a company's openness to and aspiration to continually generate, implement, and realize innovations.

Thus, the use of innovative technology in the agricultural sector helps ensure the progressive development of agriculture, facilitate the attraction of investment, and bolster economic and technological security. However, market conditions in the sector are changing, with new technology continually coming out which may require further research and in-depth substantiation.

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