

IMPROVING MECHANISMS FOR HUMAN CAPITAL DEVELOPMENT IN THE AGRICULTURAL MANAGEMENT SYSTEM

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Abstract. This article examines ways to improve human capital development mechanisms in agricultural management. Particular attention is given to professional skills, digital competencies, continuous training, management capacity, and innovation. The study analyzes the role of education, extension services, and modern management practices in increasing labour productivity and agricultural competitiveness. An integrated mechanism is proposed to strengthen human capital development and support sustainable agricultural development in Uzbekistan.

Keywords: human capital, agricultural management, professional skills, digital competencies, training, innovation, labour productivity, sustainable agriculture, Uzbekistan.

INTRODUCTION

Agriculture remains one of the strategically important sectors of the economy, contributing to food security, employment, rural development, and industrial value chains. At the same time, digitalization, technological modernization, climate change, water scarcity, and changing market requirements are transforming agricultural production. These changes increase the demand for specialists and managers with modern professional, digital, analytical, and managerial competencies. Therefore, human capital is becoming an increasingly important factor in improving the efficiency and competitiveness of agricultural organizations.

The relevance of human capital development is particularly significant for Uzbekistan. According to the National Statistics Committee, agricultural production, forestry and fisheries increased by 5.1% in January-March 2026, while growth reached 4.7% in January-June 2026 compared with the same period of the previous year. During January-June 2026, UZS 26 trillion of foreign investments and loans were utilized in fixed capital in agriculture, forestry and fisheries [1]. These indicators demonstrate the sector's continuing development and the growing need for qualified personnel capable of effectively managing modern technologies and investments.

Human capital development has also become an important component of national agricultural policy. The Agriculture Development Strategy of Uzbekistan for 2020–2030 emphasizes the development of agricultural science, education, information, and advisory services, as well as closer links between science, education, and production [2]. In addition, FAO's National Programme of Action for the Digitalization of Agriculture in Uzbekistan promotes the use of digital technologies, geospatial tools, smart sensors, and decision-support systems in agriculture [3]. These developments require agricultural workers and managers to acquire new digital and analytical competencies.

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Recent initiatives demonstrate a shift toward practical and continuous learning. In 2026, FAO and the European Union implemented Farmer Field Schools in Fergana, Namangan, and Jizzakh regions to strengthen farmers' practical knowledge and promote sustainable agricultural practices [4]. FAO also supported training-of-trainers activities in Kashkadarya focused on No-Till technologies, crop rotation, soil-moisture conservation, and resource-efficient production methods [5]. Such initiatives show that modern human capital development increasingly depends on field-based learning, knowledge exchange, digital skills, and climate-adaptive competencies.

Another important direction is strengthening cooperation among agricultural universities, research institutions, extension services, businesses, and farmers. Previous FAO-supported programmes in Uzbekistan combined professional training with demonstration activities, modern irrigation technologies, greenhouse technologies, and technical consulting, providing practical support to farmers and rural communities [6]. This experience confirms that training becomes more effective when it is directly connected with technology adoption and real production challenges.

Thus, improving human capital development mechanisms in agricultural management requires an integrated approach that combines professional education, lifelong learning, digital competencies, practical training, advisory services, innovation, motivation, and performance evaluation. The aim of this study is to examine these mechanisms and identify approaches that can strengthen labour productivity, management efficiency, innovation capacity, and sustainable development of the agricultural sector in Uzbekistan.

Human capital is increasingly recognized as one of the key factors determining the efficiency, adaptability, and competitiveness of modern agriculture. Classical human capital theory considers education, professional training, and accumulated experience as investments that increase individual productivity and generate long-term economic returns [8]. In agriculture, however, the concept of human capital is broader because it includes not only formal education and professional knowledge, but also practical experience, managerial abilities, digital competencies, innovation capacity, communication skills, and the ability to adapt to technological and environmental changes [9]. This broader understanding is particularly important under the current transformation of agricultural production, where digital technologies, precision farming, smart irrigation, modern machinery, and climate-adaptive practices are becoming increasingly important.

International research emphasizes that investment in agricultural human capital should develop alongside investment in physical infrastructure and technology. FAO and IFPRI note that agricultural development programmes frequently allocate substantially more resources to physical assets than to the knowledge and skills of farmers, despite the important role of human capabilities in technology adoption and productivity improvement [10]. Extension and advisory services also play a significant role because they provide a mechanism through which scientific knowledge and technological innovations can be transferred to agricultural producers. Contemporary extension models increasingly focus on participatory learning, farmer-to-farmer knowledge exchange, field demonstrations, digital advisory services, and practical problem-solving rather than traditional one-way dissemination of information [11].

An important recent development is the growing integration of digital technologies into agricultural human capital development. Digital platforms, geospatial technologies, smart sensors, remote monitoring systems, and decision-support tools are changing the competency requirements for agricultural managers and specialists. A 2026 FAO evidence review based on 44 experimental and quasi-experimental studies

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found that agricultural extension, education, digital tools, and social networks can support improvements in farmers' knowledge, skills, technology adoption, productivity, and income [12]. These findings indicate that the modernization of agriculture requires a transition from traditional workforce development toward a continuous competency-based learning system.

This transformation is particularly relevant to Uzbekistan. The country's agricultural development policy identifies science, education, information, and advisory services as important elements of agricultural modernization and emphasizes stronger links between scientific institutions, education, and agricultural production [2]. In addition, the National Programme of Action for the Digitalization of Agriculture, developed with FAO support, promotes the use of digital tools, geospatial technologies, smart sensors, and decision-support systems in the agrifood sector [13]. The implementation of these technologies requires agricultural personnel to possess increasingly sophisticated digital, analytical, managerial, and technical skills.

Recent statistical data illustrate the growing economic significance of the agricultural sector and, consequently, the importance of developing its human resources. According to the National Statistics Committee of the Republic of Uzbekistan, 3.13 million people were employed in agriculture, forestry and fisheries in 2025 [14]. The average monthly nominal accrued wage in the sector increased from approximately 2.31 million soums in 2024 to 2.75 million soums in 2025, representing growth of about 19.2% [15]. At the same time, the volume of agricultural, forestry, and fisheries products and services increased by 5.1% in January–March 2026 compared with the same period of 2025 [16], while sectoral growth reached 4.7% in January-June 2026 [17].

Investment activity has also expanded considerably. During January–June 2026, approximately UZS 26 trillion of foreign investment and loans were utilized in fixed capital in agriculture, forestry, and fisheries, compared with UZS 16.9 trillion in the corresponding period of 2025. This represents an increase of approximately 53.8% [18]. Such investment growth creates additional demand for qualified specialists who can manage modern agricultural equipment, digital systems, financial resources, technological processes, and production risks. Therefore, the expansion of investment without corresponding human capital development may limit the effective utilization of new technologies and infrastructure.

Table 1. Selected indicators of agricultural development and human capital conditions in Uzbekistan

Indicator	2024	2025	2026	Change
Employment in agriculture, forestry and fisheries	3.24 mln	3.13 mln	—	Decline in employment
Average monthly wage	2.31 mln UZS	2.75 mln UZS	—	+19.2%
Agricultural sector growth	—	—	5.1%*	Positive growth
Agricultural sector growth	—	—	4.7%**	Positive growth
Foreign	—	16.9 trln	26.0 trln	+53.8%

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investment and loans		UZS**	UZS**	
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* January–March 2026.

** January–June 2026.

Source: National Statistics Committee of the Republic of Uzbekistan [14–18].

The statistical evidence suggests a gradual structural transformation of agricultural employment. The number of people employed in the sector decreased between 2024 and 2025, while wages, investment, and output continued to increase. These trends may be associated with productivity growth, technological modernization, structural changes in employment, and greater capital intensity. However, the available aggregate statistics do not establish a direct causal relationship between human capital development and these changes. Nevertheless, they demonstrate the growing importance of improving the quality and productivity of agricultural labour.

Practical programmes implemented in Uzbekistan provide additional evidence concerning the role of human capital. The World Bank's horticulture development programme combined financing, technological modernization, improved agricultural practices, market linkages, and capacity development. Participating producers achieved reported yield increases of approximately 25–30%, while gross sales increased by around 35%. The programme also contributed to more than 34,500 permanent jobs and approximately 22,000 seasonal jobs [19]. These results should be understood as the outcome of an integrated intervention rather than training alone, but they demonstrate that skills, technology, finance, and market access can reinforce one another.

The transition toward practical and participatory learning is another important development. In 2026, FAO and the European Union implemented Farmer Field Schools in Fergana, Namangan, and Jizzakh regions. The programme established four field-school sites, with each school involving 15 smallholder farmers. The activities focused on practical knowledge, sustainable plant protection, field observation, and exchange of production experience [20]. Such a model provides an alternative to purely classroom-based training because participants learn by observing, testing, discussing, and applying solutions directly in production conditions.

Similar Farmer Field School activities were introduced in the Fergana Valley, where training focused on potato production, resource-efficient greenhouse management, and raspberry cultivation. Farmers participated directly in identifying production constraints and testing practical solutions [21]. This approach demonstrates that agricultural human capital development can become more effective when education is connected to actual production problems and localized environmental conditions.

Another significant development is the training-of-trainers model. In September 2026, 20 researchers and agricultural specialists in Kashkadarya participated in training on conservation agriculture, including No-Till planting, crop-residue retention, crop rotation, soil-moisture conservation, and resource efficiency [22]. A 40-hectare No-Till wheat demonstration was subsequently conducted in Qamashi district, allowing farmers, agronomists, machinery operators, and specialists to observe the technology in field conditions [23]. This creates a knowledge multiplier mechanism in which trained specialists transfer knowledge to wider groups of farmers.

The relationship can be represented as:

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Research and education → trained specialist → field trainer → farmer → practical application → technology adoption → knowledge diffusion.

Table 1. Selected indicators of agricultural development and human capital conditions in Uzbekistan

Competency	Main skills	Expected effect
Professional	Agronomy, livestock management, plant protection	Higher production quality
Digital	Sensors, GIS, platforms, data analysis	Better decision-making
Managerial	Planning, budgeting, HR, risk management	Organizational efficiency
Innovative	Technology adoption, experimentation	Faster modernization
Environmental	Water saving, soil protection, climate adaptation	Sustainability
Entrepreneurial	Marketing, finance, market analysis	Higher profitability
Communication	Teamwork, advisory work, knowledge transfer	Faster knowledge diffusion

The findings indicate that the management of agricultural human capital should move from an administrative training model to a competency-based system. Under such a model, agricultural organizations first identify the competencies required for their strategic objectives, then assess existing employee capabilities, design individualized development programmes, monitor the practical application of acquired knowledge, and connect professional development with performance evaluation and career progression.

A proposed mechanism can therefore be expressed as: Competency assessment → targeted training → practical application → mentoring → performance evaluation → incentives → career development → innovation.

The motivation component is also significant. The observed increase in agricultural wages suggests improving remuneration, but financial incentives alone are insufficient to ensure effective human capital development. Agricultural enterprises can supplement wages with competency-based promotion, professional certification, innovation bonuses, recognition systems, and career-development opportunities. Such mechanisms can encourage employees to apply newly acquired knowledge rather than treating training as a formal requirement.

Digitalization represents another central component of the proposed mechanism. As smart agriculture expands, digital literacy should become a basic requirement for agricultural managers and specialists. Employees should be capable of using digital monitoring systems, interpreting production data, working with agricultural information platforms, and applying data to irrigation, input management, crop protection, and production planning. Consequently, digital training should be integrated into both formal agricultural education and continuous professional development.

The issue of inclusiveness should also be incorporated into agricultural human capital policy. FAO reported in 2026 that women represented only 6% of landholders allocated land for farming activities in

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Uzbekistan [24]. This indicates that human capital policy cannot focus exclusively on technical training; access to productive resources, technology, finance, knowledge, and decision-making opportunities must also be considered. Similarly, developing the competencies of rural youth can support labour-market renewal and encourage the emergence of a more technologically oriented agricultural workforce.

Based on the reviewed literature, statistical evidence, and practical programmes, the study identifies six interconnected mechanisms for improving human capital development in agricultural management:

First, agricultural education should become competency-oriented and more closely connected with production enterprises, agribusinesses, research institutions, and technology providers. Second, continuous professional development should replace one-time training through short courses, digital learning, field schools, certification, mentoring, and peer learning. Third, digital agriculture should be incorporated into workforce development through training in data analysis, smart sensors, GIS, digital platforms, and technology-assisted decision-making. Fourth, human capital development should be integrated with agricultural investment projects so that new technologies and infrastructure are accompanied by corresponding workforce competencies. Fifth, motivation systems should connect professional development with career advancement, productivity, innovation, and financial incentives. Sixth, agricultural organizations should introduce measurable human-capital indicators, including training coverage, competency growth, technology adoption, labour productivity, innovation activity, employee retention, and the economic return on training.

Thus, the evidence shows that human capital development should be treated as a strategic component of agricultural management rather than as an independent personnel function. The combination of increasing agricultural investment, technological modernization, practical field schools, digitalization initiatives, and conservation agriculture programmes demonstrates the need for a workforce capable of operating within a rapidly changing production environment. An integrated human capital mechanism can strengthen technology adoption, improve resource efficiency, support innovation, and increase the productivity and competitiveness of agricultural organizations in Uzbekistan.

CONCLUSION

The study confirms that human capital has become a strategic component of agricultural management and an important condition for improving productivity, technological adaptation, innovation, and sustainability. The transformation of agriculture under the influence of digitalization, resource constraints, climate change, and technological modernization requires a workforce with a broader combination of professional, digital, analytical, managerial, and environmental competencies.

The current situation in Uzbekistan demonstrates the growing importance of this issue. Official statistics show that agriculture, forestry and fisheries recorded 5.1% growth in the first quarter of 2026, while the sector continued to expand during the first half of the year. At the same time, foreign investment and loans directed to fixed capital in agriculture, forestry and fisheries reached UZS 26 trillion in January–June 2026, compared with UZS 16.9 trillion during the same period of 2025. Such investment growth increases the demand for qualified specialists capable of effectively operating modern equipment, digital systems, irrigation technologies, and new production models.

The research also indicates that human capital development produces greater value when it is integrated with technology, finance, infrastructure, and market opportunities. International evidence summarized by FAO in 2026, based on 44 experimental and quasi-experimental studies, emphasizes the role of practical learning, extension, digital tools, education, and social networks in improving farmers'

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knowledge and supporting productivity and income. This supports the transition from traditional short-term training toward continuous and practice-oriented competency development.

Recent initiatives in Uzbekistan illustrate this transition. Farmer Field Schools in the Fergana Valley provide producers with opportunities to observe crops, analyze problems, test solutions, and develop decision-making skills under real production conditions. Similarly, the September 2026 training-of-trainers programme in Kashkadarya strengthened the competencies of 20 researchers and agricultural specialists in conservation agriculture and Farmer Field School approaches. A subsequent 40-hectare No-Till wheat demonstration in Qamashi further connected specialist knowledge with practical technology adoption. These examples demonstrate the increasing importance of knowledge-transfer mechanisms that combine research, education, field practice, and peer learning.

Based on the findings, the improvement of human capital development mechanisms in agricultural management should focus on an integrated system consisting of competency assessment, continuous professional education, digital agricultural training, practical field learning, knowledge-sharing networks, managerial development, and performance-based incentives. Agricultural universities, research institutions, government agencies, businesses, extension organizations, and farmers should be treated as interconnected participants in this system rather than as separate institutions.

Particular attention should also be given to inclusive human capital development. Rural youth, women, smallholder farmers, and agricultural workers in less-developed regions should have wider access to training, technology, advisory services, and professional development opportunities. FAO's updated 2026 gender profile for Uzbekistan confirms that structural inequalities continue to affect the participation of women in agriculture and rural livelihoods, highlighting the importance of inclusive approaches in agricultural policy and capacity development.

In conclusion, human capital should be regarded not as a supporting element of agricultural development, but as a strategic investment that increases the effectiveness of other forms of investment. The proposed mechanism can help agricultural organizations strengthen employee competencies, accelerate technology adoption, improve resource efficiency, support innovation, and enhance competitiveness. For Uzbekistan, linking human capital development with digital transformation, sustainable production, agricultural investment, and practical knowledge transfer can provide an important institutional foundation for the long-term modernization and resilience of the agricultural sector.

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