



Economics and Business Management

17(1), 85-101

Journal homepage: <https://economicscience.com.ua/en>

Received: 19.09.2025 Revised: 28.01.2026 Accepted: 26.02.2026 Published: 03.04.2026

ISSN 2786-7390; e-ISSN 2786-7404

UDC 338.43:631.11

DOI: 10.31548/economics/1.2026.85

Oleksandr Bilichenko*

PhD in Economic Sciences, Associate Professor
Mykolaiv National Agrarian University
54008, 9 Georgiy Gongadze Str., Mykolaiv, Ukraine
<https://orcid.org/0000-0002-5241-3195>

Oksana Bolshaia

PhD in Economic Sciences, Associate Professor
Poltava V.G. Korolenko National Pedagogical University
36003, 2 Ostrohradskyi Str., Poltava, Ukraine
<https://orcid.org/0000-0003-0543-5196>

Impact of human capital on the efficiency of resource management and production processes in agricultural enterprises

Abstract. The study aimed to determine the effect of human potential on management decisions and production. The methodological foundation of the study was an empirical approach, incorporating descriptive, dynamic, structural and comparative analysis of official statistics, analysis of relative labour market indicators, case studies and analysis of human capital management practices of leading agricultural enterprises. Based on the results of 2020 and mid-2025, the number of employees in the agriculture sector increased by 3.5%, while average monthly nominal wage increased from UAH 9,737 in 2020 to over UAH 21,413 in the first quarter of 2025, exceeding UAH 25,000 for certain roles. Given the labour shortage, the increase in labour costs has strengthened the role of staff quality in resource management. The study established that staff qualifications, investment, and motivation improved labour productivity by 5-15% and enterprise profitability by 10-20%, while results-oriented remuneration systems increased the performed volume of work by 20-25%. The share of agriculture in Ukrainian GDP reached approximately 17% in 2024, reflecting structural transformations in the labour force. Human capital management practices analysed using the examples of Myronivsky Hliboproduct, Kernel and Astarta-Kyiv showed a 15-20% reduction in staff turnover, a 10-30% increase in labour productivity, and an 85-95% increase in the efficiency of material and technical resources, which reduced operating losses by 15-25%. The practical significance of the study is determined by the possibility of using the results obtained by agricultural enterprises to improve the efficiency of personnel and resource management

Keywords: unemployment; productivity; competencies; qualifications; wages; motivation

Suggested Citation:

Bilichenko, O., & Bolshaia, O. (2025). Impact of human capital on the efficiency of resource management and production processes in agricultural enterprises. *Economics and Business Management*, 17(1), 85-101. doi: 10.31548/economics/1.2026.85.

*Corresponding author



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INTRODUCTION

The development of the agricultural sector is progressing amid increased market volatility, rising production costs, more complex technological operations, and limited resources. In such circumstances, the performance of agricultural enterprises is increasingly determined not only by the volume of material and financial resources involved, but also by the ability of personnel to ensure their rational combination, the coordination of production operations and the adaptation of technological solutions to specific economic conditions (Bilichenko, 2015). In the functioning of agricultural production, there is a mismatch between the qualitative characteristics of labour resources and the growing complexity of managing resource flows and production operations, which limits the ability of enterprises to adapt to structural changes and recovery processes. These issues were addressed by A.O. Kalynovskyi *et al.* (2024) in an analysis of models of human capital development through educational, socio-institutional and economic mechanisms. The results showed that the level of education, professional training, and the ability of personnel to acquire new competencies form the prerequisites for increasing productivity, technological renewal and the sustainability of economic systems during periods of transformation. O.V. Ptashchenko & O.M. Sher-sheniuk (2024) emphasised the development of human capital in the context of digital transformations, revealing the role of continuous learning, digital literacy, management innovations and motivational mechanisms in improving the performance of enterprises. The conclusions demonstrated that the adaptation of personnel to the digital economy creates the conditions for growth in productivity, sustainability, and competitiveness of agricultural enterprises.

The development of the agricultural economy insufficiently analysed innovative production modernisation and existing approaches to the formation and use of human resources, which limit productivity growth. O. Radchenko (2025) addressed the strategic principles of human capital development, highlighting the factors of its formation and substantiating the role of qualitative characteristics of personnel in the implementation of innovations. The results of

the study substantiate that the level of education, professional training, motivation and institutional support determines the ability of agricultural production to implement technological innovations, reduce dependence on extensive factors and ensure long-term competitiveness. Y. Yuhnovska *et al.* (2024) highlighted the essence of human capital, its structure, types and role in the enterprise management system. The study proved that the development of staff competencies, knowledge and skills creates the preconditions for increasing productivity, competitiveness and consistency of management processes.

Human Resource Management (HRM) is considerably more complex than the management of other resources. Firstly, people are intellectually capable, and their response to management is emotional, thoughtful, and not mechanical, which implies a two-way process. Therefore, HRM requires specific approaches and methods. While the management of material, immaterial, and financial resources does not lead to a conscious response from the managed system to the manager, when influencing human resources, the manager may receive an inadequate and unexpected response. Secondly, due to human consciousness, the possibility of self-development and self-organisation, the expected results and consequences of management may be inadequate, ranging from dynamic growth to complete destruction of the enterprise. Thirdly, it is necessary to address those human resources are used to manage other resources, i.e., there is a synergistic effect that can significantly increase or decrease the effectiveness of managing other resources. Fourthly, human resources can participate in the enterprise on a long-term basis, since a person's professional life can span several decades. Fifthly, employees join the organisation consciously, with certain goals and motives, sometimes contrary to the goals of the enterprise's development, and their goals and motives inevitably change over time (Bolshaia & Bilyk, 2022).

In business management practice, there is still insufficient coordination between the use of digital tools and the systematic development of human capital, which limits the potential for improving the effectiveness of management

decisions. O. Grishnova (2025) developed a comprehensive model of human capital management based on digital technologies, covering strategic, structural, technological, optimisation and evaluation-performance blocks. The study also developed a system of quantitative indicators for assessing the effectiveness of personnel utilisation and the level of automation of HRM processes, which can be used to compare the state of human capital over time and between companies. M. Kozik (2025) substantiated human resource potential as a multi-component system covering quantitative, qualitative, organisational, socio-psychological and innovative characteristics of personnel, and proposed a model of the relationship between “strategy – tools – indicators – results”. The results showed that systematic personnel development contributes to increased labour productivity, reduced staff turnover, the formation of a personnel reserve and increased adaptability of enterprises to technological changes.

With the spread of digital solutions and changes in social and labour relations, there is a growing complexity in the requirements for the quality of human capital and the mechanisms for its involvement in economic activity, which directly affects the organisation of production and the use of resources. I. Krysovaty (2025) combined digitalisation and an inclusive approach to human capital development, justifying changes in the content of employment, the transformation of competency requirements, and the expansion of the participation of various social groups in production processes. The results of the study showed that digital tools increase the flexibility of management decisions, while inclusive mechanisms contribute to the expansion of human resources and the sustainability of economic systems. In the activities of agricultural enterprises, the role of intangible factors, in particular knowledge, staff competencies and organisational practices, which determine the effectiveness of production and management decisions, is growing. Ye. Pyrohov *et al.* (2025) considered intellectual capital as an integrated system of human, structural and relational components, and approaches to assessing its contribution to the economic performance of enterprises are proposed. The results obtained

showed that the development of human capital and related organisational elements contributes to increased labour productivity, innovative activity and adaptability of enterprises.

At the same time, existing studies predominantly focus on strategic and conceptual approaches, while the impact of human capital on resource management efficiency and the organisation of production processes at the level of agricultural enterprises remains insufficiently formalised and empirically substantiated. This study aimed to analyse the impact of human capital on the effectiveness of resource management and the organisation of production processes in agricultural enterprises. To achieve this goal, the following tasks were set: to identify the key components of human capital that influence the effectiveness of resource management and production processes in agricultural enterprises; to analyse the relationship between human capital development and the performance indicators of agricultural enterprises based on statistical and analytical data; to summarise human capital management practices in the activities of leading agricultural enterprises in Ukraine.

MATERIALS AND METHODS

The study was empirical in nature and covered the period from 2020 to mid-2025, which was due to the need to analyse the transformations of Ukraine’s agricultural sector in the context of the pandemic crisis, military shocks and subsequent adaptation processes. The theoretical basis of the study was the human capital theory developed by Gary Becker and Theodore Schultz, which was used as a conceptual framework for analysing management processes in agrarian business based on scientific sources by T.W. Schultz (1960) and G.S. Becker (1962). To clarify the analytical boundaries of the study, a comparative characterisation of approaches to human capital theory was performed using comparative analysis and generalisation of theoretical provisions based on following criteria: interpretation of investments in human capital, the level and economic content of their profitability, the scope of application of the theory, and the key differences between micro- and macroeconomic interpretations, which ensured the formation

of a comprehensive conceptual framework for the study. To identify the factors that influence the effectiveness of personnel, the study analysed and summarised the results of scientific publications and industry analytical materials by I. Dvornyk (2021), Ye. Lanchenko (2023) and O. Khadzhinova & A. Hryshyn (2025), which systematised the impact of remuneration systems, motivational mechanisms and digital competencies on productivity and resource efficiency.

The study analysed the impact of human capital on the efficiency of resource and production process management, in particular by examining the dynamics of average annual nominal wages in Ukrainian agriculture for 2020-2025. A dynamic analysis of changes in the cost of labour resources and their impact on management decisions in agricultural enterprises was conducted based on official statistical data from Minfin (n.d.a), which tracked changes in wage indicators over time in 2020-2025. A comparison of annual wage indicators revealed trends in nominal wage growth and assessed the increasing role of qualitative characteristics of personnel in the context of a reduction in the number of employees, based on the official Minfin source. To assess the macroeconomic context of human capital utilisation, the dynamics of gross added value in Ukrainian agriculture were examined based on statistical data from various sources, using structural analysis to determine the role of the agricultural sector in gross domestic product formation and the relationship between production efficiency and labour resource quality. At the same time, the age structure of those employed in agriculture was analysed using descriptive statistical analysis to assess the demographic constraints on human capital development and their impact on the implementation of managerial and digital innovations based on a source from the Razumkov Centre (2024). The analysis of unemployment dynamics in Ukraine in 2020-2024, based on statistical data from O. Bilous (2025) and Minfin (n.d.b), using dynamic analysis and analysis of relative indicators by comparing the number of unemployed to the total population to characterise changes in the overall labour potential and conditions for the formation of human capital for the agricultural sector.

Case study methodology was used to analyse practices and directions for improving the efficiency of agricultural enterprise management based on human capital development, using MHP (n.d.a), Kernel (n.d.) and Astarta-Kyiv (2025a; 2025b), which were selected due to their system-forming role in the agricultural sector, the scale of their activities and the existence of formalised approaches to personnel management. For MHP (n.d.b), an analysis of internal educational and motivational personnel management practices was conducted using the method of structural analysis of corporate materials, which was used to assess the integration of professional training, digital competencies and incentive systems with production process management (Major agricultural producer..., 2021). The analysis covered the use of digital management tools, in particular Systems, Applications and Products in Data Processing (SAP) and Power Platform, as components of the development of personnel management competencies. For Kernel, within the framework of descriptive analysis of corporate materials, a systematic approach to human capital management was considered, including the use of internal digital training and communication tools, in particular LMS Collaborator (n.d.) and Kernel HUB (n.d.). The use of Microsoft Navision (Dynamics NAV), Office 365, and Power BI corporate digital solutions to support management and analytical processes was also considered. Educational project "Re: Knowledge Industry" was emphasised as an element of the system for developing and transferring professional competencies of personnel (Kernel agroholding uses..., 2023). In addition, the remuneration system at Kernel was considered as a component of stimulating staff performance to determine its role in increasing productivity and consistency of management decisions (Kernel HR strategy, 2025). A descriptive analysis of corporate and institutional materials addressed the cooperation between Astarta-Kyiv (2025a) and the European Bank for Reconstruction and Development (EBRD) based on the AgriAcademy platform as an institutional mechanism for human capital development. Astarta's motivational model and management innovations were also analysed based on materials presented by Astarta in the report for 2024 (Astarta-Kyiv, 2025b),

which characterised approaches to improving management efficiency in agribusiness. Based on a summary of materials on the activities of these companies, recommendations were formulated for optimising management processes through human capital development, aimed at their practical implementation in small and medium-sized agricultural enterprises.

RESULTS

Human capital as a factor in the effectiveness of management processes in agribusiness

Human capital in economic science is interpreted as the accumulated stock of knowledge, professional skills, abilities, health status and motivational characteristics of employees, which is formed as a result of investments in education, training and professional development and determines the level of labour productivity and the effectiveness of economic activity. Unlike the traditional approach, in which labour was viewed primarily as a quantitative factor of production, the concept of human capital focuses on its qualitative dimension, which explains

differences in the efficiency of resource use under the same technological and natural conditions. For agribusiness, this approach is fundamental, as productivity growth depends less on the expansion of land areas or the growth of the material and technical base and increasingly on the level of staff competence (Lisnichenko, 2018).

The theory of human capital was developed in the 1960s by G.S. Becker (1962) and T.W. Schultz (1960), conceptually proving the investment nature of education and professional training costs. Both researchers viewed human capital as a productive resource, similar to physical capital, which is part of the production function and provides economic returns in the form of income and productivity growth. At the same time, their approaches differed in terms of the level of analysis and scope of application, which determines the different analytical value of these concepts for the study of agribusiness in the context of structural changes. A summary comparison of the key characteristics of the approaches of G.S. Becker and T.W. Schultz is presented in Table 1.

Table 1. Comparative characteristics of approaches to human capital theory

Aspect	G.S. Becker	T.W. Schultz
Definition of investment	Rational individual investment in education and training to maximise income, similar to business investment in capital	Socially significant investments in human capital for economic growth, with an emphasis on education as the foundation for development
Profitability	12-14% annual return on education explains the dispersion of earnings	Similar profitability, but emphasis on the role in the transformation of sectors such as agriculture
Scope of application	The general labour market, education as "capital" for any job	Economic development, especially in the agricultural sector, where education overcomes inefficiency
Key difference	Microeconomics: firms and individuals take human capital into account in production	Macroeconomics: Education is more relevant than physical capital for the growth of poor countries

Source: compiled by the authors based on T.W. Schultz (1960), G.S. Becker (1962)

The approach of G.S. Becker determines the mechanisms of productivity formation at the enterprise level through individual investment decisions of employees and employers, which is relevant for the analysis of personnel management, motivation and efficiency of production resources use. In the context of agribusiness, this is evident in the ability of employees to apply new technologies, optimise production operations and increase the return on the material and technical base. The approach of T.W. Schultz

demonstrates the role of human capital as a factor in overcoming the structural inefficiency of traditional agriculture, where limited knowledge and skills hinder the introduction of innovations and reduce the effectiveness of resource use. In the context of innovation and structural change, human capital in agribusiness is becoming increasingly relevant, as it determines the ability of enterprises to adapt to digitalisation, climate change, market transformation and demographic shifts. Staff qualifications and

motivation ensure labour productivity growth, increase resource management efficiency and create the conditions for sustainable development of production processes. Thus, human capital development is the economic basis for improving the performance of agribusiness and shaping its long-term competitiveness.

In the agricultural enterprise management system, human capital is central in transforming resource potential into real production and financial results. This influence is manifested not only in the professional training of employees, but also in motivational, managerial and digital competencies, which ensure the effective organisation of production processes and the rational use of material and financial resources. In the context of increasingly complex technologies and growing demands for precision in production operations, it is human capital that acts as the integrating element of the management system. A significant factor in efficiency is the system of remuneration and incentives for staff. An increase in remuneration attracts qualified personnel and reduces staff turnover, increasing labour productivity by 5-15% (Dvornyk, 2021). This has a positive impact on the financial results of enterprises through a 10-20% increase in profits due to more efficient use of resources and reduced costs associated with staff turnover. Piecework wages create a direct link between performance and employee income, which improves performed work volume by 20-25% and reduces costs per unit of output. Bonus systems focused on achieving specific production and financial indicators stimulate innovation and adaptation to change, ensuring an average increase in profitability of 8-12%. In contrast, low wages lead to a loss of motivation and a decrease in productivity of approximately 10%, accompanied by financial losses due to staff turnover and deterioration in product quality (Lanchenko, 2023).

The digital skills of personnel are becoming increasingly relevant, as they determine the efficiency of the use of technology and the material and technical base of agricultural enterprises. Employees trained on digital platforms for production management, precision farming systems, drones, Internet of Things (IoT) sensors, and analytical tools can reduce equipment downtime by 20-30%, reduce fuel, fertiliser and

seed costs, and increase yields (Ministry of Digital Transformation of Ukraine & WinWin, n.d.). Digital literacy of personnel ensures precise control of equipment (tractors with Global Positioning System (GPS), combines with Artificial Intelligence (AI)), reducing fuel and fertiliser overconsumption by 10-20%. Training agronomists and mechanics to use monitoring platforms (FMS) improves yield forecasting and maintenance, extending the service life of the material and technical base (MTB). In Ukraine, the shortage of AgroTech specialists is holding back digitalisation, but retraining programmes increase efficiency by 25% in pilot projects (Khadzhinova & Hryshyn, 2025).

The interconnection between human capital and material and financial resources manifests itself in the growth of returns on investments in technology and infrastructure. Qualified and motivated personnel ensure the efficient operation of the material and technical base, optimisation of costs and increased capital turnover. As a result, human capital is not only a separate factor of production, but also a system-forming element of management that determines the level of productivity, financial performance and sustainability of production processes in agricultural enterprises. The impact of human capital is reflected in the level of professional, motivational, managerial and digital competencies of personnel, which determine the efficiency of the use of material and technical resources and financial resources and ensure the adaptation of production processes to innovative and structural changes, creating the conditions for growth in the performance and sustainability of agricultural enterprises.

Analysis of the impact of human capital on the efficiency of resource and production process management

In 2020-2025, agricultural enterprises in Ukraine were developing in the context of structural transformations, changes in the labour market, decline in employment and a growing role of human capital in the efficiency of production processes. One of the effects of the changes is the wage dynamics in the agricultural sector, reflecting both financial capabilities and labour potential retention and restoration. In 2020,

the average nominal annual wage of the agriculture industry in Ukraine was approximately UAH 9,737, increasing throughout the year. In 2021, the wage increased even further, as the average monthly wage reached UAH 12,226, corresponding to an increase of 18-20%. This indicated a recovery of agricultural enterprise solvency and an increase in demand for skilled labour, given the favourable conditions in agricultural markets (Minfin, n.d.a). At the beginning of 2022, wages in the agricultural industry reached UAH 13,070, reflecting the positive trend on the eve of the Russian full-scale invasion. At the same time, wages fluctuated significantly throughout 2022 due to war, logistical disruptions, a reduction in productive areas, and the relocation of enterprises. In these conditions, the agricultural sector demonstrated greater resilience than many other types of economic activity, but employee income levels varied significantly across regions and seasons (Minfin, n.d.a).

In 2023, the average wage of the agriculture industry in the first quarter was UAH 12,326,

and in the third quarter, UAH 15,690. The average annual figure was approximately UAH 14,954, demonstrating a gradual recovery of the labour market and adaptation to war-time conditions. In 2024, wages were growing, as in the first quarter, the average monthly wage was UAH 15,004, and by the third quarter, it was UAH 18,970. At the same time, the average wages in Ukraine during the period were higher, demonstrating the gap between the agricultural sector and the national average (Minfin, n.d.a). In 2025, the trend for wage increases was still present. According to labour market data, in the first quarter, the average wage in the agriculture sector was UAH 21,413, and, as of August 2025, reached approximately UAH 25,000 (Minfin, n.d.a). The highest values were recorded among agronomists and veterinary specialists, indicating an increase in demand for highly skilled human capital. The average monthly nominal wage dynamics in agriculture in Ukraine in 2020-2025 are presented in Figure 1.

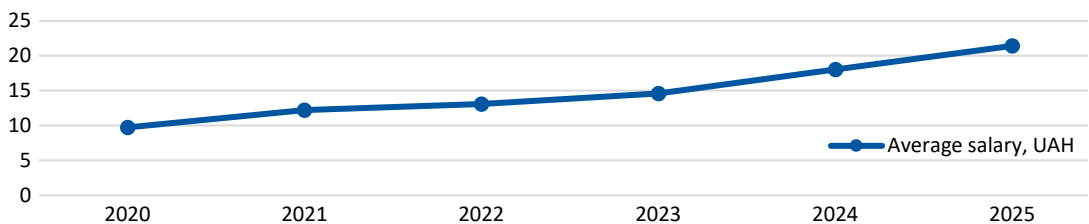


Figure 1. Dynamics of average monthly nominal wages in agriculture in Ukraine in 2020-2025

Source: compiled by the authors based on Minfin (n.d.a)

The data presented indicates a consistent trend towards growth in nominal wages in Ukrainian agriculture in 2020-2025, despite military and macroeconomic challenges. The increase in wages amid a decline in the number of employees indicates the growing role of human capital as a factor in maintaining the efficiency of resource and production process management in agricultural enterprises. Changes in wages occurred during a decline in employment in the agricultural sector. While in 2020, official employment in agriculture was about 659,000 people, in 2023 it grew to about 682,000 people, which corresponds to an increase of about 3.5%. This growth occurred amid structural changes

and labour shortages, which increased the value of labour productivity, professional training and accumulated experience of personnel in maintaining production volumes (Pepelya, 2023).

In 2020, the gross added value of the Ukrainian agriculture sector was UAH 388 billion, equivalent to 10.8% of gross domestic product (GDP), while in 2021, the agricultural sector covered more than 10% of GDP and improved production by 19.2%, thus a primary contributor to economic growth (In 2021, more than 10%..., 2022). In 2022-2023, the gross value added of the Ukrainian agriculture sector was formed under military and macroeconomic constraints, which affected the production dynamics. In

2024, agriculture accounted for approximately 17% of Ukrainian GDP, confirming a systemic role in the structure of national production amid military and macroeconomic challenges (The agricultural sector..., 2025). A structural factor affecting the efficiency of resource management is the age of those employed in agriculture. In 2020-2025, the share of workers over 50 years of age increased from 45% to over 60%, while the share of employees under 30 remained within

10-15%. Such statistics demonstrate a high level of accumulated production experience but limit the implementation of digital technologies and management practices, especially among small and medium-sized enterprises (Razumkov Centre, 2024). An additional macroeconomic factor influencing the formation and use of human capital in the agricultural sector is the dynamics of the unemployment rate in Ukraine in 2020-2024, as demonstrated in Figure 2.

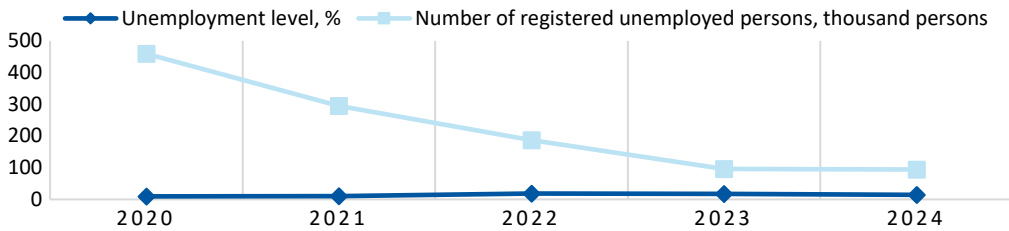


Figure 2. Unemployment trends in Ukraine in 2020-2024

Source: compiled by the authors based on Minfin (n.d.a; n.d.b)

In 2020, the unemployment rate in Ukraine was 9.5%, while the official unemployment rate was 459,200. In 2022, the unemployment rate was 18.5%, while official unemployment declined to 186,500. In 2024, the unemployment rate declined to 14.3%, but it was still 4.8 percentage points higher than in 2020, while official unemployment dropped to 94,200. The combination of relative unemployment growth and absolute decline reflects structural transformations in the labour market and an increasing labour shortage. An analytical review of the obtained results concluded that, in shrinking labour resources and rising labour costs, the efficiency of agricultural enterprises is increasingly determined by the qualitative characteristics of human capital rather than its quantitative parameters. A decrease in the number of employees accompanied by an increase in wages means an increase in specific personnel costs, which raises the bar for the effectiveness of every management and production decision. Under such conditions, even minor miscalculations in the organisation of labour, planning of production processes, or use of material and technical resources can lead to disproportionately large economic losses.

The increasing role of human capital is transforming approaches to resource management in agricultural enterprises, shifting the focus from extensive expansion of production factors to optimisation of internal processes. The high cost of labour encourages enterprises to use land, equipment, fuel and working capital more rationally, as the efficiency of their use correlates with professional training and managerial competencies of the personnel. In this context, human capital is an integration element that ensures consistency between technological capabilities, financial constraints and the organisational structure of production. At the same time, the existing age structure of the workforce creates additional management challenges. The predominance of older workers ensures stability in production experience, but hinders adaptation to changes in the technological environment and the introduction of management methods. In the absence of targeted management decisions, this may limit the return on investment in technology and infrastructure, even under favourable macroeconomic conditions. Thus, human capital in Ukrainian agricultural enterprises is becoming systematically relevant as a key factor in improving

resource management efficiency and ensuring the sustainability of production processes.

**Practices and directions
for improving the efficiency
of agricultural enterprise management
based on human capital development**

Human capital management practices at leading agricultural enterprises in Ukraine in 2020-2025 were characterised by a transition to systemic models in which staff training, motivational mechanisms and management innovations are integrated with resource management and production processes. At MHP (n.d.a; n.d.b), human capital management is based on a developed educational ecosystem that includes an in-house training centre, a network of specialised schools (agricultural school, business analytics school, human resources (HR) school) and more than 80 educational events annually. The system includes 10 programmes for management personnel and over 50 online courses, which are implemented according to a model where 70% is practical experience, 20% is mentoring, and 10% is formal training. This training structure prioritises the development of professional, managerial, and digital competencies, including working with SAP, Power Platform, and AI tools, as well as funding for obtaining a second higher education degree. According to the estimates of the company, the integration of training programmes with digital transformation has made it possible to increase the efficiency of production processes by 20-30% by reducing errors, equipment downtime and optimising the use of resources. In addition, MHP develops citizen development programmes and competence centres, uniting more than 350 internal experts, and implements initiatives on stress resistance and reintegration of veterans, which strengthens staff adaptability and reduces personnel risks in wartime (Major agricultural producer..., 2021).

The MHP (n.d.b) motivational model combines tangible and intangible tools. Tangible incentives include competitive salaries, bonuses for achieving key performance indicators (KPI) (productivity, quality), interest-free loans for housing and medical treatment, company housing, and financial assistance in crisis situations.

In 2024, the volume of social initiatives exceeded UAH 37 million, in particular in the form of additional payments to military personnel and their families. Intangible incentives include educational programmes, mentoring, flexible working hours, dual education, and a corporate culture of engagement. As a result, the set of motivational tools has reduced staff turnover by 15-20%, achieving an optimal balance between material (about 60%) and non-material (40%) incentives.

Kernel (n.d.) implements a systematic approach to human capital development based on a digital HR infrastructure that includes LMS Collaborator (n.d.) and Kernel HUB (n.d.). It also includes Microsoft Navision and Office 365, covering the entire HR cycle – from recruitment and staff onboarding to performance evaluation and training. The use of these tools ensures transparency in management decisions through automated KPI monitoring, the use of analytics in Power BI, and real-time access to management data, which minimises subjectivity in the assessment process. In addition, the job profile system supports professional training of production personnel and regular competency assessment based on the Kirkpatrick model. As part of the Re: Knowledge Industry project, knowledge is being scaled up for more than 1,000 factory workers through microlearning, which can be used for expertise in agrotechnology, processing, and logistics to be preserved and transferred in the context of military challenges and seasonal fluctuations (Kernel agro-holding uses..., 2023). Kernel HUB has over 500 daily users and provides access to training materials, videos and internal courses. The training and mentoring system has contributed to a 15-25% reduction in operational losses and an increase in the utilisation of material and technical resources to 85-95% (Forbes, n.d.). Kernel's remuneration system is based on a transparent model, where the base salary is supplemented by monthly bonuses of 30-50% of the salary for production assets for the fulfilment of operational KPIs, annual bonuses for the achievement of strategic goals, and additional payments in the event of exceeding financial plans. Linking remuneration to indicators of MTB utilisation, yield and logistics reduces losses by 15-20% and increases productivity in grain and oil processing

by 10-30%, which ensures staffing levels at 99% (Kernel HR Strategy, 2025).

Astarta-Kyiv (2025a) develops human capital through partnership programmes with educational institutions and international organisations, including cooperation with the European Bank for Reconstruction and Development (EBRD) within the AgriAcademy platform, which offers 25 online courses on sunflower and rapeseed cultivation and processing. The educational initiatives have reached over 1,000 farmers and are complemented by cooperation with Ukrainian universities, dual education programmes, and the involvement of young people in practical work. Partnership programmes have ensured that key positions are filled at a rate of about 80% and reduced staff turnover by 15.20%. Astarta-Kyiv's incentive model combines a base salary with annual reviews, KPI bonuses (yield, MTB efficiency) and career development programmes, which have contributed to increased staff engagement and stability in production processes. Astarta's management innovations in the context of military risks included decentralisation of management, diversification of supply chains, consolidation of assets in safe regions, and the introduction of AI forecasting tools. In 2024, the company recorded a 34% increase in profit, an Earnings Before Interest, Taxes, Depreciation and Amortisation (EBITDA) margin of over 30% and revenue of EUR 612 million, confirming the effectiveness of integrating human capital with resource management and production processes (Astarta-Kyiv, 2025a). A summary of the results of a case study of human capital management practices implemented at MHP, Kernel and Astarta identifies a range of institutional approaches that are relevant for small and medium-sized agricultural enterprises in Ukraine. These approaches were developed during labour shortages, military risks and complications in production processes, which makes their application indicative in terms of optimising management decisions with limited financial resources.

One of the general areas is the organisation of professional training for personnel with an emphasis on specific production functions and management tasks. Within small and medium-sized enterprises, this can be achieved

by combining internal mentoring, short-term modular programmes and the involvement of external educational resources without the formation of separate training structures. From an economic point of view, this is associated with a reduction in operational losses, a reduction in equipment downtime and the stabilisation of technological processes without additional capital investment. Another area for optimising management processes is the formalisation of incentive mechanisms that link remuneration to the performance of employees and departments. The practices identified in the case study demonstrate the possibility of using performance indicator systems to align individual labour performance with the economic performance of the enterprise. For small and medium-sized businesses, this can be implemented in the form of simplified systems for assessing productivity, quality of work and compliance with technological regulations, which reduces unproductive costs and stabilises the personnel structure.

Another area is the development of managerial and digital competencies of personnel as an element of human capital integration with production and accounting systems. Within small and medium-sized enterprises, such integration can be achieved through the gradual introduction of basic digital tools for planning, monitoring and accounting, combined with training personnel in their use. This reduces information gaps, improves the consistency of management decisions and reduces time lags between planning and execution of production operations. Adapting organisational management structures to the age and professional characteristics of staff is also a separate area for optimisation. With older employees dominating the workforce, it is advisable to formalise production procedures, standardise operations and transfer accumulated knowledge within the enterprise. This reduces the dependence of performance results on the individual experience of individual employees and contributes to the reproducibility of production processes in the medium term (Lesik *et al.*, 2020). Overall, the results of the case study by MHP, Kernel and Astarta show that human capital management at leading agricultural enterprises in Ukraine in 2020-2025 has become systematic and is based on the integration

of staff training, motivational mechanisms and management innovations with the processes of using material and financial resources. The practices identified demonstrate the interconnection between the level of human capital development and the effectiveness of production processes, which creates the basis for their adaptation to the conditions of small and medium-sized agricultural enterprises, incorporating resource and organisational constraints.

DISCUSSION

Scientific literature on the development of the agricultural sector highlights the role of human capital, particularly different approaches to interpreting its role in resource management and the organisation of production processes in agricultural enterprises. For instance, S. Saha *et al.* (2025) considered human capital primarily as an investment resource that increases the productivity of agricultural labour through education, health and remittances to households. The study addressed the regional dimension, using panel data from households and econometric models to explain differences in productivity. In contrast, in this study, human capital was interpreted not as an external socio-economic factor, but as an internal system-forming resource of agricultural enterprises that determines the effectiveness of resource and production process management through the qualification, motivational and digital competencies of personnel. A similar difference in the level of analysis was noted during comparison with the study by Y. Hu *et al.* (2023). While sharing the theoretical foundations based on the concept of human capital, the Chinese authors shifted the focus to the macro level, analysing the impact of human capital on the environmental efficiency of agricultural production, considering regional differentiation and digital infrastructure. At the same time, in the study by Y. Hu *et al.*, performance was interpreted much more narrowly and practically – as the ability of enterprises to optimise management decisions, increase resource efficiency and ensure the sustainability of production processes, without a direct link to environmental indicators.

The expansion of this approach was traced in comparison with the study by X. Lei *et al.* (2025),

where the effectiveness of agricultural development was correlated with the formation of new qualitative productive forces and the growth of “green” production efficiency in regions. In this case, the human factor was considered indirectly – as part of a broader innovation and technological transformation. In contrast, in this study, human capital was the central analytical category that directly determined the effectiveness of managing production and resource flows at the enterprise level. A similar gap between the macro and micro levels was also characteristic of the comparison with the study by R. Xie (2025), in which human capital was interpreted as a factor in the growth of green total factor productivity through technological innovation and workforce modernisation. In this study, on the contrary, human capital was considered as an internal management resource that determines the efficiency of production organisation regardless of general economic or environmental transformations. The transition from macro-economic approaches to the management aspects of human capital was most clearly seen in comparison with the study by M. OGREZEANU *et al.* (2025). Both studies recognised the decisive role of personnel in ensuring the sustainability of agribusiness, but M. OGREZEANU *et al.* regarded HRM practices – recruitment, staff retention and succession planning – as tools for the development of farms. In this study, the emphasis was shifted from individual HR tools to the systemic role of human capital in resource management, production processes and the digital transformation of enterprises.

A more socially oriented approach was presented by H. Jin & H. Liu (2025), in an analysis of human capital at the household level and correlated with food security through the mechanism of agricultural specialisation. In this study, on the contrary, human capital was interpreted not as a factor of consumer or social stability, but as a production and management resource that shapes the economic performance of agricultural enterprises. Compared to the study by E.H.Y. Deme & S.A. Doli (2025), there was a common definition of the role of investment in human capital, but a fundamental difference in the channels of influence. While D.E.H.Y. Deme & S.A. Doli viewed human capital through the

prism of the macroeconomic effects of foreign direct investment and the growth of agricultural value added, the presented study interpreted human capital as an internal factor of management efficiency, not directly related to external financial flows.

A comparison of the presented study with the analysis by X. Li & Y. Jin (2025) revealed a common definition of the growing role of intangible factors in improving agricultural production efficiency. In both approaches, development efficiency was linked to the quality of production factors, primarily human capital and innovative capacity. At the same time, X. Li & Y. Jin interpreted human capital as an element of broader regional transformation associated with the integration of the digital and real economies, while in this study, it was considered as a direct factor of managerial and production efficiency at the enterprise level. A similar logic was observed in comparison with the study by M.A.M. Dávila *et al.* (2025). The common aspect was the recognition of the decisive role of knowledge, skills and organisational practices in shaping economic outcomes. The difference lay in the analytical focus: M.A.M. Dávila *et al.* linked human capital to organisational learning and innovation processes in the context of sustainable development, while this study focused on its role in ensuring the efficiency of resource and production process management.

A comparison with the study by H. Jin & H. Liu (2025) revealed a common interpretation of the impact of labour quality on the productivity of agricultural enterprises. However, H. Jin & H. Liu viewed human capital primarily through the prism of institutional factors – agricultural labour policy, employment regulation and migration processes. In this study, however, the internal management mechanisms for performance formation were addressed without a direct emphasis on the regulatory environment. A comparison of the presented study with the analysis by Y. Buchana *et al.* (2025) revealed a common approach to the multifactorial nature of agricultural productivity and the role of human capital in improving production efficiency. At the same time, Y. Buchana *et al.* emphasised the quantitative analysis of classical production factors at the local level, while this study

emphasised the qualitative measurement of human capital as a factor of managerial coordination and resource efficiency.

The similarity of theoretical foundations was also evident in comparison with the study by Y.S.A. Frijat & A.A. Elamer (2024), where human capital was interpreted as a key intangible asset of enterprises. The difference lay in the interpretation of performance: Y.S.A. Frijat & A.A. Elamer associated it with corporate governance, financial transparency and investment attractiveness, while the presented study addressed the production and management aspects of agricultural activity. E. Sánchez-García *et al.* (2025) considered human capital and management practices as tools for ecological performance through green HR approaches and behavioural factors. There was a common recognition of the role of staff competencies, but the difference lay in the targets: environmental responsibility in E. Sánchez-García *et al.* was contrasted with the management and resource efficiency that this study focused on.

A comparison with the study by M. Bin & H. Qiong (2024) demonstrated a common interpretation of human capital as a factor in the socio-economic development of the agricultural sector. At the same time, M. Bin & H. Qiong analysed it at the macro level, linking it to the processes of rural revitalisation and professionalisation of farmers, while this study addressed the micro level of enterprises and resource management mechanisms. A comparison of the presented study with the analysis by D. Antonioli *et al.* (2025) revealed a common recognition of human capital and HRM practices as key factors in improving the performance of enterprises. Both studies emphasised that training, employee engagement and organisational change improved corporate adaptability to technological and structural transformations and increased resource efficiency. Another common aspect was the perception of human capital as a dynamic resource that shapes the innovative potential and long-term sustainability of a business. At the same time, the analytical focus differed. D. Antonioli *et al.* addressed the “dual transformation” of combining digital and green innovations in industrial enterprises, where HRM practices were considered as a tool to support

environmental and digital innovations. Instead, in this study, human capital was analysed in an agricultural context as a system-forming factor in the effectiveness of resource management and the organisation of production processes, without a direct emphasis on ecological and digital transformation.

A summary of scientific approaches showed that human capital was consistently considered a key factor in improving the performance of the agricultural sector, but approaches to its analysis differed significantly in terms of the level of generalisation and interpretation of the mechanisms of influence. Most studies addressed macroeconomic, social, environmental or institutional aspects, interpreting human capital as a prerequisite for structural transformations, innovative development and productivity improvement. At the same time, in practical terms, it was treated as an internal resource that determined the effectiveness of resource management and the organisation of production processes at the level of agricultural enterprises. This confirmed the multidimensional nature of human capital and its decisive role in shaping the performance of agricultural production.

CONCLUSIONS

The study confirmed that between 2020 and mid-2025, human capital became a key factor in the effective management of resources and production processes at Ukrainian agricultural enterprises amid a decline in labour resources, rising labour costs and a more complex technological environment. The statistical data obtained showed that during the study period, the number of people employed in agriculture increased by 3.5%, while the average monthly nominal wage increased from UAH 9,737 in 2020 to UAH 21,413 in the first quarter of 2025, and for certain specialities in 2025 exceeded UAH 25,000. This means an increase in specific personnel costs and, accordingly, higher requirements for the effectiveness of each management decision. An analysis of wage and productivity dynamics showed that investments in staff qualifications, motivation and management skills resulted in a 5-15% increase in labour productivity and a 10-20% increase in enterprise profitability due to reduced staff

turnover, time losses and unproductive costs. The use of results-oriented wage systems made it possible to increase the volume of work performed by 20-25%, while insufficient motivation and low wages contributed to a decline in productivity of approximately 10%. In a situation where agriculture accounted for about 17% of Ukrainian gross domestic product in 2024, the efficient use of human capital had a direct impact on the macroeconomic stability of the agricultural sector.

The results of case studies of MHP, Kernel, and Astarta demonstrated the economic return on systematic human capital development. At MHP, the integration of educational programmes, mentoring and digital management tools has increased the efficiency of production processes by 20-30%, reduced equipment downtime and lowered staff turnover by 15-20%. At Kernel, the digitalisation of HR processes and the use of KPI analytics helped reduce operational losses by 15-25% and increase the utilisation of material and technical resources to 85-95%, which ensured a 10-30% increase in processing productivity and maintained staffing levels at 99%. At Astarta, a combination of partner educational programmes, performance-based motivation and management innovations made it possible to maintain staffing levels for key positions at around 80%, reduce staff turnover by 15-20% and achieve a 34% increase in profit in 2024 with an EBITDA margin of over 30%. Based on the results obtained, it was recommended to address the management decisions of agricultural enterprises on systemic investments in human capital development through modular professional training, results-oriented motivation systems, and the phased digitalisation of management processes, which would increase labour productivity, resource efficiency, and the sustainability of production processes within limited financial constraints.

The results obtained showed that the improvement of employees' qualifications, the development of professional competencies and the application of motivational mechanisms were accompanied by an increase in the efficiency of resource management and production processes in agricultural enterprises. The limitation of this study is the temporal,

statistical, and institutional conditions of the Ukrainian agricultural sector in 2020-2025, which determine the specificity of the results obtained. Further research should expand analytical models for assessing human capital, incorporating regional differentiation, the digital maturity of enterprises, and the long-term effects of management innovations.

None.

None.

None.

ACKNOWLEDGEMENTS

FUNDING

CONFLICT OF INTEREST

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Олександр Біліченко

Кандидат економічних наук, доцент
Миколаївський національний аграрний університет
54008, вул. Георгія Гонгадзе, 9, м. Миколаїв, Україна
<https://orcid.org/0000-0002-5241-3195>

Оксана Большая

Кандидат економічних наук, доцент
Полтавський національний педагогічний університет імені В. Г. Короленка
36003, вул. Остроградського, 2, м. Полтава, Україна
<https://orcid.org/0000-0003-0543-5196>

Вплив людського капіталу на ефективність управління ресурсами та виробничими процесами сільськогосподарських підприємств

Анотація. Метою дослідження було визначення ролі характеристик людського потенціалу у формуванні управлінських рішень та функціонуванні виробничої діяльності. Методологічну основу дослідження становив емпіричний підхід із застосуванням описового, динамічного, структурного та порівняльного аналізу офіційних статистичних даних, аналізу відносних показників ринку праці, а також методу кейс-стаді та аналізу практик управління людським капіталом провідних аграрних підприємств. Результати засвідчили, що у період 2020 – середини 2025 років чисельність зайнятих у сільському господарстві зросла на 3,5 %, тоді як середньомісячна номінальна заробітна плата зросла з 9,737 грн у 2020 році до понад 21,413 грн у першому кварталі 2025 року, а за окремими спеціальностями перевищила 25,000 грн. За умов дефіциту робочої сили підвищення вартості праці посилило роль якісних характеристик персоналу в управлінні ресурсами. Встановлено, що інвестиції у кваліфікацію та мотивацію персоналу забезпечували приріст продуктивності праці на 5-15 % і зростання прибутковості підприємств на 10-20 %, тоді як результатоорієнтовані системи оплати праці дозволяли збільшувати обсяги виконаних робіт на 20-25 %. Частка сільського господарства у валовому внутрішньому продукті України у 2024 році досягла близько 17 %, що відображало структурні трансформації трудового потенціалу. Практики управління людським капіталом, проаналізовані на прикладі «Миронівського хлібопродукту», Kernel та Astarta-Kyiv, засвідчили скорочення плінності персоналу на 15-20 %, підвищення продуктивності праці на 10-30 % та зростання ефективності використання матеріально-технічної бази до 85-95 %, що дозволяло зменшувати операційні втрати на 15-25 %. Практичне значення дослідження полягає у можливості використання отриманих результатів аграрними підприємствами для підвищення ефективності управління персоналом і ресурсами

Ключові слова: безробіття; продуктивність; компетентності; кваліфікація; заробітна плата; мотивація