THE DIGITALIZATION EFFECTIVENESS AS AN INNOVATIVE FACTOR DEVELOPMENT OF THE AGRICULTURE IN AZERBAIJAN

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ABSTRACT

The purpose of this paper is to systematize and justify the factors for the effective implementation of digitalization to ensure the innovative development of agriculture in Azerbaijan. Based on the survey completed by 1,513 senior managers of agricultural enterprises in Azerbaijan, the key factors and barriers to a digitalization of agriculture were substantiated: the cost of introducing and using digital technologies, unregulated legislative processes of digitalization of the industry, and the level of cybersecurity. The levels of development of digitalization of the country's agricultural sector have been determined and empirically substantiated the qualitative nature of the influence of digitalization factors on the innovative development of agricultural enterprises using the regression modeling method. The results obtained can help develop a state strategy for enhancing the digitalization of the country's agricultural sector to ensure its innovative development, food security, and diversifying the economy.

Keywords: Agricultural, digitalization, innovative development, Azerbaijan, agricultural enterprises

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INTRODUCTION

Azerbaijan's economy is characterized by the fact that the extraction, processing, and export of crude oil and gas is the defining industry of the mining and energy sectors of the economy but also a critical factor in the development of the

national economy. In the historical era of the USSR, Azerbaijan was one of the leading industrial centers of the union, as it provided above 70% of chemicals for consumption by the Soviet economy (Ministry of Industry and Trade of Russia, 2020). The oil and gas industry has always been the driver of the development of the Azerbaijani economy. The volume of oil and gas trade accounts for the lion's share of the country's export volume. At the beginning of 2021, the percentage was up to 80% of the country's exports (568,000 b/d crude oil and 418 Bcf of natural gas) (Fig. 1) (Deloitte, 2021). That indicates the excessive dependence of the national economy on the energy sector and the low level of its differentiation regarding the energy production sources.

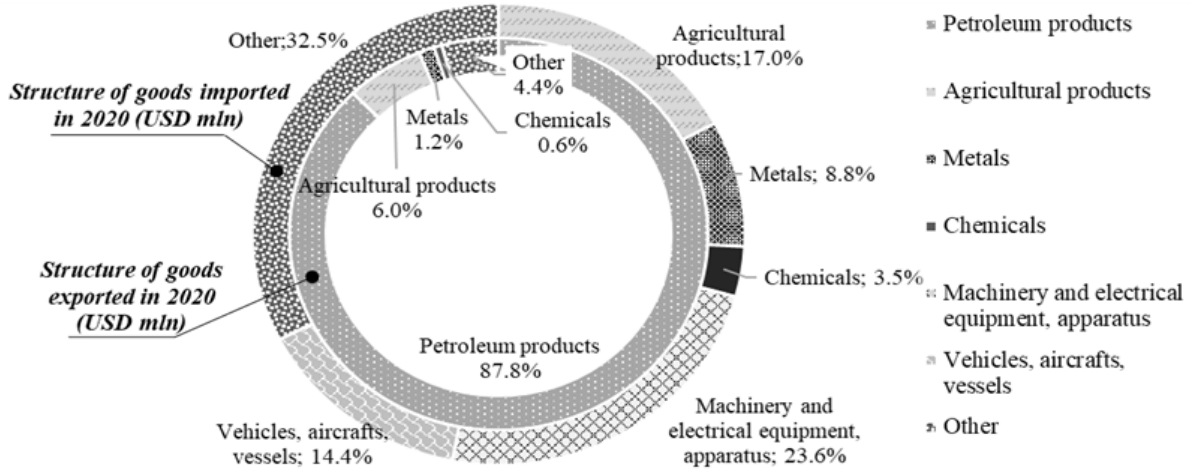


Figure 1: Commodity structure of export/import of Azerbaijan on the beginning of 2021
Source: Authors' finding

The sharp decline in oil prices and profound imbalance in spot prices because of spreading the COVID19 pandemic against the background of the progressive low productivity of the country's oil industry led to 4.3% decline of GDP at the beginning of 2021.And the volume of foreign direct investment (FDI) has reached a minimum value, which can compare with the level during the crisis period of 2008 (International Monetary Fund, 2020). The consequences of the pandemic have shown that the existing growth factors have lost their potential. During the period of crisis manifestations, the pandemic has emphasized the urgent need for deep transformations in the national economy, at the center of which should be its diversification.

The agricultural sector occupies one of the central places in the sectoral structure of the country, providing production for more than 6% of Azerbaijan's GDP and employment for almost 40% of the population (Deloitte, 2021). The development of the agro-industrial complex has a significant potential for developing the non-oil sector of the country's economy. Therefore, according to "Azerbaijan 2030: National Priorities for Socio-economic Development", the government has identified agriculture as one of the key factors contributing to the diversification of the national economy (President of the Republic of Azerbaijan, 2021). According to the results of the latest sociological survey by Deloitte in 2020, most companies and other business entities adhere to the point of view that agriculture is the most promising industry to ensure the non-oil development of the national economy in the next five years (Fig. 2) (Deloitte, 2021).

In modern conditions, development of the agricultural industry is exposed to the risks of worsening climatic conditions, degradation of irrigation systems, progression of salinization, erosion and soil depletion, difficulty in accessing freshwater for straits, rising temperatures, lack of precipitation, etc. (Hajiyeva, 2021). Along with these negative impacts, the industry is affected by the inefficiency of infrastructural factors, such as severe depreciation of production capacities, unresolved legislative issues of privatization and

division of land, a decrease in the number of agricultural enterprises, the lack of highly qualified specialists in the development of the agrarian sector, the inefficiency of the lending mechanism, subsidies, investment and more (Aliyev, 2019).

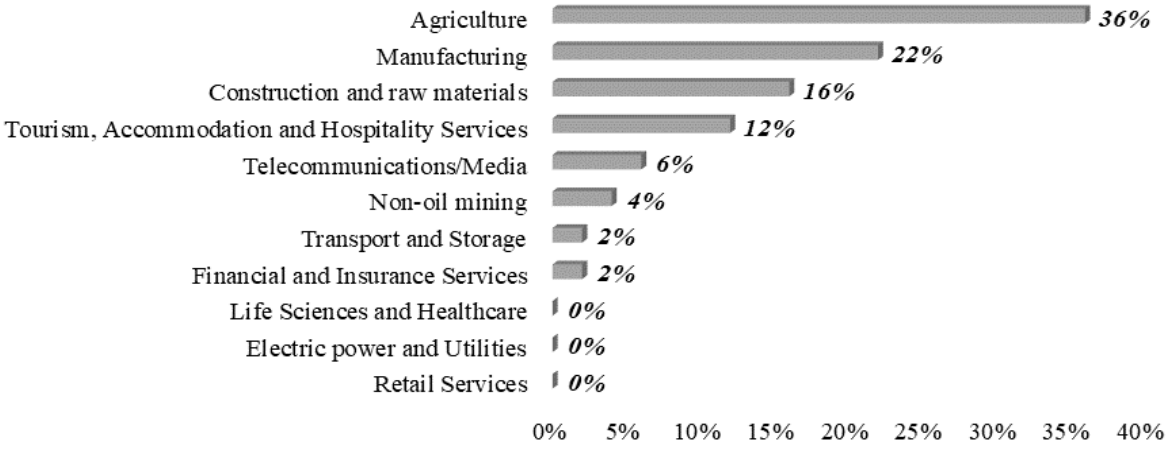


Figure 2: Results of a survey by Deloitte on the importance of industries ensuring the diversification of the Azerbaijani economy, 2020

Source: Authors' finding

The current conditions for the functioning of the agriculture of Azerbaijan against the backdrop of the need for its development require urgent resolution of existing problems, which, according to leading experts and scientists, can be achieved only through innovative development. The introduction of a new paradigm for agriculture development in the country should be based on various innovations everywhere (Hajiyeva, 2021; Aliyev, 2019). But ensuring a creative direction of action that is adequate to the upcoming scale and goals of agricultural production's scientific and technical transformation is possible only if correct, creative and effective business decisions are made (Figueiredo et al., 2019). The innovative development of the industry must be able to generate and process large datasets describing climate characteristics, crop history, agrochemical, physical, and chemical soil properties, field characteristics, and much more. In other words, it is possible to ensure rapid innovative development for Azerbaijan's agriculture today through the digital transformation of the industry (Figueiredo et al., 2019; Hajiyeva, 2021). Such an approach for an industry characterized by a low level of surplus value can create the effect of an agricultural revolution, reducing manual labor costs and changing the entire value chain of agribusiness while increasing productivity.

The dominant number (about 70%) of farmers in such developed countries as the USA, Canada, and European countries actively use digital technologies to develop agriculture (Rostec, 2020). Agrarians in Azerbaijan are very far from such activity, but the demand for digitalization is gradually increasing. For example, in 2019, an online platform of Azerbaijan's Electronic Agricultural Information System was introduced as an innovative initiative, which provides widespread access to the services of agricultural enterprises, contains general information on the availability of sown areas and agricultural producers, information about the quality soil in various regions of the country, and much more (FAO, 2021).

Based on the "National Strategy on the development of information society in the Republic of Azerbaijan (2014-2020)" and "Strategic Roadmap for Development of Telecommunications and Information Technologies in the Azerbaijan Republic," digitalization was put as a priority direction of the country's socio-economic development and diversification of the national economy (President of the Republic of Azerbaijan, 2014; President of the Republic of Azerbaijan, 2016). The country is a participant in projects digital transformation: EU4Digital Facility, EaPConnect, EU4Digital Cyber and EU4Digital Broadband (EU4Digital, 2022). But as far as agriculture is

concerned, these processes are in their infancy in Azerbaijan. Therefore, this study aims to identify the contributing factors or barriers that directly impact the development of digitalization in the agriculture of Azerbaijan. We argued the nature of their influence on ensuring agriculture's effective, innovative development in current conditions.

LITERATURE REVIEW

The concepts of innovative development of agriculture as a whole can be divided into two approaches: development along the horizontal and the vertical axis (Figueiredo et al., 2019; Bezpartochnyi, Britchenko & Bezpartochna, 2021; Figueiredo et al., 2019). The horizontal trajectory of the development involves development in three differentiated areas: the traditional agribusiness story, the digitalization of agriculture, and the formation of ecosystems with market participants (Bezpartochnyi, Britchenko & Bezpartochna, 2021).

The vertical trajectory of agribusiness development reflects the complexity of the evolution of technological development, and agriculture is the most suitable for such an increase in productivity, particularly seed production and breeding. Today, the technical basis is characterized by developing hybrid breeding, breeding, agrobiology, and GMOs, which are widely known in agribusiness. But also, the technological development of agriculture is evolving, and some technologies are just beginning to be applied, for example, CRISPR / Cas9 gene-editing RNA interference (RNAi tech) (Figueiredo et al., 2019). Because the vertical trajectory of agricultural development is not the object of our study, we omitted the analysis of scientific research in this direction.

The concept of traditional development is based on the dominant dependence of the industry on the human resource factor, the main characteristic of which is the low level of the added value of the industry due to high production costs (Hajiyeva, 2021). The efficiency of the industry development can be ensured by maintaining the high cost of production, which is possible only under the condition of an accompanying price environment (Shapran & Britchenko, 2021a; Shapran & Britchenko, 2021b).

Agricultural development through digital transformation focuses on the innovative intensification in each structural component of the industry, the production process, and individual operations. It achieves the complete automation of production and the industry by introducing various digital elements. The main goal of the industry development is a significant reduction in the cost of production due to considerable increases in productivity (Figueiredo et al., 2019).

A third approach to the development of agriculture is based on the formation and consolidation of business ties, which include the use of information technology and digital platforms that unite participants in agribusiness. Such ecosystems create a digital structure of the agricultural market, making it possible to disseminate ideas and innovative business models, eliminate intermediaries, algorithmize mutually beneficial relationships and thus reduce transaction costs (Wysel, Baker & Billingsley, 2021).

Most scientists consider that digitalization is the format of aggregation, processing, and use of information data arrays that allow making effective business decisions, optimizing business processes, and replacing human labor with machine labor. Almost all over the world, agriculture is characterized by the introduction of digital technologies, and there is a clear upward trend. However, the industry still lags far behind other areas of the economy regarding the level of implementation of IT solutions (Harvard Business Publishing, 2016). This has given rise to many works devoted to studying constraints in introducing digital technologies for the innovative development of the economy or its sectors and agribusiness in particular. (Subeesh & Mehta, 2021; Vasiljeva et al., 2020; Figueiredo et al., 2019; Nguyen & Tuyen, 2021; Megits, Neskorodieva & Schuster, 2020). Among the main destructive factors are the high cost of implementing these technologies, legislative uncertainty, low level of cybersecurity, etc.

The high cost of digital technologies limits the possibilities to use digital technologies for innovative development due to their limited financial capabilities. A study by the Eurasian Development Bank indicates the impact of GDP per capita (an indicator of economic capacity) on the level of the population with access to the Internet (an indicator of digitalization) (Eurasian Development Bank, 2019). The part of the population with access to the Internet

characterizes the most elementary, basic level of the digital economy. Its further development: implementing e-commerce models, electronic order, the introduction of artificial intelligence technologies, etc. requires even higher financial costs. This assumption was confirmed by the tightness of the relationship between GDP per capita and Networked Readiness Index, GDP per capita, and Digital development in 130 countries for 2020 (Portulans Institute, 2020; E-Governance Academy, 2022). The calculated correlation coefficients were 0.66 and 0.74, respectively, which is statistically significant at a significance level of p=0.05 (Cunningham, Weathington & Pittenger, 2013). More developed countries can allow greater use of digital technologies than less developed countries. Due to the high cost of digital technologies, less developed countries do not have the necessary funds to implement technologies.

Within the framework of this problem, scientists have differentiated levels of information transformation. The low level (the level of development of e-commerce) is characterized by isolated examples used in the economy or industry such as digital technologies: electronic payments, digital technologies to establish communications, electronic document flow, basic models of e-commerce (B2B, B2C) (Maghlaperidze, Kharadze & Kuspliak, 2021; Nguyen & Tuyen, 2021). The middle level (the level of digitalization of production processes and information processing) is characterized by more systematic use of digital technologies in business that ensure its innovative development: automation of the production process, work with large amounts of data, storage, a transformation of information (Figueiredo et al., 2019; Wysel, Baker & Billingsley, 2021). A high level (the level of development of artificial intelligence) is characterized by the introduction of artificial intelligence technologies at the enterprises of the industry, making it possible to automate the production process management and decision-making fully (Subeesh & Mehta, 2021).

The influence of digital development on the Global Innovation Index has been proven empirically, which may indicate that the high level of cost of digital technologies hinders the scales of digitalization. As a result, it inhibits the innovative development of countries or industries at the macro-and meso- levels (Portulans Institute, 2020; E-Governance Academy, 2022). Based on the preceding, we can assume that at this stage of agriculture development in Azerbaijan, the expansion of digitalization does not consistently positively impact the effectiveness of innovations in the industry due to the high cost of introducing digital technologies (Hypothesis 1).

The second limiting factor in the digital economy development is legislative unsettledness, manifested in the absence of laws regulating copyright for artificial intelligence, rules that determine responsibility when making decisions using artificial intelligence, etc. (Subeesh & Mehta, 2021). Consequently, the lack of legislative regulation for transformation mechanisms hinders the innovative development of agriculture in Azerbaijan (Hypothesis 2).

The National Cyber Security Index testifies to the low level of cybersecurity in Azerbaijan. According to this index, in 2020, Azerbaijan occupied the 82nd position in the rating with an index value of 37.66 out of the maximum 100. It was in 50th place (out of 160 countries) in the gap between cybersecurity and digitalization level (E-Governance Academy, 2022). Based on data for 130 countries for 2020, pairwise correlation coefficients were calculated between the cybersecurity lagging behind the level of digitalization, GDP per capita, and the Global Innovation Index (Portulans Institute, 2020; E-Governance Academy, 2022). The obtained values were -0.68 and -0.73, respectively. The statistical significance of the correlation coefficients and their negative values indicate that the development of the digital economy does not always contribute to the economic and innovative development of countries. In the absence of appropriate cybersecurity measures, the digital economy development can lead to financial losses due to unauthorized access to company accounts, illegal access to confidential information, the use of phishing technologies, etc. In this regard, we assumed that the agricultural sector digitalization in Azerbaijan increases innovation efficiency, subject to the availability of appropriate measures to ensure cybersecurity (Hypothesis 3).

METHODOLOGY

To assess the innovative development of agriculture through digitalization, we developed

a survey with questions that characterize the industry's digitalization level (DIG) and the factors for effective digitalization implementation (Subeesh & Mehta, 2021; Figueiredo et al., 2019).

According to our hypotheses, the main limiting factors are the cost of implementing and using digital technologies *(COST*), legislative unregulated industry digitalization processes (*LEG*), and the level of cybersecurity *(SEC*). Using indicators characterizing the scale of digitalization and their impact on the components of sustainable development of the industry (economic, environmental, social), we assessed the level of development of industry digitalization (*DIG*) (Nguyen & Tuyen, 2021).

We used the term "digitalization factors" to designate the factor characterizing the level of digitalization development in the industry and the factors hindering the growth.

One thousand five hundred thirteen top managers took part in the survey - one representative from an agricultural enterprise in Azerbaijan. There were no restrictions on the size or territorial location of enterprises whose managers took part in the survey. This made to comprehensively assess the features of digitalization and innovative development in the industry. The sample size is representative, with an acceptable error level of 5% (Taherdoost, 2017). The survey was conducted during January-May 2021 remotely using Google Forms (2022). The survey included answers to the questionnaire questions using the 5-Point Likert Scale, according to which the respondents gave marks in the range of "1"-"5". The higher the score, the closer respondent agrees with the survey question.

Cronbach's alpha assessed the reliability of the questionnaire. The values of this indicator were calculated based on scores for each group of indicators (*DIG, COST*, *LEG, SEC*) and the entire survey. We used the program Statistica 12.0 for the calculation. The calculated values of the Cronbach's alpha index for the *DIG, COST, LEG, SEC* factors are in the range of 0.84-0.88 for the entire questionnaire – and 0.78, which indicated the reliability of the questionnaire (Hair et al., 2017).

Factors *DIG, COST, LEG, SEC* have been formed so that each of them characterizes its subject area. Statistical confirmation of this is the value of Cronbach's alpha.

We used integral indicators to quantify the impact of digitalization factors on the innovative development of enterprises in the industry (Formula 1). Weight coefficients for particular indicators in integral models were determined based on the information entropy indicator (Quax, Har-Shemesh & Sloot, 2016). The stable level of the indicator or its continuous change is more informative than the alternation of stages of growth and decline. In this case, the dynamics of the indicator may not be the result of systemic changes in the agricultural industry caused by digitalization but be the result of the influence development of some short-term impulses of an episodic nature.

$$I = \sum \frac{1-e_i}{\sum_{i=1}^{n}(1-e_i)} \times b_i, \quad (1)$$

$$e_i = -\left[\frac{|v_i|}{\sum_{i=1}^{n}|v_i|} \times ln \frac{|v_i|}{\sum_{i=1}^{n}|v_i|}\right], \quad (2)$$

where:

I – integral value of the digitalization factor;

e_i – information entropy indicator of the i-th digitalization indicator;

b_i – scoring of the i-th digitalization indicator;

v_i – coefficient of variation of the i-th indicator of digitalization;

n – the number of digitalization indicators based on which the integral indicator was calculated

The integral indicator of the development of digitalization (*DIG*) using the Fibonacci rule formed the basis for grading the digitalization levels of the industry (Megits, Neskorodieva & Schuster, 2020). The integral indicator measured in the range [1; 5], therefore, according to the Fibonacci rule: a low level of digitalization corresponds to values of the integral indicator [1; 2.52]; medium - (2.52; 3.48]; high - (3.48; 5].

Transitional levels are also defined: low and medium, medium and high due to the lack of precisely determining turning points that separate the digitalization levels. These transition levels have been defined using the 3-sigma rule (Quax, Har-Shemesh & Sloot, 2016). As a result, the following digitalization levels have been formed: low - with the value of the integral digitalization indicator of the industry in the range [1; 2.34], medium - [2.57; 3.41], high -

(3.48; 5]. Since none of the surveyed enterprises has a high level of digitalization, we did not adjust the high level using the 3-sigma rule. We determined its boundaries on the Fibonacci rule. The qualitative criteria to assess the levels of information transformation were the generalized characteristics presented in the Literature review (Nguyen & Tuyen, 2021; Figueiredo et al., 2019).

Linear and non-linear regression models were used to assess the impact of digitalization factors on enterprises' innovative development and thus test the research hypotheses, sing the EViews10 program to build regression models. The innovations efficiency indicator of agricultural enterprises (innovative profitability) we used as a dependent variable (Formula 3):

$$RI = \sum_{i=1}^{n} \frac{Pr_i - Pr_0}{(1+r)^i} \Big/ \sum_{i=1}^{n} \left(\frac{I_i}{(1+r)^i}\right) + I_0, \quad (3)$$

where:

RI – innovation profitability;

Pr_i – net profit of the enterprise for the *i*-th period (year);

Pr_0 - net profit of the enterprise for the *0*-th period - the period before the introduction of innovations;

I_i – the volume of investments to innovations for the *i*-th period;

I_0 – the amount of initial investment;

r – discount rate (average interest on deposits of commercial banks for legal entities in the country);

n – the period (years) during which the economic effect of innovation is the most significant.

We used the concept of time series discounting for making formulas (Berkman & Malloch, 2021). At the same time, we did not use net profit indicators, but the absolute increase in net profit compared to the base period. We used growth to estimate the change in earnings due to innovation. We selected the enterprises for the study from those for which, during the study period, apart from innovation, no other significant activities were carried out that could affect profits (for example, change of ownership, rebranding, development of new sales markets, mergers, or acquisitions, etc.). Innovation refers to any digitalization-related activities connecting with new production technologies, new communication capabilities, new data processing, decision-making capabilities, new areas of e-commerce (Nguyen & Tuyen, 2021).

We used as independent variables the values of integral indicators - digitalization factors and the cybersecurity margin indicator (MC), calculated by analogy with (E-Governance Academy, 2022) as the difference between the integral indicator of cybersecurity and digitalization (*SEC-DIG*). Regression models have built using a sample of 1513 agricultural enterprises in Azerbaijan under study.

The choice of the type of model has been determined by the adequacy indicators: t-criterion, p-value, F-criterion, the deviation percentage of the values of the resulting indicator of the models from the actual values. The deviation percentage does not exceed 4%; empirical values of t-test |2.76|-|4.95| exceed the critical significance of 1.97 at a significance level of p=0.05; p-value→0; empirical values of the F-criterion 29.64-71.77 exceed the critical importance of 3.89 at a significance level of p=0.05 (Cunningham, Weathington & Pittenger, 2013). The number of observations was more than 90 times greater than the independent variables. For linear regression models, provided the normal distribution of variables. This indicates the adequacy of the constructed regression models.

RESULTS

The average indicator of the digitalization development in Azerbaijan agriculture was "2.02" with a maximum of "5" points. The highest scores on issues that characterize the use of digital technologies to:

- optimization of communications within the enterprise and with external entities (“5.0” points);
- electronic payments (“4.8” points);
- online advertising ("4.0" points);
- predicting market trends (“3.5” points);
- data processing ("3.1" points);
- ordering and selling products through corporate websites (“2.7” points);
- interaction through electronic services (“2.3” points).

To a lesser extent, digital technologies are used in the production process and increase labor productivity (2 points each). In other areas of digital technologies, average estimates we measured in the range [1; 1.6]. These are areas such as the use of digital technologies for:

1) reducing the level of air pollution, groundwater, land;
2) creation of additional competitive advantages;
3) rationale for decision-making;
4) optimization of management processes;
5) the process of warranty and post-warranty service;
6) freeing up part of the time of employees for their self-development and development of creativity;
7) paper flow automation.

Using formulas (1-2), we calculated the average integral indicator of digitalization for the agricultural industry in Azerbaijan: “2.08”. This level showed a low level of digitalization of the sector (Table 1).

Table 1: Digitalization level of the agriculture in Azerbaijan, 2021

Level of digitalization	The range of values of the integral digitalization indicator (points)	Share of enterprises understudy, %
Development of e-commerce (low level)	[1; 2.34]	69.73
Transitional level	(2.34; 2.57)	16.39
Digitalization of production processes (intermediate level)	[2.57; 3.41]	13.88
Transitional level	(3.41; 3.48]	-
Development of artificial intelligence (high level)	(3.48; 5]	-

Source: Authors' finding

The majority of the agricultural enterprises (69.73%) are at the stage of development of e-commerce (low level of digitalization) (Table 1). 13.88% of enterprises are at the stage of digitalization of production processes (middle level). Popular for them are drones to detect diseases of crops and spray them (Deloitte, 2021). The use of drones is more cost-effective due to savings in operating costs. 16.39% of enterprises are at the transitional level of digitalization - between low and medium. We did not reveal a high level of digitalization among the enterprises.

In terms of the cost of implementing and using digital technologies, the average score was “4.4” points, confirmed by studies (Subeesh & Mehta, 2021; Nguyen & Tuyen, 2021), which indicates the destabilizing effect of the high cost of implementing digitalization development. According to all respondents, the reasons for the non-use of digital technologies in the enterprise (or the use is not as active) are the high cost of technology, significant financial costs for the restructuring of assets, adaptation of the production process, infrastructure to new technologies, reprofiling of personnel, and development of new competencies. The financial capabilities of the enterprise do not allow financing the introduction of artificial intelligence technologies. The average score for the relevant questionnaire questions was "5" points.

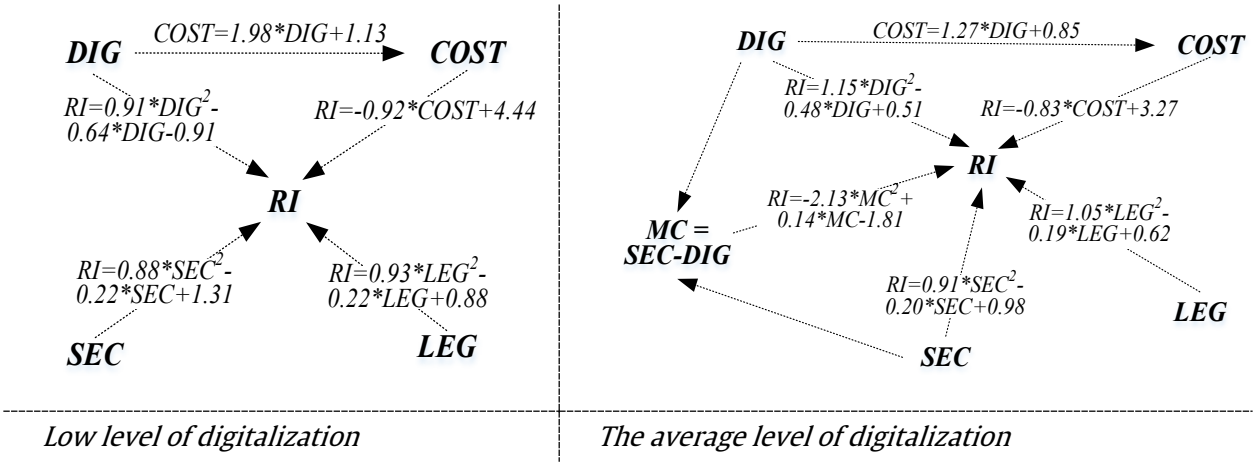
The nonprogress digitalization of agriculture is also a consequence of the unregulated legislation in using digital technologies. The average score for this group of questions was "1.6" points, while a higher score indicates a more advanced mechanism for legislative regulation for using digital technologies.

The questions on cybersecurity have been designed according to the higher the score, the higher the level of cybersecurity. Most enterprises have not developed a cybersecurity policy and a program to combat cyberattacks because there are no cybersecurity specialists, no courses, or training to improve personnel's cyberliteracy. The average score for the questions was "1.8" points, which indicates a low level of

cybersecurity in agricultural enterprises in Azerbaijan.

The results showed that only within three years was there an economic effect from innovations: there was an increase in the net profit of enterprises by more than 5%.

We built regression models separately for each level of digitalization (Fig. 3).



Legend: RI is the profitability of innovations; DIG is an integral indicator of business digitalization; COST is an integral indicator of the cost of using digital technologies; LEG is an integral indicator of the legislative regulation; SEC is an integral indicator of MC that is a margin indicator in cybersecurity.

Figure 3: Regression models of the digitalization factors influence the innovative development of agriculture in Azerbaijan

Source: Authors' finding

We can indicate that digitalization growth has a significant positive impact on innovative development (increasing innovations and income profitability).

DISCUSSION

The results concluded that for the studied enterprises of Azerbaijan, taking into account the growth of costs with the expansion of the scale of digitalization, the growth of the integral digitalization indicator ultimately has a positive effect on the profitability of innovative development. For agricultural enterprises at a low level of digitalization, the increase of integral digitalization indicator by 1% leads to a rise in the profitability of innovation by 1.08%. For enterprises at the average level of digitalization, the growth in profitability is 1.59%. The increase in the elasticity of the innovation profitability indicator and level of digitalization indicates a positive economic effect for enterprises increasing digitalization, considering the growing costs of introducing digital technologies. This conclusion refutes the provisions of the H1 hypothesis and the statements of scientists that the high price of technologies, firstly, limits their use, making producers abandon more efficient but expensive technologies (Nguyen & Tuyen, 2021). Secondly, the growth of digitalization leads to an increase in financial costs, which may exceed the positive effect of introducing technologies (Subeesh & Mehta, 2021). Therefore, the introduction of digital technologies, even at a high-cost level, can quickly provide economic benefits by leveling wrong decisions and increasing the return on production, reducing production costs several times.

The findings, in our opinion, are of significant value in enhancing the innovative development of the agricultural business in Azerbaijan through digitalization since it is possible to understand what barriers need to be removed first of all for the creative development of the industry. It is expedient to inform agricultural enterprises and popularize the benefits of using digital technologies in business in the short term. But at the same time, the problems of lending and subsidizing agriculture should be solved in

the country. Preferentially targeted lending to enterprises of the agricultural sector can become effective in this matter. As the practice of other countries shows, such an approach makes digital technologies accessible even for small businesses (Figueiredo et al., 2019; Nguyen & Tuyen, 2021). And taking into account the fact that the peculiarity of agriculture in Azerbaijan is the fragmentation of business, one can argue that concessional lending today seems to be the only way to informatization of innovative development accessible to agriculture in the country.

The indicator of legislative regulation for both models (for low and medium levels of business digitalization) positively impacts the effectiveness of innovative development. We can conclude there is a significant destabilizing effect of legislative unsettledness of the efficacy of digital innovations. Due to legislative conflicts, the actual level of profitability of innovative development is 7.9 times lower than the potential for enterprises at a low level of digitalization and 8.6 times for enterprises at an average level of digitalization. A loss of efficiency with legislative unsettledness confirms the H2 hypothesis.

Regulatory barriers are a significant obstacle to the innovative development of agriculture and the digital economy in general. In the case of Azerbaijan, the rapid updating of legislation, the unification of data transmission standards and regulations, the availability of testing grounds and pilot production facilities for testing new technologies, the introduction of state support measures for the transition to digital technologies, and the development of specialized programs for the training of qualified personnel for the digitalization can significantly stimulate innovative growth in agriculture.

Cybersecurity is a necessary condition for effective digitalization. Increasing integral cybersecurity indicators by 1% leads enterprises to increase efficiencies with a low level of digitalization by 1.5%, on average - by 1.7%. For enterprises of an intermediate level of digitalization, the negative value of the cybersecurity margin offsets the positive impact of digitalization development on innovation effectiveness. As a result, increasing the level of digitalization by 1% and the negative value of the cybersecurity margin, the profitability of digital innovations decreases by 2.4%, which empirically confirms the H3 hypothesis put forward in this study. Based on the results obtained, we can conclude that those cybersecurity measures implemented at agricultural enterprises are sufficient for effective functioning at a low level of digital technology development. At an average level with a constant level of cybersecurity, the development of digitalization negatively affects innovation effectiveness. This is due to the risk of unauthorized access to financial information and fraud.

CONCLUSION

This study has revealed the differential influence nature of the development level of digitalization on the efficiency of innovation in agricultural enterprises under the power of the cost factor, factors of legislative regulation, and cybersecurity. Developing measures to ensure cybersecurity should be a priority task for enterprises in the agricultural industry in Azerbaijan. The next step in ensuring the development of the sector should be the expansion of using digital technologies, namely the digitalization of production processes and information processing (which corresponds to the average level of digitalization) and, in the future, the use of artificial intelligence (which corresponds to a high level of digitalization). The economic effect from introducing these technologies will have a more extended period. It will be more significant than e-commerce, which characterizes most agricultural enterprises in Azerbaijan. In parallel with these stages, Azerbaijan should take measures to improve legislation regulating business digitalization.

Since the enterprises' understudy was not characterized by a high level of digitalization, all the conclusions drawn relate to enterprises with a low and medium level of digitalization. This does not allow applying the findings to enterprises that characterize a high level of business digitalization. In addition, the study was based on the enterprises of agriculture in Azerbaijan, which also limits spreading the identified patterns to the industries of other sectors of the economy and other countries. But because of the relevance of the topic, the scientific priority of our further research will be to study a broader range of factors in the effectiveness of digitalization in agriculture, including the limitation in digitalization

personnel, administrative, managerial, and information barriers, etc., and consideration of the influences on the example of various countries.

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