DIGITAL LITERACY AND READINESS FOR DIGITAL TRANSFORMATION IN SERBIAN AGRICULTURE

Marko Pavlović[1], Siniša Mitić[2], Vana Colić[3], Predrag Ranitović[4], Jelena Maslovara Jovanović[5]

**Corresponding author E-mail: mpavlovic@politehnika.edu.rs*

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ABSTRACT

Digital transformation plays an increasingly important role in improving productivity and competitiveness in agriculture. This study analyzes the level of digital literacy and readiness for digital transformation among farmers in the Republic of Serbia from an economic and information-technology perspective. A quantitative exploratory approach was applied using survey data collected through face-to-face interviews with 170 agricultural producers who voluntarily participated in the study. The results show frequent use of basic digital tools, particularly mobile applications and online sales, while advanced technologies such as sensor systems are rarely adopted. Multiple linear regression did not identify a statistically significant relationship between the selected indicators of digital literacy and farmers' overall readiness for digital transformation. Descriptive findings indicate that lack of knowledge represents the main perceived barrier to digitalization, while training and competency development are identified as important priorities for further digital development. The findings highlight the need for targeted training programs and supportive measures aimed at facilitating the further digitalization of Serbian agriculture.

1 Marko Pavlović, Ph.D., Professor, Academy of Applied Technical Studies, Address: Katarine Ambrozić 3, 11000 Beograd, Serbia, Phone: +381642194881, E-mail: mpavlovic@politehnika.edu.rs, ORCID ID (https://orcid.org/0000-0003-1817-9734)

2 Siniša Mitić, Ph.D., Lecturer, Novi Sad School of Business, Novi Sad, Address: Vladimira Perića Valtera 4, 21102 Novi Sad, Serbia, Phone: +38163590481, E-mail: sinisa.mitic@vps.ns.ac.rs, ORCID ID (https://orcid.org/0009-0004-2037-3928)

3 Vana Colić, MSc, Teaching Assistant, Novi Sad School of Business, Address: Vladimira Perića Valtera 4, 21102 Novi Sad, Serbia, Phone: +381214854038, E-mail: vana.colic@vps.ns.ac.rs, ORCID ID (https://orcid.org/0009-0003-9466-2522)

4 Predrag Ranitović, Ph.D., Professor, Novi Sad School of Business, Address: Vladimira Perića Valtera 4, 21102 Novi Sad, Serbia, Phone: +381638817003, E-mail: predrag.ranitovic@gmail.com, ORCID ID (https://orcid.org/0000-0002-8687-6534)

5 Jelena Maslovara Jovanović, PhD, Directorate of Criminal Police, Trg Slobode no 3, Trg Slobode no 3, 34000 Kragujevac, Serbia, E-mail: jelenamaslovara@gmail.com, ORCID ID (https://orcid.org/0009-0009-3908-8170)

Introduction

Digital transformation is increasingly reshaping agricultural production by enabling more efficient resource management, improved decision-making, reduced operating costs, and better access to markets. Digital technologies such as mobile applications, sensor systems, the Internet of Things (IoT), and data-driven solutions can contribute to productivity and competitiveness. However, their effective adoption depends not only on technological availability but also on farmers' knowledge, skills, and readiness to integrate digital tools into agricultural activities. Digital literacy is therefore an important aspect of agricultural digitalization. Farmers with limited digital knowledge and skills may face difficulties in adopting and effectively using digital technologies, even when such technologies are available. This challenge is particularly relevant in transition economies such as Serbia, where agricultural digitalization is characterized by uneven technology adoption, financial constraints, infrastructure limitations, and differences in farmers' digital competencies. Accordingly, this study examines the level of digital literacy and readiness for digital transformation among farmers in the Republic of Serbia. Particular attention is given to the use of digital technologies, perceived benefits and barriers to digitalization, and farmers' priorities for future digital development. The study aims to provide empirical evidence that may contribute to a better understanding of digital transformation in Serbian agriculture and support the development of appropriate training, policy, and institutional measures.

Literature Review

Digital transformation in agriculture involves the integration of digital technologies into production, management, and decision-making processes. Within the broader development of Agriculture 4.0, technologies such as sensors, mobile applications, the Internet of Things (IoT), artificial intelligence, and data-driven systems can support more precise monitoring, resource management, and agricultural productivity (Kara et al., 2023). However, the benefits of agricultural digitalization depend not only on the availability of technologies but also on farmers' capacity to understand, adopt, and effectively use them. This makes farmers' digital competencies and readiness for technology adoption important dimensions of agricultural digital transformation. Previous studies show that digital technologies can contribute to agricultural productivity, operational efficiency, and more sustainable resource management (Subeesh & Mehta, 2021; Javaid et al., 2022). Nevertheless, digitalization also introduces barriers related to implementation costs, data management, cybersecurity, regulatory requirements, and the complexity of advanced technologies (Osinga et al., 2022). These findings indicate that agricultural digitalization should be examined not only from the perspective of technological benefits, but also in terms of the barriers that may affect farmers' ability and willingness to adopt digital solutions.

The primary challenge for high-technology agriculture lies in ensuring that new technologies help farmers become more economically competitive (Jurjević et al., 2019).

Effective adoption of smart agriculture requires not only technological infrastructure but also information-intensive and knowledge-based competencies (Milovanović, 2014). IoT and mobile technologies can support agricultural monitoring and decision-making (Gondchawar & Kawitkar, 2016), while ICT provides farmers with more timely access to relevant information (Mahant et al., 2012). These studies indicate that farmers' knowledge and ability to use digital information represent important conditions for translating technological availability into practical agricultural benefits.

From an economic perspective, digital technologies may reduce labor and information costs, improve resource utilization, facilitate access to markets, and strengthen farm competitiveness (Mykulskyi, 2019; Jurjević et al., 2019; Jia, 2024). Digital solutions may also support production planning and decision-making by providing timely information relevant to agricultural activities (Fuentes-Peñailillo et al., 2024). However, farmers' perceptions of these benefits are particularly important because perceived usefulness may influence their willingness to use and further adopt digital technologies.

At the policy level, digital agriculture is recognized as an important component of the development of resilient and sustainable agri-food systems, with technology, innovation, and data identified as important accelerators of agricultural development (FAO, 2021). Nevertheless, the growing technological potential of digital agriculture does not automatically imply successful adoption at the farm level. The human dimension—particularly farmers' knowledge, digital competencies, perceptions, and readiness to use available technologies—therefore requires greater attention.

Although previous research has extensively examined the technological potential of digital agriculture, the successful implementation of digital technologies also depends on farmers' ability to understand, adopt, and effectively use these technologies. Existing studies indicate that digital solutions can improve access to information, support decision-making, optimize agricultural activities, and increase productivity (Mahant et al., 2012; Jha et al., 2019; Charania & Li, 2019). However, technological availability alone does not ensure successful digital transformation. Farmers' knowledge and ability to integrate digital tools into everyday agricultural activities remain important conditions for effective adoption. In this context, examining digital literacy together with readiness for digital transformation provides an important user-centered perspective that complements predominantly technology-oriented studies. This is particularly relevant in the Serbian agricultural context, which remains insufficiently examined in the literature reviewed in this study. Accordingly, the following hypothesis is proposed:

H1: There is a statistically significant relationship between the level of farmers' digital literacy and their readiness for the digital transformation of agricultural holdings.

Use of digital technologies and perceived benefits of digitalization

Previous studies emphasize that the application of digital technologies can improve resource utilization, reduce labor requirements, facilitate access to information and markets, and strengthen the competitiveness of agricultural producers (Mykulskyi,

2019; Jurjević et al., 2019; Jia, 2024). Digital tools can also support more efficient production planning and decision-making through access to real-time information and data (Mahant et al., 2012; Fuentes-Peñailillo et al., 2024). These findings suggest that farmers who use digital technologies more frequently may have greater direct experience with their economic and operational benefits and may therefore evaluate the benefits of digitalization more positively. Based on this reasoning, the following hypothesis is proposed:

H2: More frequent use of digital technologies in agricultural production and business operations is associated with more positive farmers' perceptions of the benefits of digitalization.

Knowledge and institutional barriers to digitalization

The literature also demonstrates that the adoption of advanced technologies in agriculture involves numerous challenges. Previous studies identify implementation costs, data management, cybersecurity, regulatory requirements, and the complexity of digital technologies as important constraints (Osinga et al., 2022; Amorim et al., 2021). At the same time, effective smart agriculture requires information-intensive and knowledge-based competencies, indicating that farmers' knowledge and skills constitute an important condition for successful technology adoption (Milovanović, 2014; Gondchawar & Kawitkar, 2016). These different categories of barriers justify examining whether farmers perceive insufficient knowledge as a more important obstacle than legal and institutional constraints. Accordingly, the following hypothesis is proposed:

H3: A lack of knowledge represents a more significant barrier to the adoption of digitalization than legal and institutional constraints among farmers in the Republic of Serbia.

Materials and methods

This study is designed as a quantitative, exploratory research aimed at examining the level of digital literacy and readiness for digital transformation among farmers in the Republic of Serbia. The research focuses on farmers' perceptions, usage patterns, and attitudes toward digital technologies in agricultural production and business activities.

The subject of this research is the level of digital literacy and readiness for the digital transformation of agricultural holdings in the Republic of Serbia, with particular emphasis on the frequency and forms of digital technology adoption, barriers to the digitalization process, and priorities for further development.

The primary objective of the study is to determine the degree of digital literacy and readiness of farmers in Serbia for the introduction and broader adoption of digital technologies in agricultural production and business operations.

The secondary objectives of the study include:

- Analyzing the frequency and modes of digital technology use in agricultural holdings;
- Identifying key barriers in the process of agricultural digitalization;
- Examining the relationship between farmers' socio-demographic characteristics and their readiness for digital transformation;
- Identifying farmers' priorities for the upcoming period in the context of digital development (training, financing, and market access).

This quantitative exploratory research was conducted with the aim of determining the digital literacy and readiness for digital transformation of farmers in Serbia. The study was conducted from September to mid-December 2025. The initial sampling frame consisted of a list of 422 farmers obtained through local community offices (mesne zajednice) in the territory of the Republic of Serbia. Farmers from this list were contacted and invited to participate in the study. Participation was voluntary, and interviews were scheduled only with farmers who agreed to take part in the research. Consequently, the final sample consisted of 170 farmers who voluntarily participated in face-to-face interviews. Given this recruitment procedure, the sample should be considered a non-probability voluntary response sample rather than a random sample. Participation was anonymous, and prior to the interview, each participant provided informed consent for the use of the collected data for academic research purposes. The data analysis was performed with SPSS version 25 and JASP version 0.95. A survey was carried out involving 170 participants ($N = 170N = 170$). The questionnaire was divided into two separate sections. The initial section contained seven questions designed to collect vital demographic data, while the subsequent section featured 17 Likert-type research questions (see Table 1) and 7 closed-ended research questions, which pertained to the digital literacy and readiness of farmers.

Results

Table 1. Seventeen Likert-type ordinal variables from the questionnaire

No.		N		Mean	Std. Dev.	Min.	Max.
		Valid	Missing				
01	Digitalization increases my productivity	170	0	4.65	0.547	3	5
02	I rate my knowledge of digital technologies in agriculture as:	170	0	3.30	0.842	2	5
03	I believe that digital technologies contribute to sustainable agriculture	170	0	4.77	0.422	4	5
04	I have sufficient knowledge to use digital tools	170	0	2.45	0.522	2	4
05	Digitalization will improve market access	170	0	4.76	0.425	4	5
06	I use the internet daily for agriculture information	170	0	2.66	0.670	1	4
07	Digital technologies reduce my costs	170	0	3.58	0.928	2	5

No.		N		Mean	Std. Dev.	Min.	Max.
		Valid	Missing				
08	I am satisfied with the technical support provided by digital solution suppliers	170	0	3.20	0.735	2	5
09	I plan to expand the use of digital technologies in the next two years	170	0	4.72	0.449	4	5
10	Subsidies would motivate me to adopt more digital tools	170	0	4.98	0.132	4	5
11	I use digital methods for traceability	170	0	2.50	0.501	2	3
12	Digitalization helps reduce the use of pesticides	170	0	2.50	0.501	2	3
13	Digitalization contributes to the competitiveness of my farm	170	0	2.50	0.501	2	3
14	Digital technologies are too expensive for my farm	170	0	4.65	0.548	3	5
15	Poor internet infrastructure makes my work more difficult	170	0	4.77	0.422	4	5
16	I am concerned about data security	170	0	4.86	0.349	4	5
17	Overall readiness of my farm for digital transformation	170	0	3.13	0.456	2	4

Source: Authors' calculations

A total of 170 respondents completed the survey, of which 90 (53%) were female and 80 (47%) were male. In terms of age distribution, 16 respondents (9.4%) fell into the 18-30 age group, while the largest segment, 105 respondents (61.8%), belonged to the most economically active age group of 31-50 years. Additionally, 49 respondents (28.8%) were part of the oldest age group. The majority of respondents held a secondary vocational qualification, totaling 108 or 63.5%, while the remaining 62 respondents or 36.5% possessed a higher education qualification. All respondents own agricultural land. Of these, 133 or 78.2% reside in rural areas, while 37 or 21.8% live in suburban regions. The largest number of respondents, 117 (68.8%), have agricultural land measuring between 10.01 and 20 hectares. There are 33 respondents (19.4%) who are larger landowners with over 20 hectares, whereas the smallest group, consisting of 20 respondents (11.7%), has smaller plots ranging from 2 to 5 hectares. Regarding the frequency of sectors in which they are engaged (see Table 2), the sample predominantly includes livestock farmers, followed by organic producers and fruit growers, with the fewest being crop farmers.

Table 2. Frequencies for Production sector

Production sector	Frequency	Percent	Valid Percent	Cumulative Percent
Crop farming	25	14.706	14.706	14.706
Fruit growing	37	21.765	21.765	36.471
Livestock	72	42.353	42.353	78.824
Organic production	36	21.176	21.176	100.000
Missing	0	0.000		
Total	170	100.000		

Source: Authors' calculations

Descriptive statistics of the dataset

The following tables present a summary of descriptive statistics based on the results of closed-ended research questions on the phenomenon of literacy among Serbian farmers.

Table 3. Frequencies for Do you track income and expenses digitally?

Do you track income and expenses digitally?	Frequency	Percent	Valid Percent	Cumulative Percent
No	58	34.118	34.118	34.118
Yes	112	65.882	65.882	100.000
Missing	0	0.000		
Total	170	100.000		

Source: Authors' calculations

The results of the descriptive statistics indicate that the majority of respondents use digital tools to monitor income and expenditures. Specifically, 65.88% of respondents reported that they digitally track their finances, while 34.12% do not use digital methods in this area. This distribution of responses indicates that digital tools for monitoring income and expenditures are relatively widely used among the surveyed farmers. However, this finding alone should not be interpreted as evidence of a high level of financial literacy, as financial literacy was not directly measured in this study.

Table 4. Frequencies for Investments in modernization in the last 3 years (EUR)

Investments in modernization in the last 3 years (EUR)	Frequency	Percent	Valid Percent	Cumulative Percent
5001 - 20000 EUR	164	96.471	96.471	96.471
< 5000 EUR	4	2.353	2.353	98.824
> 20000 EUR	2	1.176	1.176	100.000
Missing	0	0.000		
Total	170	100.000		

Source: Authors' calculations

The data presented in Table 4 indicate that the predominant share of respondents (96.47%) invested between EUR 5,001 and EUR 20,000 in modernization over the past three years. A significantly smaller proportion of respondents invested less than EUR 5,000 (2.35%), while only 1.18% reported investments exceeding EUR 20,000. This distribution of results suggests that most respondents pursue moderate levels of investment in modernization, which may reflect a gradual and cautious approach to improving business processes, influenced by financial capacity and/or risk perception. The absence of missing data further confirms the validity and consistency of the collected information.

Table 5. Frequencies for Do you use credit for business operations?

Do you use credit for business operations?	Frequency	Percent	Valid Percent	Cumulative Percent
No	50	29.412	29.412	29.412
Yes	120	70.588	70.588	100.000
Missing	0	0.000		
Total	170	100.000		

Source: Authors' calculations

Table 5 shows that the majority of respondents (70.59%) use credit in their business operations, while 29.41% do not rely on credit financing. This result indicates a high dependence on external financial sources among farmers, suggesting that credit represents an important instrument for maintaining liquidity and supporting investments in agricultural production. The widespread use of credit also implies that access to financial resources may play a relevant role in enabling modernization and the adoption of digital technologies, which often require initial capital investments. The absence of missing data confirms the reliability of the findings and allows for consistent interpretation.

Table 6. Frequencies for I use the following technologies:

I use the following technologies:	Frequency	Percent	Valid Percent	Cumulative Percent
E-invoicing	31	18.235	18.235	18.235
Mobile applications	70	41.176	41.176	59.412
Online sales	54	31.765	31.765	91.176
Sensors	15	8.824	8.824	100.000
Missing	0	0.000		
Total	170	100.000		

Source: Authors' calculations

The results presented in Table 6 illustrate the structure of modern technology adoption among the respondents. Mobile applications are the most widely used technology, adopted by 41.17% of respondents, indicating a high level of acceptance of mobile digital solutions in everyday business operations. This is followed by online sales channels, used by 31.76% of respondents, confirming the growing importance of electronic commerce. E-invoicing is applied by 18.23% of respondents, while the use of sensor technologies is the least prevalent (8.82%), which may indicate the higher technical and financial complexity associated with these solutions. Overall, the results point to an uneven level of digital transformation, characterized by the predominant use of basic and moderately complex digital technologies.

Table 7. Frequencies for Frequency of using digital technologies

Frequency of using digital technologies	Frequency	Percent	Valid Percent	Cumulative Percent
Daily	103	60.588	60.588	60.588
Occasionally	67	39.412	39.412	100.000
Missing	0	0.000		
Total	170	100.000		

Source: Authors' calculations

Specifically, 60.59% of respondents (N = 103) reported using digital technologies on a daily basis, while 39.41% of respondents (N = 67) indicated that they use these technologies occasionally. The obtained results point to a relatively high frequency of digital technology usage among the respondents, confirming that digital solutions are to a significant extent integrated into their business activities. This response structure suggests the existence of a favorable environment for further digital transformation, while also highlighting the need for additional measures to encourage more intensive and continuous use of digital technologies among the segment of respondents who currently use them only occasionally.

Table 8. Frequencies for Main obstacles to introducing digitalization

Main obstacles to introducing digitalization	Frequency	Percent	Valid Percent	Cumulative Percent
Lack of knowledge	131	77.059	77.059	77.059
Legal obstacles	39	22.941	22.941	100.000
Missing	0	0.000		
Total	170	100.000		

Source: Authors' calculations

The analysis of the results presented in Table 8 indicates that a lack of knowledge represents the dominant barrier in the process of introducing digitalization. As many as 77.05% of respondents stated that insufficient knowledge and digital competencies constitute the key limiting factor, clearly highlighting the need for additional education, training programs, and advisory support. On the other hand, legal constraints were identified as the main barrier by 22.94% of respondents, suggesting that the regulatory framework, although important, has a considerably smaller impact compared to human and organizational factors. This structure of responses suggests that successful digital transformation may depend not only on institutional support but also on the development of knowledge, skills, and users' readiness to adopt new technologies.

Table 9. Frequencies for Most important priority for the next two years

Most important priority for the next two years	Frequency	Percent	Valid Percent	Cumulative Percent
Financing	53	31.176	31.176	31.176
Market	53	31.176	31.176	62.353
Training	64	37.647	37.647	100.000
Missing	0	0.000		
Total	170	100.000		

Source: Authors' calculations

The analysis of Table 9 shows that respondents most frequently identify training and knowledge enhancement as the most important priority for the next two years (37.64%), indicating a growing awareness of the importance of human capital development and continuous learning. Financing and market access rank second, with equal shares of responses (31.17% each), suggesting that these factors are recognized as important but less dominant compared to investments in knowledge and skills. Overall, the results indicate a shift in focus toward strengthening competencies as a foundation for long-term development and adaptation to contemporary business challenges. Accordingly, the findings reveal a high level of acceptance and daily use of digital technologies among respondents, with mobile applications and online sales emerging as the most frequently used digital tools. At the same time, a lack of knowledge is identified as the key barrier to further digitalization, while investment in training and competency development is recognized as the most important priority for the upcoming period, ahead of financing and market access.

Validation of the research scales

Before conducting the reliability analysis, the distribution of responses to the Likert-type items was examined. The descriptive results presented in Table 1 indicate a restricted range of responses across several items, suggesting limited variability in the data. Item 17 ("Overall readiness of my farm for digital transformation") was retained as a separate single-item indicator of overall readiness. Given the limited response variability and the exploratory nature of the study, the psychometric properties of the proposed scales were subsequently assessed before further statistical analysis. To assess the potential presence of common method bias in the Likert-type items, Harman's single-factor test was conducted. A principal axis factor analysis with one fixed factor indicated that a single factor explained 11.468% of the total variance, which is below the commonly used 50% threshold (Aguirre-Urreta & Hu, 2019). This result suggests that common method variance is unlikely to represent a dominant source of variance in the data. However, given the limitations of Harman's single-factor test, this finding should be interpreted with caution. We divided the research questions from the questionnaire into two research scales, a larger one with 13 variables that measured the positive aspects of digitalization in agriculture and a smaller one with 3 variables that measured the negative aspects of the aforementioned digitalization. In Table 1, the first 13 variables

refer to the positive scale, which we called the Digital Farmer (DF) Scale, while the next 3 variables make up the DF Obstacles scale. The first step in the analysis was to check the relationship between these two scales by conducting the Pearson product-moment correlation coefficient test. There was a positive, very weak and statistically insignificant correlation between the scales, $r = .126, n = 170, p = .110$. Although statistically insignificant, we were surprised by the positive sign of the correlation, as we expected a negative one. The next step in our analysis was to conduct a reliability study for our scales. The internal consistency of both scales was assessed as unacceptable, as values below .60 are considered unacceptable (Pallant, 2020). The 13-item DF scale recorded a Cronbach's alpha coefficient of .332. Furthermore, the 3-item Obstacles to DF scale even recorded a slightly negative coefficient of -.022. The negligible result automatically led to the discontinuation of the smaller-scale testing, while we decided to conduct a factor analysis on a larger scale. The 13 items of the DF Scale were subjected to further analysis through principal component analysis (PCA). This statistical technique is employed to decrease the dimensionality of a dataset that contains numerous interrelated variables while still retaining a significant amount of variance. The Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy was .538, indicating only marginal adequacy for exploratory analysis. Therefore, the results of the subsequent principal component analysis should be interpreted with caution. Additionally, Bartlett's test of sphericity yielded statistically significant results ($p < .001$). The principal component analysis using an Oblimin rotation procedure revealed six factors with eigenvalues above 1, explaining a total of 63.619% of the variance. However, the variable "I have enough knowledge to use digital tools" was excluded, since it recorded an unsatisfactory result below .3 in the Communalities table. In the next step, the two variables "Digitalization increases my productivity" and "I rate my knowledge of digital technologies in agriculture as" were also excluded because they weighed more than one factor in the Pattern Matrix with a results above .3. Finally, the rotated solution yielded four interpretable factors or components with eigenvalues above 1, explaining a total of 58.294% of the variance (Table 10). The KMO score increased to .554. It is important to emphasize, however, that the factor structure reported in this study should be interpreted with considerable caution. The Kaiser–Meyer–Olkin (KMO) measure of .554 and the unsatisfactory Cronbach's alpha coefficient (.401) indicate that the DF-10 scale does not meet the conventional criteria for reliability and construct validity. Consequently, the factors identified through principal component analysis are not presented as validated thematic dimensions, but rather as exploratory patterns that may inform future hypothesis generation. Any substantive interpretation of these factors would require replication on a larger, more representative sample, using a revised and pilot-tested measurement instrument.

Table 10. Pattern Matrix[a]

	Component			
	1	2	3	4
Digitalization helps reduce the use of pesticides	.860			
Digitalization contributes to the competitiveness of my farm	.832			
I use digital methods for traceability	.711			
I am satisfied with the technical support provided by digital solution suppliers		.884		
Digital technologies reduce my costs		.860		
I use the internet daily for agriculture information			.664	
I believe that digital technologies contribute to sustainable agriculture			.613	
Subsidies would motivate me to adopt more digital tools			.511	
I plan to expand the use of digital technologies in the next two years				.765
Digitalization will improve market access				.714
Extraction Method: Principal Component Analysis. Rotation Method: Oblimin with Kaiser Normalization. a. Rotation converged in 6 iterations				

Source: Authors' calculations

The reliability analysis of the new 10-item DF scale showed improvement, with Cronbach's alpha increasing to .401. However, this indicates that the internal consistency of the new DF scale or DF-10 scale was still unacceptable. We checked the correlation between this new DF-10 scale and the Obstacles to DF scale. Although the coefficient was now negative, as expected, a non-significant, very weak, close to zero correlation was recorded between these two scales, $r = -.036, n = 170, p = .637$. The exploratory principal component analysis yielded four tentative components. However, given the low internal consistency of the scale and the marginal KMO value, these components should not be considered stable or validated dimensions. They are reported solely as descriptive outcomes of the exploratory analysis, and no substantive interpretation or policy implications are derived from their structure. Further research should first develop and validate a more reliable measurement instrument before examining the dimensional structure of digital literacy among farmers.

Regression analysis

To directly test the hypothesis that digital literacy is associated with readiness for digital transformation (H1), a multiple linear regression analysis was conducted using the enter method. The dependent variable was the item „Overall readiness of my farm for digital transformation" (Item 17). The independent variables included self-rated knowledge of digital technologies (Item 2), perceived sufficiency of knowledge to use digital tools (Item 4), daily use of the internet for agricultural information (Item 6), and intention to expand the use of digital technologies in the next two years (Item 9). The regression model was not statistically significant ($F(4, 165) = 1.662$, $p = .161$),with an R^2 of .039 and an adjusted R^2 of .015. This indicates that the selected predictors explain only a small and non-significant proportion of variance in farmers' readiness for digital transformation. None of the individual predictors reached statistical significance (p > .05 for all coefficients). These findings suggest that, within this

sample, the selected indicators of digital literacy do not significantly predict overall readiness for digital transformation. However, due to the previously noted limitations regarding scale reliability and the use of a single-item dependent variable, these results should be interpreted as preliminary and warrant further investigation. It is possible that other unmeasured factors—such as access to infrastructure, financial resources, social influence, or prior experience with digital technologies—play a more important role in shaping farmers' readiness for digitalization.

Comparison of the group means

A series of t-tests was conducted to examine the impact of additional reserve variable, listed as variable number 17 in Table 1, "Overall readiness of my farm for digital transformation", an dependent continuous variable, on the three socio-demographic independent variables. No statistically significant differences were observed based on sex $(t(168) = 0.455, p = .650)$, level of education $(t(168) = 0.340, p = .734)$, and place of residence $(t(168) = -1.312, p = .191)$.

Moreover, a series of t-tests was conducted to examine the impact of dependent continuous variable "Overall readiness of my farm for digital transformation", on the four closed-ended research questions' independent variables. No statistically significant differences were observed based on the "Do you track income and expenses digitally?" variable $(t(168) = 0.455, p = .650)$, on the "Do you use credit for business operations?" variable $(t(168) = 0.933, p = .352)$, on the "Frequency of using digital technologies" variable $(t(168) = -0.801, p = .424)$, and on the "Main obstacles to introducing digitalization" variable $(t(168) = 0.418, p = .677)$. For socio-demographic independent variables with more than two groups, a series of ANOVA tests were conducted. The dependent variable was the "Overall readiness of my farm for digital transformation" variable, as in the previous tests. There was not the significant difference observed among the three level of farm size groups $(F(2,167) = 0.085, p = .919)$, or the four level of production sector groups $(F(3,166) = 0.179, p = .910)$, However, a significant difference was observed among the three level of age groups $(F(2,167) = 9.061, p < .001, \eta^2 = .098)$. The effect size, determined through eta squared, was .098, which means that the actual difference in mean scores between the groups was medium. Post-hoc comparisons using the Tukey HSD test indicated that the mean score for age group 18-30 $(N = 16, M = 3.375, SD = 0.500)$ was significantly different from age group 31-55 $(N = 105, M = 3.019, SD = 0.416)$. Moreover, the mean score for age group 31-55 $(N = 105, M = 3.019, SD = 0.416)$ was significantly different from age group 56-70 $(N = 49, M = 3.286, SD = 0.456)$. The results indicate that the youngest age group reported the highest mean readiness for digital transformation, followed by the oldest age group, while the middle-aged group reported the lowest mean readiness. However, the present data do not provide sufficient evidence to explain the reasons underlying the observed differences between age groups. These differences may be associated with factors not examined in this study and therefore require further investigation. However,

given that this analysis relied on a single-item dependent variable, these findings should be treated as exploratory and interpreted with caution. Finally, a series of ANOVA test was conducted to examine the impact of dependent continuous variable "Overall readiness of my farm for digital transformation", on the three closed-ended research questions' independent variables with more than two groups. No statistically significant differences were observed based on the "Investments in modernization in the last 3 years (EUR)" variable $(F(3,166) = 0.179, p = .910)$, on the "I use the following technologies" variable $(F(3,166) = 0.416, p = .742)$, and on the "Most important priority for the next two years" variable $(F(2,167) = 0.311, p = .733)$.

Conclusion

This paper analyzes the level of digital literacy and readiness for digital transformation among farmers in the Republic of Serbia, with particular emphasis on the economic and information-technology dimensions of agricultural digitalization. The study contributes to the existing literature by providing empirical evidence from a transition economy in which the digital transformation of agriculture remains uneven and is strongly conditioned by human capital constraints. The findings indicate that basic digital tools—such as mobile applications and online sales channels—are relatively widely adopted, whereas the use of advanced digital technologies remains limited. Several methodological limitations of this study must be acknowledged. First, the final sample consisted of 170 farmers who voluntarily agreed to participate from an initial sampling frame of 422 farmers. Since participation was based on respondents' willingness to take part rather than random selection, the sample may be subject to self-selection bias. Farmers who agreed to participate may differ systematically from those who declined, particularly in their interest in or familiarity with digital technologies. Therefore, although the sample is adequate for exploratory purposes, the findings should not be generalized to the broader population of Serbian farmers without caution. Second, the digital literacy scale used in this study demonstrated low internal consistency (Cronbach's $\alpha = .401$), which undermines the reliability of any conclusions drawn from the factor analysis. Third, the dependent variable „Overall readiness for digital transformation" was measured using a single Likert-type item rather than a validated multi-item scale. Single-item measures, while occasionally used in exploratory research, do not possess the psychometric robustness of composite scales. Fourth, the factor structure identified through PCA should not be interpreted as validated thematic dimensions, but rather as exploratory patterns requiring further empirical scrutiny. Fifth, the regression model was not statistically significant, which indicates that the present data do not provide sufficient statistical evidence of a relationship between the selected indicators of digital literacy and readiness for digital transformation. Future research should focus on developing and validating a comprehensive digital literacy instrument specifically tailored to the agricultural context in Serbia, employing larger and more diverse samples, and incorporating qualitative methods to gain deeper insights into farmers' perceptions and needs. These findings point to potential disparities in digital technology adoption

and digital competencies among the surveyed farmers. The findings indicate that insufficient knowledge and digital skills represent an important barrier to the broader adoption of digital technologies. Based on the empirical findings, the research hypotheses were evaluated as follows. Hypothesis H1, which posits a statistically significant relationship between farmers' digital literacy and their readiness for digital transformation, was not supported. The multiple linear regression model was not statistically significant ($F(4, 165) = 1.662$, $p = .161$), and none of the individual predictors reached statistical significance. Therefore, the present findings do not provide sufficient statistical evidence of a significant relationship between the selected indicators of digital literacy and farmers' overall readiness for digital transformation. Hypothesis H2 proposed that more frequent use of digital technologies in agricultural production and business operations is associated with more positive perceptions of the benefits of digitalization. Although the descriptive findings indicate relatively frequent use of digital technologies and generally positive perceptions of several benefits of digitalization, this relationship was not directly tested using an appropriate inferential statistical procedure. Therefore, H2 cannot be statistically confirmed on the basis of the present analysis and should be regarded as not formally tested. Hypothesis H3 proposed that a lack of knowledge represents a more significant barrier to digitalization than legal and institutional constraints. The descriptive findings provide support for this hypothesis, as 77.05% of respondents identified lack of knowledge as the main barrier, compared with 22.94% who identified legal obstacles. However, because this comparison was based on descriptive frequencies rather than an inferential statistical test, H3 should be interpreted as descriptively supported rather than statistically confirmed. In addition, the cross-sectional and self-reported nature of the data may involve subjective response bias and does not allow for causal inference. Accordingly, future research should employ larger and more representative samples, longitudinal research designs, and advanced econometric methods to examine causal relationships between digital literacy, technology adoption, and economic performance indicators such as productivity, costs, and profitability. Furthermore, comparative studies across different regions or countries would enhance the robustness and international relevance of findings in the field of agricultural digital transformation.

Conflict of interests

The authors declare no conflict of interest.

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