Role of Agronomists in Agriculture Digitalisation in Croatia

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Graduate thesis

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1. INTRODUCTION

In today's uncertain times, marked by global pandemics, conflicts and climate change, it is essential to ensure food security for the entire population while maintaining safe and sustainable farming practices (that minimize the destruction of ecosystems and the emission of greenhouse gasses) in line with the United Nations' goal of eradicating hunger. Especially considering that the world population is projected by the UN to reach 9.6 billion people by 2050 (Sanh et al., 2019). This increasing demand for productivity increases for small and large players while reducing input costs (water, fertilizers, pesticides, etc.) requires the use of new modern and advanced agricultural and management techniques. In achieving the goal of increasing productivity, the" cost" doesn't have to be deterioration in food quality in the form of nutrient deficiencies or environmental damage. Especially when large-scale agricultural producers are on a largely unsustainable path that shows they are contributing to greenhouse gas emissions, water pollution and biodiversity loss (Springman et al., 2018). The solution could lie in digital agriculture (Chergui et al., 2020). Although the term digital agriculture is a widely used term, its definition is subject to different interpretations due to its wide range of applications (Fors, 2020). One of the definitions according to Basso and Antle (2020) describes the term digital agriculture as "a set of digital and geospatial information technologies that integrate sensors, analytics and automation to monitor, assess and manage soil, climate and genetic resources at the field and landscape level". This next step in the agricultural revolution has the potential for numerous benefits. The agricultural food production chain could be transformed as better connectivity and big data processing enable greater economic returns for stakeholders of all sizes, better working conditions in the field and therefore improved environmental benefits. When we talk about the benefits of digital agriculture that are not only focused on food production, another important impact is the development of rural areas in terms of higher income and living standards of rural dwellers, overall environmental changes, etc. (FAO, 2017). However, the possibility of using digital technologies in rural areas is still uncertain, as the capacity to apply these technologies varies among small, medium and large agricultural producers (Lončarić et al., 2023). For these technologies to be successfully deployed, governments must also improve and strengthen rural infrastructure if they aim to develop rural communities and businesses (Bolfe et al., 2020). This technology in particular is of crucial importance, as small-scale producers account for at least 56% of total global agricultural production. More specifically, there are more than 570 million farms, 500 million of which are family-owned (FAO, 2017). This technology has a wealth of benefits and opportunities to offer, but also presents potential risks and problems (Charatsari, et al., 2023). An example of the ineffective use of this technology was found in the Midwestern United States, where it failed to improve the environment. This region struggled with groundwater and surface water quality, which was severely impacted by the overuse of chemicals. Farmers were applying excessive amounts of nitrogen fertilizer on low-yielding rainfed areas instead of using less nitrogen fertilizer to avoid losses through leaching and surface runoff, which in turn caused the environmental problems. The reason for this misuse was that the developers of the data algorithms lacked sufficient information and computational tools to transform the information to provide farmers with efficient and accurate recommendations for their production (Basso et al., 2019). Farmers should evaluate the potential benefits and risks before adopting these digital technologies (Bolfe et al., 2020). Considering this observation, stakeholders in agricultural production should be trained and prepared to fully utilize the potential of digital components and systems (Shepherd et al., 2020). Therefore, support from other actors is necessary (Meng et al. 2023). It is often agricultural advisors who face this difficult challenge. They must have the skills and knowledge to facilitate the transition to the digital age of agriculture (Charatsari et al., 2022). Trust between agronomists and farmers is also crucial when it comes to building solid advisory relationships between the two (Hilkens et al. 2018). Farmers who were asked questions in a research study about their perception of an agronomist with whom they would agree to work rated the agronomist's skills, goodwill, and integrity. The results gave a clear answer: in terms of ability, they indicated that since an agronomist has a college degree, they should have a deeper understanding and knowledge of farming in addition to growing crops, and continuously improve this. In terms of consideration for the farmers themselves, they should establish clear communication, not have interests that could work against the farmers, and show active engagement in the form of frequent visits to the farm. In terms of integrity, they should treat farmers fairly, regardless of the size of their farm, by setting honest and clear expectations of the farmer's advice (Pappa and Koutsouris, 2024). Most advisors working in the profession today received their training before technological advances in agriculture (Soma et al., 2021). Considering this potential problem, many higher education institutions have realized the importance of equipping future advisors and agronomists with the necessary skills and knowledge to cope with the process of digitalization of agriculture. One of these higher education institutions that has recognized the importance of preparing students to become key players in the digitalization process is the Faculty of Agrobiotehnical Sciences Osijek, which started graduate studies in Digital Agriculture in 2021.

1.1. Research Goal

The aim of this research was to find out how the demographic and socio-economic characteristics of the respondents may correlate with the level of theoretical knowledge, potential role as key actors and general opinion on the topic of the ongoing digital transformation in the Croatian agricultural sector. The questionnaire was addressed to people working in agricultural production, i.e. people involved in management processes in agricultural production, regardless of the legal form and scale of production.

2. LITERATURE REVIEW

A study published by Bolfe et al. (2020) states: “Digitalization will transform all parts of the agricultural production chain, as connectivity and the processing of large amounts of information in the shortest possible time will enable more efficient work, higher economic return, greater environmental benefits and better working conditions in the field”. This prediction should be put into action, especially considering the rapid population growth in today’s world, leading to an increased demand for more food, energy, water and fibre. Therefore, the authors of this study wanted to find out in which direction Brazilian agriculture is developing. They conducted a survey of Brazilian farmers, in which 504 people took part. The focus was on the extent of current and future use of digital agriculture, the perceived benefits and the possible limiting factors. The results of this survey came to the following conclusion: most respondents (84%) stated that they use at least one segment of digital agriculture, but as the complexity of this technology increases, their level of use decreases. When asked about the perceived benefits of digital agriculture, better management of production systems and higher productivity were rated highest. Furthermore, a promising 95% of all respondents stated that they are willing to learn about these technologies, which gives an optimistic outlook for the further development of agriculture in their country. As for the main perceived constraints, respondents stated that the high cost of machinery and equipment is a barrier to adopting this technology on their farm, especially if they are a small player, so to speak. Another problem was rural connectivity. This perception should be taken into account by local and state authorities because if poor connectivity and infrastructure persists in rural areas, it can lead to a decline in production, where 56% of the world's total food production comes from. Rural areas must be at the centre of this change, but at the same time, implementation could be considered problematic due to the significant capacity differences between small, medium and large producers. From this perspective, the integration of these technologies in rural areas could prove problematic. Satellite services are one of many features that are part of digital agriculture. Lončarić et al. (2023) conducted a survey in Croatia to ask stakeholders' opinions on this technology and the willingness to use it in relation to the nature of its production, the price of services, the IT literacy of users and, above all, their willingness to be educated on the matter. They came to the following conclusion: there is an increased willingness to participate in educational programmes on satellite services, but only a small proportion of stakeholders want to acquire their knowledge through the guidance of agronomists. This result is worrying because our agronomists are experts who have the necessary theoretical skills and knowledge, and their role in this process should be emphasised alongside other sources of education. Another interesting study was conducted at a Greek university. According to the authors Pappa and Koutsouris (2024), “the current extension landscape in Greece is characterised by the lack of a structured extension system as well as by a weak and fragmented AKIS (agricultural knowledge and innovation system)”. In light of this conclusion, a survey was conducted to gain a clear understanding of how farmers understand the characteristics of a trusted advisor. The research was based on the population of 51 respondents who were professional farmers at the time and worked continuously with agronomists. The questionnaire was designed using the snowball technique to gain important insights into what characteristics an agronomist should have for a successful collaboration. More specifically, what ideal characteristics an agronomist should have so that the farmer trusts him as an advisor, what skills he has in his working environment and what characteristics an agronomist should not have. The following can be concluded from this. A strong and comprehensive knowledge is required for the skills segment, as all agronomists have a university degree. They should also be experts in the crop that the farmer is growing. In this way, they can provide appropriate advice that demonstrates their technical knowledge and ability for an optimal crop management system, while remaining confident and maintaining clear and comprehensive communication with the agronomist. In addition, their constant presence on the farm keeps them up to date with the latest developments, enabling them to make appropriate and accurate decisions. In addition, compassion was highlighted as an important quality that a trustworthy agronomist should have. They must work to ensure that the interests of the farmers are protected and not their personal interests, which could work against the farmers. They must also show their genuine care for the farmer through certain actions and behaviours that allow for clear and honest communication between the two. Finally, integrity was described as an essential element of a trustworthy agronomist, which can be underpinned by various means. Honesty and transparency are expected when it comes to informing farmers of the expected outcomes of their advice and services. They should also admit their mistakes and act when they realise them. Furthermore, a research study was conducted by Charatsari et al. (2023) at a Greek university, which could provide a possible explanation for the lack of a structured advisory service and the low competence in AKIS. As the development of digital agriculture is more evident than ever, current advisors need to develop skills relevant to this agricultural revolution in addition to their existing knowledge. They could achieve this through the work environment, but the problem revolves around the students who are expected to have the skills and knowledge to work in this profession, as they stated in their paper that “previous work indicates that Greek agricultural universities emphasise theory over practise and technical mastery over soft skills, thus not equipping students with the competencies they need to make the transitions with farmers and other stakeholders." So they wanted to find out if the current curriculum was providing the necessary guidance and mentoring to steer them in the right direction. The survey covered 8 skill areas that revolved around technology assimilation, technology use and support in the transition from conventional to digital farming. From this, the following can be concluded: The students who participated in this survey scored considerably low in all groups that revolved around technological skills, which may confirm the authors' statement in this paper. On the contrary, they scored highest in the areas of empathy and future orientation. As the authors stated in their paper, no general conclusions can be drawn, but the results can be used as literature to reveal shortcomings in education and possibly change the curriculum of universities so that agricultural science graduates can be considered as complete and capable experts in the future.

3. MATERIAL AND METHODS

Primary data were collected through the survey method, using an online questionnaire (n = 80) as the research instrument. The target group of respondents were agronomists, irrespective of age and occupation. The full questionnaire contained a total of 35 open and closed questions, divided into several groups. The first group of questions were intended to obtain a clear demographic structure based on gender, place of residence and age. The second group of questions provided an insight of the socio-economic status of the respondents (work status, years of work experience in agriculture, sector of employment and years of last education level competition). Acquired results from these two groups are of crucial importance. The reason behind it is that later in the research, they were used to give valuable perceptions into potential patterns and relationships between the overall knowledge, opinions, and perceived competence of agronomists, based on the demographic and socio-economic structure of the survey. For the main part of the survey, one of the goals was to get an insight how Croatian agronomists and stakeholders in agricultural production perceive their role and importance in the digitalization process of Croatian agriculture, based on questions such as "Do you consider agronomists as key factors (stakeholders) in the digitalization process of Croatian agriculture?" and "Evaluate the importance of agronomists in the process of digitalization of agriculture". These results can serve as a strong indicator on the perception of their role, and based on the results, the urgency of including them as key factor in the digitalization process. Another important aspect of the main part was their general theoretical knowledge and familiarity with the terminology. They were given a set of questions regarding familiarity with various digital agriculture terms, upon conclusion could be made if they have the basic theoretical knowledge. Also, they were asked from which sources did they obtained their knowledge, putting in focus which channels of information should be used more to educate them, based on their answers. Overall, the results of this survey can be used to future recommendations on how to educate, improve and involve agronomists in the process of digitalization of Croatian agriculture. Statistical analysis was carried out using the statistical software package IBM SPSS Statistics V26. Descriptive statistics were used to describe the sample (percentages, frequencies, arithmetic mean, and standard deviation). The collected data were analyzed using descriptive statistics (frequency analysis, arithmetic mean, mode, median and standard deviation) and parametric tests (independent samples t-test, one-way test ANOVA). Descriptive statistical analysis was used to describe the socio-demographic characteristics of the sample, and the knowledge about digital agriculture. The independent samples t-test and ANOVA were conducted to determine the significant differences between the segments in terms of consumers socio-demographic characteristics and agronomists' knowledge about digital agriculture. The independent t-test was carried out to discover if differences exist between responses regarding the importance of each factor in the education process of agronomists and the current ability to participate in the digitalization process. Different arithmetic means of ratings were obtained as a result from agronomists, on multiple inquiries, such as the year of completion of their final level of education, familiarity with the concept of digital agriculture, on the importance of agronomists in the digitalization of agriculture etc.

4. RESULTS

For accomplishing the results of this research, an online survey questionnaire was used with the population of 80 respondents. Of the 80 respondents, 48 or 60% identified as male, while the other 32 or 40% identified as female (Figure 1). In addition to gender, the survey data also captured the age distribution of respondents. The data structure shows that 29% of respondents fall into the 23-34 years category, which makes them the largest group, 29% are aged 35-44 years, 25% are aged 45-54 years and 12% are over 50 years old (Figure 2). These groups can be divided into two bigger groups. The first group represents young subjects (ages 23-34), which is the largest amongst the other groups. This group may represent people that may be more familiar with the terminology and may be more open-minded to implement new technologies into their work environment. On the other side, we can observe a second group of subjects or “Experienced professionals”. Although their experience and insight are invaluable, their levels of exposure to digital technologies may vary from their younger colleagues. Placement of residence for respondents can be categorized as follows: 25% of respondents live in suburban settlements, 29% of respondents live in settlements that serve as the center of the municipality and 46% of respondents live in settlements that are not the center of the municipality. Socio-economic factors were also investigated, and the following was concluded: 78% of respondents are full-time employed, 16% are students, and the rest 6% account for respondents, which are retired, working-part time, and owning a company (Figure 2).

Figure 1 Gender of respondents

Source: Author

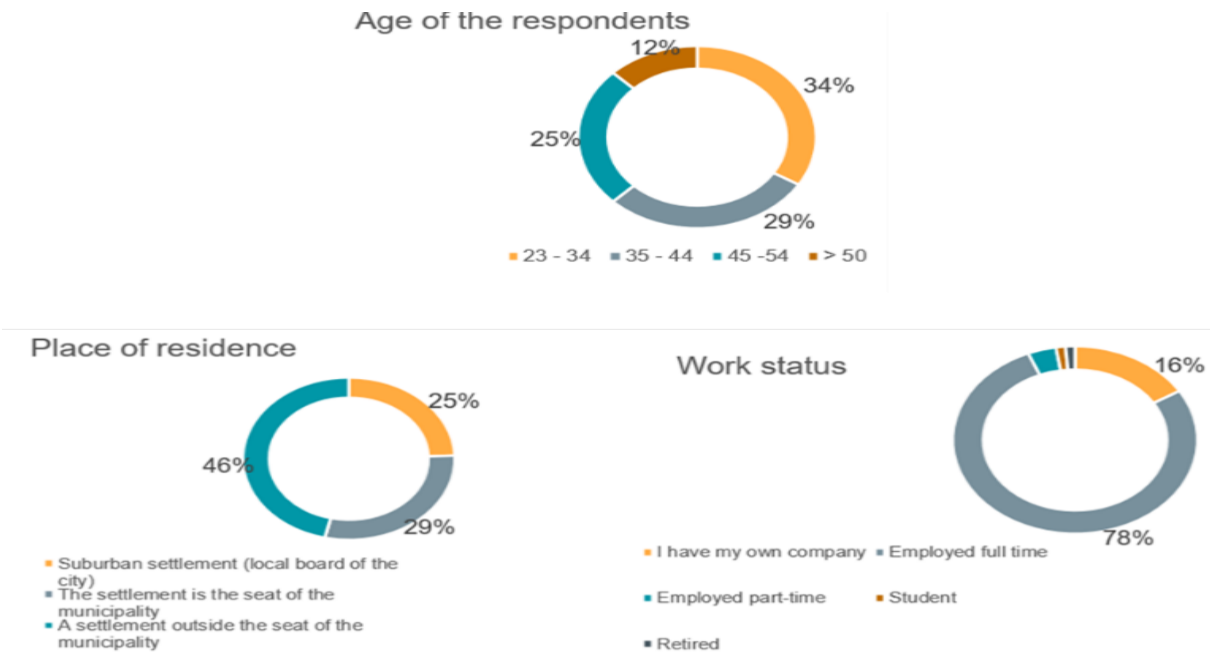

Figure 2 Demographic results

Source: Author

Another important factor when it comes to employment is years of experience in agriculture. Most respondents, or 46%, declared that they have up to 10 years of experience working in agriculture. Following with 17% stated that they have between 10-20 years of experience. The second biggest group, or 28%, stated that they have over 20 years of experience. Only a small portion of respondents stated that they are not employed in agriculture (Figure 3). When it comes to sector of employment, the following was stated: Employment in the primary sector is 59%, secondary accounts for 3%, tertiary sector accounts for 11%, quaternary sector accounts for 26% and only 1% accounts for Other (Figure 3). And for the last socio-economic factor, years of competition of last education level was examined. Many respondents (50%) stated that they finished their last education level under 10 years ago. The second biggest group, or 31%, stated that they finished their education between 10 and 20 years ago. And for the last and smallest group, 19% stated that they completed their education over 20 years ago (Figure 3).

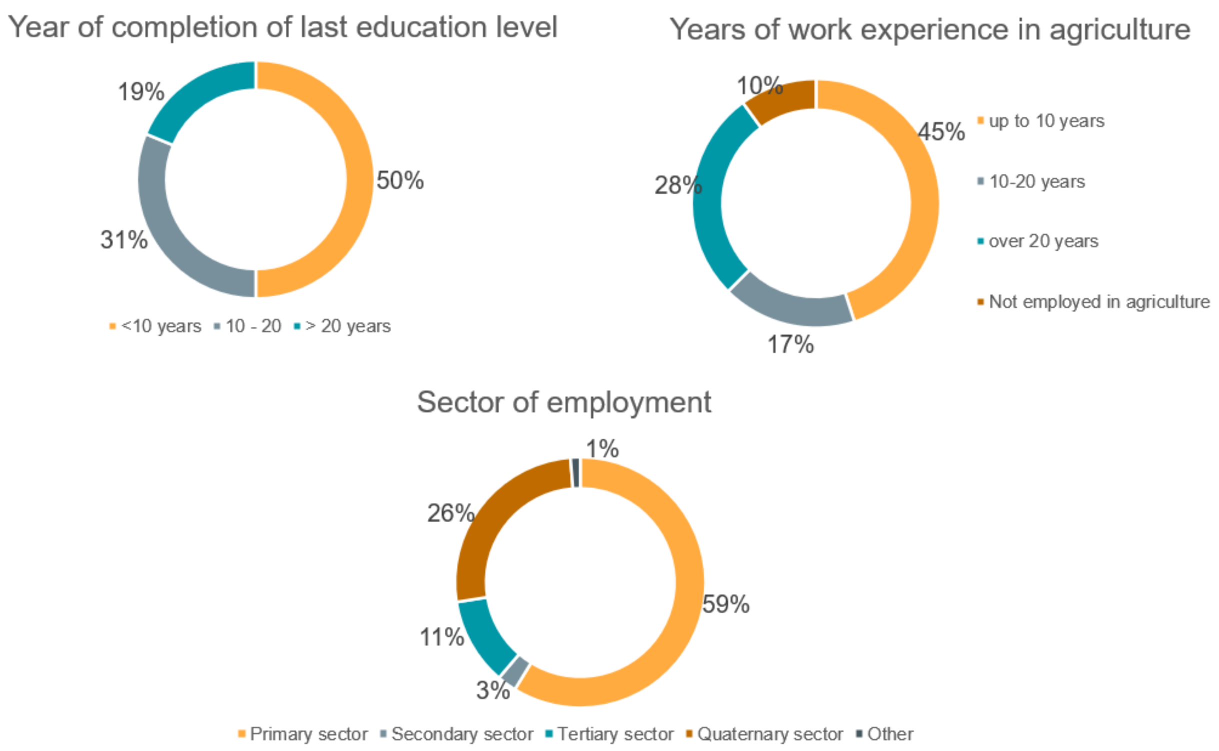

Figure 3 Socio-economic results

Source: Author

4.1 Familiarity with the term "digital agriculture" and opinion of agronomists of their importance in the digitalization process of Croatian agriculture

It comes to no surprise that 92,5% of all respondents were familiar, and only 7,5% were not with the term digital agriculture (Figure 4). It is possible to make a connection between this result and the age of respondents. As is observable in the previous chapter, most respondents are under 50 years. This of course doesn't prove the hypothesis that people under 50 years have better digital skills than the ones over it, but there could be a speculation that people under 50 years were under greater exposure to various digital sources of information, like the internet and media, hence introducing them to the terminology. Regarding the next results, which are one of the most important in the entire survey, asking the agronomists if they perceive themselves as key factors in the digitalization process of Croatian agriculture. An overwhelming percentage of subjects, or 96,3% perceive themselves to be key factors. This raises an important question: what steps are imperative to put Croatian agronomists in the spotlight of this process?

To begin with, an acknowledgement of their importance must be made. Agronomists are individuals who dedicate a significant portion of their lives to studying various aspects of agricultural practices, and the skills they acquire in the process are of crucial importance for the digitalization process. Another step that can be implemented is to create platforms on which agronomists can develop collaborations between themselves and discuss important topics, where their expertise is valued. Also, if their knowledge isn't sufficient, offer workshops to enhance their digital skills, which later can be effectively utilized in the work environment.

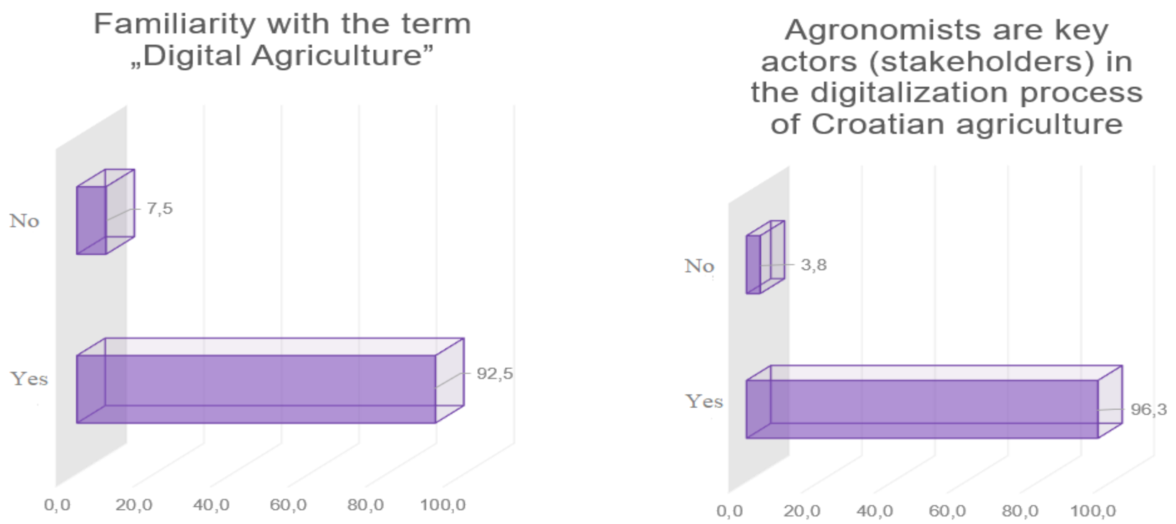

Figure 4 Percentages of familiarity with the term "digital agriculture" and opinion of agronomists of their importance in the digitalization process of Croatian agriculture

Source: Author

4.2 Sources of education about the term digital agriculture

From this bar chart, results about the sources of education regarding digital agriculture can be observed. The longest bar indicates that 28,7% of the respondents obtained their knowledge about digital agriculture through their own exploration on various internet platforms. Second longest bar states that 25% of the respondents acquired their knowledge through media. Third longest bar indicates that 21,3% obtained their knowledge from numerous scientific papers and articles. Other notable sources are educational seminars or conferences and oral communication of information (Figure 5).

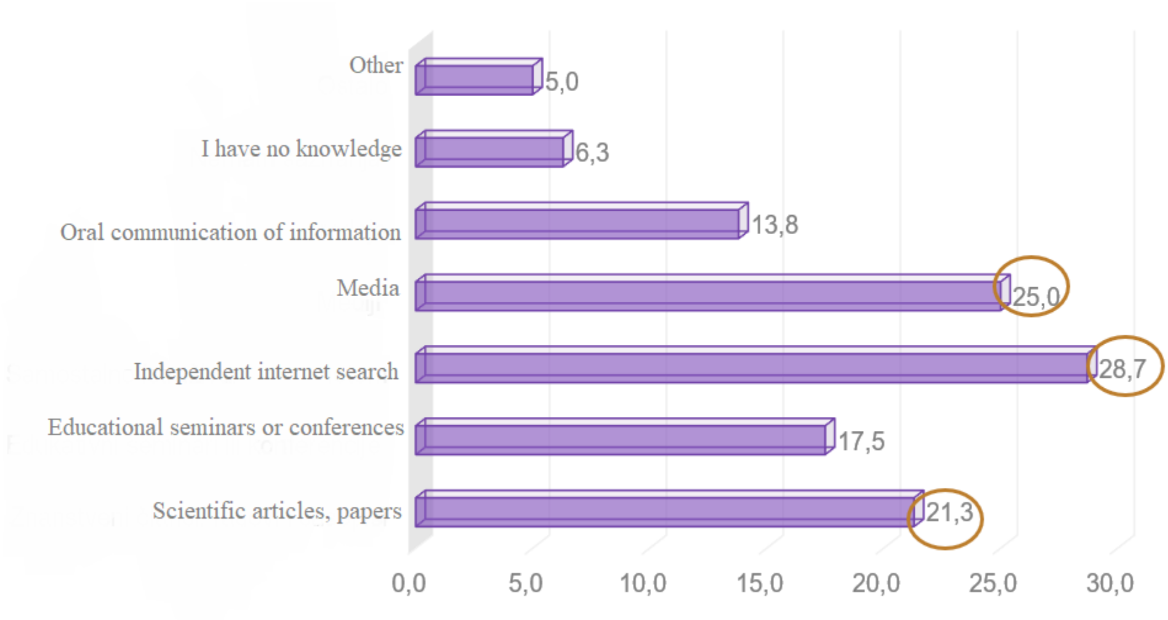

Figure 5 Sources of education regarding the term Digital Agriculture

Source: Author

4.3. The opinion of digital technologies from the perspective of business management and development

The results of this question provide different opinions of agronomists on the impact of digital technologies on business management. Four prominent effects were noted. The most significant one, by 73.8%, was that it simplifies everyday work and administration. Following with 57,5% that it decreases production costs and increases profits. The third most prominent effect with 47,5% was that it is essential for the management of business. Followed by the last one with 45%, stating that it is essential for market competitiveness (Figure 6).

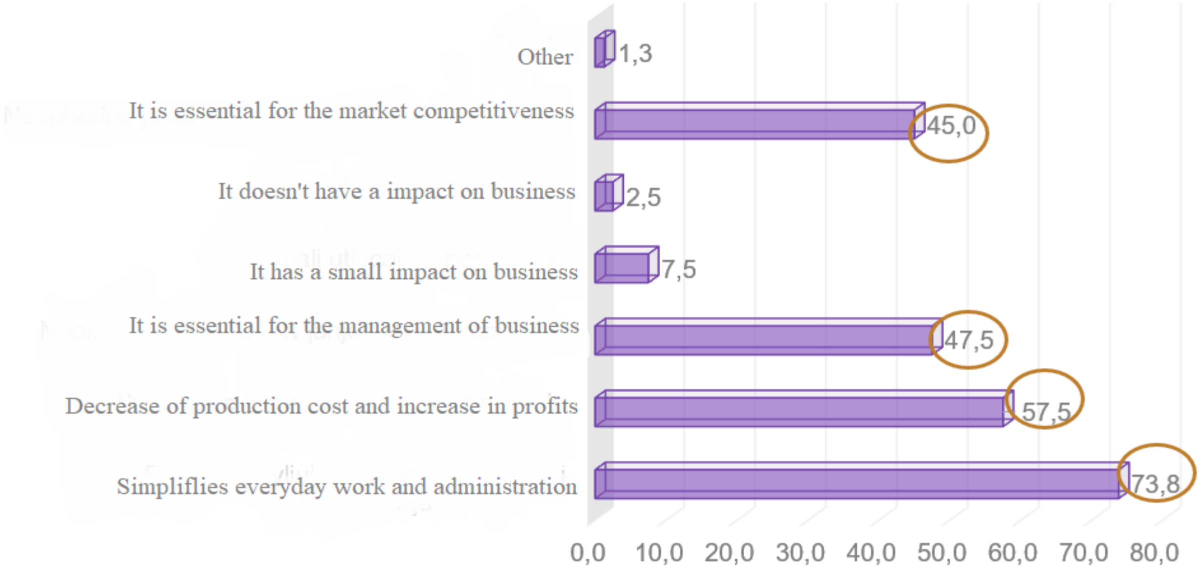

Figure 6 Distinct opinions on the impact of digital technologies on business management and development

Source: Author

4.4. Difficulties using digital technologies in business

The biggest percentage, 67,5%, answered that they did not encounter any problems with using digital technologies in their work environment. 15% of respondents answered that they have partly experienced problems using digital technologies. Followed by 12,5% of respondents stated they don’t use digital technologies in their workplace and only a small portion of respondents (5%) declared they have problems with using digital technologies (Figure 7).

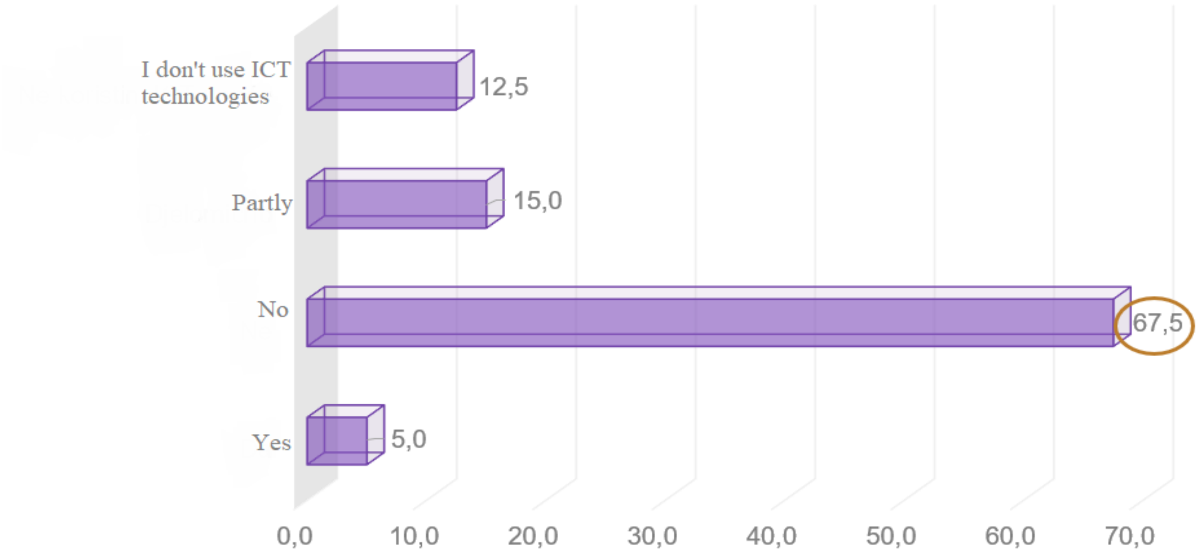

Figure 7 Difficulties with the use of digital technologies in business

Source: Author

4.5. Familiar terminology

Numerous terms were included in this survey questionnaire, like artificial intelligence, Cloud-ICT system, Agriculture 4.0 etc. to find out the level of knowledge of Croatian agronomists when it comes to digital agriculture terminology. The three most prominent terms were noted in the results. Digital Agriculture was the most recognized one with 83,8%. The second one being Precision Agriculture with 80% and third being Smart Agriculture with 66,3% (Figure. 8).

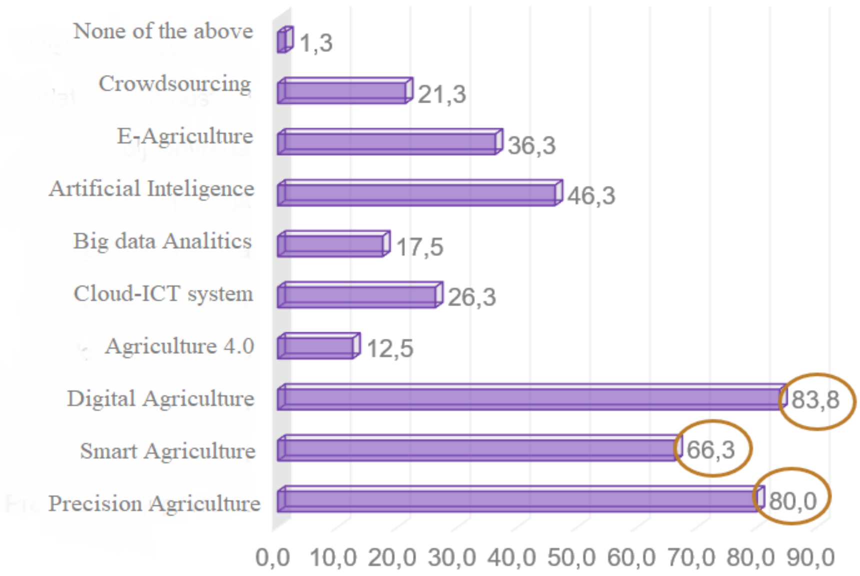

Figure 8 Familiar terms

Source: Author

4.6. T-test results

Independent or student's t-test was one of the statistical methods of data analysis. T-test are utilized where they assess whether mean values (M) are statistically distinct from one another relative to an estimate of sample variability. They can be calculated with independent samples where different participants are in each group, or dependent samples where the same participants are in each group (Gay, Mills, & Airasian, 2012).

4.6.1 Perceived competence in the participation of Croatian agriculture digitalization based on gender and employment in the profession

The results of the independent samples t-test show that there is a statistically significant difference in the statement of current competence of agronomists for digitalization of agriculture ($t = 3.223$, $df = 78$, $p = 0.002$) with respect to gender of the respondents. Table 1 shows that male ($M = 3.38$, $SD = 1.003$) compared to female agronomists ($M = 2.66$, $SD = 0.937$) are, according to their own opinion, more competent in the digitalization of Croatian agriculture. Furthermore, analysis was done regarding the same questions, however in this case, based on employment in the profession. T-test provided the following result: a statistically significant difference was observed ($t = 2.068$, $df = 78$, $p = 0.042$) in the perceived knowledge and expertise for the digitalization process with respect to their employment status.

Agronomists who stated that they're employed in the profession, had a higher mean score (M = 3.2, SD = 0.971) compared to those agronomists who stated that they're not employed in the profession (M = 2.6, SD = 1.183) shown in Table 2.

Table 1 Results comparing current competence of agronomists for the digitalization of agriculture in relation to the gender of the respondents

	Gender					
	Male		Female		t-test	p
Agronomists are trained to participate in the digitization process of Croatian agriculture.	M	SD	M	SD		
	3.38	1.003	2.66	0.937	3.223	0.002**

M = mean; SD = standard deviation; **p ≤0.01; *p ≤0.05

Table 2 Results comparing current competence of agronomists for the digitalization of agriculture regarding their employment in the profession

	Employed in the profession					
	Yes		No		t-test	p
Agronomists are trained to participate in the digitization process of Croatian agriculture.	M	SD	M	SD		
	3.2	0.971	2.6	1.183	2.068	0.042*

M = mean; SD = standard deviation; **p ≤0.01; *p ≤0.05

4.6.2. Knowledge and skills of agronomists for current training to participate in the process of digitization of agriculture

Results from t-test analysis regarding knowledge and skills of agronomists for the current readiness to participate in the process of agricultural digitalization, based on employment in the profession were observed: source of education and skills gained from high school proved no statistical differences noted between agronomists who are employed in the profession and those who are not (t = -0.739, df = 78, p = 0.462). The same conclusion based on the results can be made when it comes to education and skills from studies (t = -0.987, df = 78, p = 0.327). When it comes to knowledge and skills acquired from courses and seminars, a marginally significant difference can be observed (t = 1.982, df = 78, p = 0.051) where in the opinion of agronomists employed in the profession (M = 2.85, SD = 1.235) this source can be seen as a prominent one, in contrast to the ones who are not employed (M = 1.83, SD = 0.753).

The Internet as the source of knowledge and skills showed a statistically significant difference between agronomists (t = 2.265, df = 78, p = 0.026). Those who are employed in the profession consider the Internet as a crucial source of their knowledge (M = 3.55, SD =1.100), opposed to those who are not (M = 2.50, SD = 1.049). The second source that proved a statistical difference was the workplace (t = 3.174, df = 78, p = 0.002) where employed agronomists think of it as an important source as well (M = 3.81, SD = 1.190) opposed to those who are not (M = 2.17, SD = 1.602). And the last origin was personal interest and engagement (t = 2.279, df = 78, p = 0.025) in favor of employed agronomists in the profession (M = 4.03, SD = 1.060) rather than those who are not (M = 3.00, 1.095), shown in Table 3.

Table 3 Results comparing current sources of knowledge and skills of agronomists for current training to participate in the process of digitalization of agriculture with regard to their employment in the profession

Knowledge and skills of agronomist for current training to participate in the process of digitization of agriculture	Employed in the profession					
	Yes		No		t-test	p
	M	SD	M	SD		
Education and skills from high school	2.45	1.229	2.83	1.329	-0.739	0.462
Education and skills from studies	3.03	1.134	3.50	1.049	-0.987	0.327
Knowledge and skills from courses (seminars)	2.85	1.235	1.83	0.753	1.982	0.051*
Knowledge and skills from Internet sources	3.55	1.100	2.50	1.049	2.265	0.026*
Knowledge and skills acquired in the workplace	3.81	1.190	2.17	1.602	3.174	0.002**
Personal interest and engagement	4.03	1.060	3.00	1.095	2.279	0.025*

M = mean; SD = standard deviation; **p ≤0.01; *p ≤0.05

4.6.3. The importance of individual stakeholders in the additional education of agronomists based on the familiarity with the term “digital agriculture”

The results of the independent sample t-test for faculties (lifelong learning programs) show that there is a statistically significant difference in the recognized importance of stakeholders as additional educations sources between those agronomists who are familiar with the term digital agriculture and those who are not (t = 2.117, df = 78, p = 0.037). This source is more recognized by agronomists who are acquainted with the term (M = 3.96. SD = 1.053) than those who are not (M = 3.00, SD =1.265). Also results for the Croatian Chamber of Agronomists were (t = 2.410, df = 78, p = 0.392) suggesting that agronomists who are familiar (M = 3.97, SD = 1.085) with the term “digital agriculture” perceived the Croatian Chamber of Agronomists more crucial in terms of additional education compared to those agronomists who are not familiar with the term. It can be observed that agronomists who are familiar with the term (M = 3.97, SD = 1.085) recognize this source more than the ones who are not (M = 2.83, SD = 1.472). The remaining sources, such as the advisory service (t = -0.140, df = 78, p = 0.889), employer (t = 0.862, df = 78, p = 0.392), distributors and manufacturers of software and equipment for digital agriculture (t = 1.187, df = 78, p = 0.239) and companies and organizations for the dissemination and transfer of knowledge and skills in the digitalization of agriculture (t= 0.937, df = 78, p = 0.352) indicated that there was no statistically significant difference in the perceived importances of these sources between agronomists who are familiar with the term digital agriculture and those who are not (Table 4).

Table 4 Results comparing current importance of individual stakeholders in the additional education of agronomists in terms of familiarity with the concept of digital agriculture

The importance of individual stakeholders in the additional education of agronomists	Are you familiar with the term Digital Agriculture?					
	Yes		No		t-test	p
	M	SD	M	SD		
Faculties (lifelong learning programs)	3.96	1.053	3.00	1.265	2.117	0.037*
Advisory service (seminars)	3.59	1.238	3.67	0.816	-0.140	0.889
Croatian Chamber of Agronomists	3.97	1.085	2.83	1.472	2.410	0.018*
Employer	3.91	1.088	3.50	1.378	0.862	0.392
Distributors and manufacturers of software and equipment for digital agriculture	3.88	1.097	3.33	0.816	1.187	0.239
Companies and organizations for the dissemination and transfer of knowledge and skills in the digitization of agriculture	3.93	1.102	3.50	0.837	0.937	0.352

M = mean; SD = standard deviation; $**p \leq 0.01$; $*p \leq 0.05$

4.6.4. The importance of individual stakeholders in the additional education of agronomists based on gender

In the Table 5 are presented results comparing current importance of individual stakeholders in the additional education of agronomists in relation to the gender of the respondents. T-test results indicate a statistically significant difference between agronomists in the opinion of Advisory services as a crucial source of additional education (t = -2.289, df = 78, p = 0.025) where according to female agronomists (M = 3.97, SD = 1.031) this source of additional education is more important than to male agronomists (M = 3.35 SD = 1.263). For the employer as the source of additional knowledge the same statistical difference can be observed (t = -2.331, df = 78, p = 0.022) where according to the opinion of female agronomists (M = 4.22 SD

= 1.039) employers are crucial stakeholders in the additional education, contrary to the opinion of male agronomists (M = 3.65, SD = 1.101). Other sources such as Faculties (lifelong learning programs) (t= -0.962, df = 78, p = 0.339), Croatian Chamber of Agronomists (t = -0.316, df = 78, p = 0.753), Distributors and manufacturers of software and equipment for digital agriculture (t = -1.748, df = 78, p = 0.069) and Companies and organizations for the dissemination and transfer of knowledge and skills in the digitization of agriculture (t = -1.525 df = 78, p = 0.131) didn't provide a statistical difference between male and female agronomists.

Table 5 Results comparing current importance of individual stakeholders in the additional education of agronomists in relation to the gender of the respondents

The importance of individual stakeholders in the additional education of agronomists	Gender					
	Male		Female		t-test	p
	M	SD	M	SD		
Faculties (lifelong learning programs)	3.79	1.071	4.03	1.121	-0.962	0.339
Advisory service (seminars)	3.35	1.263	3.97	1.031	-2.289	0.025*
Croatian Chamber of Agronomists	3.85	1.288	3.94	0.914	-0.316	0.753
Employer	3.65	1.101	4.22	1.039	-2.331	0.022*
Distributors and manufacturers of software and equipment for digital agriculture	3.67	1.173	4.09	0.893	-1.748	0.069
Companies and organizations for the dissemination and transfer of knowledge and skills in the digitization of agriculture	3.75	1.176	4.13	0.907	-1.525	0.131

M = mean; SD = standard deviation; $^{**}p \leq 0.01$; $^{*}p \leq 0.05$

4.7. ANOVA analysis

ANOVA or analysis of variance is a wide-spread statistical method which is used for exploratory and confirmatory data analysis (Hesamian, G. 2015). EDA or Exploratory data analysis is a process of using graphical visualization and statistical measurements to get the initial sense for the data set, for further data analysis (Leach et al., 2003.), whereas CDA or Confirmatory Data Analysis uses traditional statistics applied to investigate existing hypotheses with pre-fixed alpha level, or in other words, proving or disproving previously set hypotheses or models (Duffy et al.,1990). Independent or student's t-test is a statistical method used to compare the means of two groups, whereas ANOVA is used to compare the means of three or more groups. This method of analysis is an extension of the independent t-test samples where the significant P value of this test refers to multiple comparisons test to identify statistically significant pairs (Mishra et al., 2019).

Using the one-way ANOVA analysis, significant statistical differences were observed in agronomist's perception of various stakeholders and limitations of implementing digital technologies in the process of Croatian agricultural digitalization, based on gender, years of employment in the profession, familiarity with the term "digital agriculture" etc.

4.7.1 Sources of knowledge and skills of agronomists for current training to participate in the process of digitization of agriculture based on year of competition of the highest education level

A statistically significant difference was found between the statement of the importance of agronomists for the digitalization of agriculture and the variable year of completion of their final level of education ($F = 4.687$, $df = 2$, $p < 0.012$). Agronomists who completed their education 10 years ago ($M = 3.40$, $SD = 1.105$) put the highest emphasis on education and skills from studies as the source of their source of knowledge, indicating that higher educational institutes made a reform in the curriculum and put an emphasis on teaching students on these technologies, compared to other age groups.

Table 6 Analysis of variance for the variable competence of agronomists in the process of agriculture digitalization according to the year of completion of agronomists' final level of education

Knowledge and skills of agronomist for current training to participate in the process of digitization of agriculture	Years of completion of the highest level of education						F	p
	<10 years		10 - 20		> 20 years			
	M	SD	M	SD	M	SD		
Education and skills from high school	2.73	1.281	2.28	1.208	2.13	1.060	1.745	0.181
Education and skills from studies	3.40	1.105	2.56	1.044	3.00	1.069	4.687	0.012*
Knowledge and skills from courses (seminars)	2.98	1.330	2.44	1.193	2.80	0.941	1.471	0.236
Knowledge and skills from Internet sources	3.65	1.099	3.40	1.225	3.13	0.990	1.239	0.295
Knowledge and skills acquired in the workplace	3.85	1.075	3.44	1.474	3.67	1.496	0.777	0.464
Personal interest and engagement	3.93	1.047	3.96	1.274	4.00	0.926	0.027	0.974

M = mean; SD = standard deviation; **$p \leq 0.01$; *$p \leq 0.05$

4.7.2. The importance of individual stakeholders in the additional education of agronomists based on age

Table 7 shows the results of the analysis of variance (ANOVA), which revealed statistically significant differences between the variables Croatian Chamber of Agronomists (F = 3.380, df = 3, p < 0.023), traders and producers of software and equipment for digital agriculture (F = 4.135, df = 3, p < 0.009) and companies and organisations for the dissemination and transfer of knowledge and skills in the field of digitalisation of agriculture important for the training of agronomists (F = 6.050, df = 3, p < 0.001), and the age of respondents.

Table 7 Analysis of variance for the variable importance of the individual actors in the continuing education of agronomists according to the age of the respondents

The importance of individual stakeholders in the additional education of agronomists	Years									
	23 - 34		35 - 44		45 -54		> 50		F	p
	M	SD	M	SD	M	SD	M	SD		
Faculties (lifelong learning programs)	3.93	1.107	4.09	1.041	3.60	0.995	3.90	1.370	0.723	0.541
Advisory service (seminars)	3.74	1.259	3.78	1.278	3.15	0.745	3.70	1.567	1.258	0.295
Croatian Chamber of Agronomists	3.70	1.103	4.35	0.885	3.40	1.314	4.30	1.059	3.380	0.023*
Employer	4.00	1.074	4.13	0.920	3.55	1.146	3.60	1.430	1.320	0.274
Distributors and manufacturers of software and equipment for digital agriculture	4.00	1.074	4.17	1.072	3.15	1.040	4.00	0.667	4.135	0.009**
Companies and organizations for the dissemination and transfer of knowledge and skills in the digitization of agriculture	4.04	1.018	4.30	1.063	3.10	1.021	4.20	0.632	6.050	0.001**

M = mean; SD = standard deviation; **p ≤0.01; *p ≤0.05

4.7.3. Limitations (problems) in the digitalization process of Croatian agriculture

Table 8 shows the results of the analysis of variance (ANOVA), which revealed statistically significant differences between the variables insufficient information and interest of farmers (F = 3.465, df = 2, p < 0.036), poor cooperation of Croatian farmers with Ministry of Agriculture (F = 4.760, df = 2, p < 0.011) and poor cooperation of Croatian farmers with local administration (F = 8.055, df = 2, p < 0.001), and the year of completion of agronomists' final level of education. The most prominent group were agronomists who finished the highest level of education less than 10 years ago, and according to their opinion, that the most significant limiting factors in the digitalization process of Croatian agriculture were: Insufficient information and interest of farmers (M = 4.55, SD = 0.639), Poor cooperation of Croatian farmers with the Ministry of Agriculture (M = 4.28, SD = 0.905) and Poor cooperation of Croatian farmers with local administrations (M = 4.35, SD = 0.736), opposed to other age groups. Other limiting factors did not provide a notable statistical difference between the groups.

Table 8 Analysis of variance for the variable limiting factor in the digitalization process of Croatian agriculture according to the year of completion of agronomists' final level of education

Limitations (problems) in the digitalization process of Croatian agriculture	Years of completion of the highest level of education							
	<10 years		10 - 20		> 20 years		F	p
	M	SD	M	SD	M	SD		
Expensive inputs (equipment purchase)	4.15	1.001	3.76	1.052	4.00	0.845	1.191	0.310
Poor technological infrastructure	4.23	0.832	3.80	0.913	3.87	0.834	2.201	0.118
Low levels of e-literacy and digital skills of farmers	4.55	0.783	4.28	1.021	3.93	1.335	2.255	0.112
Insufficient information and interest of farmers	4.55	0.639	4.00	0.957	4.20	1.082	3.465	0.036*
Limited access to services (signal and internet)	3.95	1.218	3.48	1.005	3.67	1.113	1.365	0.262
Poor cooperation of Croatian farmers with the Ministry of Agriculture	4.28	0.905	3.52	1.159	3.73	0.961	4.760	0.011**
Poor cooperation of Croatian farmers with local administrations	4.35	0.736	3.52	1.046	3.53	1.125	8.055	0.001**
Insufficient influence of agronomists in the process of digitization of agriculture	4.38	0.925	3.96	1.060	4.00	1.134	1.580	0.213
Absence of an advisory service for digitization of agriculture	4.38	1.102	3.88	1.269	3.73	1.223	2.251	0.112

M = mean; SD = standard deviation; **p ≤0.01; *p ≤0.05

4.7.4 Opinion on the usefulness or necessity of Digital technologies in agriculture for various stakeholders

Agronomists who consider the digitalisation of Croatian agriculture necessary and useful are more likely to agree with the statement that the knowledge of digital technologies in agriculture is equally important for medium-sized and large farms, as well as for cooperatives, clusters and state units. According to the results in Table 9, a statistically significant difference was found between the statements regarding medium farms ($F = 4.975$, $df = 3$, $p < 0.003$), large farms ($F = 5.513$, $df = 3$, $p < 0.002$), cooperatives ($F = 5.326$, $df = 3$, $p < 0.002$), clusters ($F = 4.410$, $df = 3$, $p < 0.006$), producers in agriculture ($F = 5.477$, $df = 3$, $p < 0.002$), local ($F = 6.269$, $df = 3$, $p < 0.001$), regional government units ($F = 4.054$, $df = 3$, $p < 0.010$), and agencies and ministries ($F = 2.876$, $df = 3$, $p < 0.042$), with regard to the digitalisation of Croatian agriculture.

Table 9 Analysis of variance for the variable importance of knowledge about digital technologies in agriculture according to the digitalisation of Croatian agriculture

The importance of knowledge of digital technologies in agriculture for the following stakeholders of agricultural production	Digitization of agriculture is necessary or useful									
	Necessary		Useful		Neither one		Both necessary and useful		F	p
	M	SD	M	SD	M	SD	M	SD		
Small OPG (and Crafts and similar)	3.67	1.414	2.71	1.083	2.33	1.155	3.34	1.180	2.566	0.061
Middle OPG (and trades and similar)	4.22	0.972	3.04	1.083	2.33	1.155	3.80	1.091	4.975	0.003**
Large OPG (and Crafts and similar)	4.67	0.707	3.63	0.970	2.67	1.528	4.36	1.080	5.513	0.002**
Large (industrial) producers	4.78	0.667	4.21	1.021	4.00	1.000	4.61	0.722	1.971	0.125
Cooperatives	4.67	0.707	3.67	1.090	2.33	0.577	4.14	1.002	5.326	0.002**
Clusters	4.44	0.882	3.75	1.073	2.33	1.528	4.23	0.985	4.410	0.006**
Producers in ecological agriculture	4.11	1.054	3.83	0.963	2.33	1.528	4.07	1.149	2.488	0.067
Producers in agriculture	4.44	0.726	3.83	0.868	2.33	1.155	4.32	0.983	5.477	0.002**
Producers in animal husbandry	4.22	0.833	3.67	0.963	3.00	1.000	4.25	1.037	2.971	0.037*
Vegetable producers	4.44	0.726	3.83	0.963	3.33	0.577	4.25	1.014	1.983	0.124
Producers in fruit growing	4.44	0.726	3.88	1.076	3.33	0.577	4.39	0.945	2.483	0.067
Winegrowers and winemakers	4.44	0.726	3.88	1.076	3.33	0.577	4.25	1.037	1.624	0.191
The local authority units	4.78	0.667	3.46	1.215	2.00	1.000	3.95	1.077	6.269	0.001**
Regional self-government units	4.78	0.667	3.63	1.135	2.67	1.528	4.05	1.077	4.054	0.010**
Agencies and ministries	4.78	0.667	4.00	0.933	3.33	1.155	4.36	0.917	2.876	0.042*

M = mean; SD = standard deviation; **p ≤0.01; *p ≤0.05

4.7.5. The possibility of additional education in the field of agriculture through a course or seminar based on the year of completion of last education level

The results in Table 10 show that if Croatian agronomists had the opportunity to receive training in digital agriculture, they would use this training to participate in mandatory administrative tasks for state institutions ($F = 3.142$, $df = 2$, $p < 0.049$), to use applications in order to update the company website ($F = 12.034$, $df = 2$, $p < 0.000$), to develop software according to the specific functional needs of the company (e.g. for production planning, optimisation of fertilisation, optimisation of crop protection) ($F = 3.280$, $df = 2$, $p < 0.043$), to follow technological changes in digital agriculture ($F = 7.379$, $df = 2$, $p < 0.01$), to become familiar with the basic rules and possibilities of e-commerce ($F = 12.447$, $df = 2$, $p < 0.000$), to be able to handle programs for data storage and transfer (databases, cloud, data transfer) ($F = 8.690$, $df = 2$, $p < 0.000$), to become familiar with the legal and ethical aspects of using digital tools (ICT) ($F = 7.051$, $df = 2$, $p < 0.002$), to become familiar with the methods of data collection, processing and storage ($F = 12.326$, $df = 2$, $p < 0.000$), to be able to select the necessary and optimal information for decision-making ($F = 4.819$, $df = 2$, $p < 0.011$) and to be able to pass on the necessary knowledge or organize training for team-work in the company in a digital environment ($F = 5.927$, $df = 2$, $p < 0.004$). Agronomists who completed their education in the last ten year and ten to twenty years ago are more likely to agree with the statement about the benefits of additional training in digital agriculture than those who completed their education more than twenty years ago (Table 10).

Table 10 Analysis of variance for the variable possibility of additional education in the field of digital agriculture according to the year of completion of agronomists' final level of education

The possibility of additional education in the field of digital agriculture through a course or seminar	Years of completion of the highest level of education						F	p
	<10 years		10 - 20		> 20 years			
	M	SD	M	SD	M	SD		
Help with mandatory administrative tasks for state institutions (requests, reports, returns, etc.)	3.95	1.108	3.56	1.356	3.07	1.100	3.142	0.049*
Use applications to update the company's website	3.95	1.154	3.56	1.387	2.13	1.125	12.034	0.000**
Develop software according to the specific functional needs of the company (e.g. for production planning, optimization of fertilization, optimization of crop protection)	3.75	1.565	3.08	1.552	2.60	1.724	3.280	0.043*
Follow technological changes in digital agriculture and the latest trends	4.25	0.981	3.60	1.225	3.00	1.309	7.379	0.001**
Familiar with the basic rules and possibilities of e-commerce	4.05	1.061	3.28	1.242	2.47	0.834	12.447	0.000**
Trained to work with data storage and transfer programs (databases, cloud, data transfer)	3.98	1.209	3.44	1.325	2.40	1.242	8.690	0.000**
Familiar with the legal and ethical aspects of using digital tools	3.78	1.250	2.96	1.274	2.47	1.246	7.051	0.002**
Familiar with methods of data collection, processing and storage	4.13	1.067	3.04	1.338	2.53	1.246	12.326	0.000**
Select the necessary (necessary and optimal) information for decision-making	4.10	1.033	3.44	1.294	3.07	1.486	4.819	0.011**
Transfer necessary knowledge or organize training for company teamwork in a digital environment.	4.13	1.017	3.24	1.300	3.20	1.320	5.927	0.004**

M = mean; SD = standard deviation; **p ≤0.01; *p ≤0.05

5. DISCUSSION

In this section of the thesis, the results of our research on the competence, potential role and perspective of agronomists in the process of digitalization of Croatian agriculture are compared with two similar surveys on "The attitude of agronomists and family farmers towards the use of satellite technologies in agriculture" (Loncaric et al., 2023) and "Competencies Needed for Guiding the Digital Transition of Agriculture: Are Future Advisors Well-Equipped?" (Charatsari, et al., 2023). The first study was conducted using an online questionnaire on a sample of 229 respondents, 56 of whom were agronomists (24.5%), while the other 173 respondents had no agronomic educational background. The target population was stakeholders in agricultural production, such as family farm owners and their employees, as well as agronomists working in different areas of agriculture, such as educational institutions, agencies and agronomists not working in the profession. The survey contained 25 open and closed questions divided into 5 groups. These groups of questions were designed to provide insight into socio-demographic issues, the frequency of use of satellite services - an aspect of digital agriculture that can be correlated with the findings on the difficulties of using digital technologies in business from this research thesis - and the role of agronomists as advisors - the central result of this research thesis. The following can be concluded: 24% of the respondents have high school as their highest educational qualification, 24% stated that their education is based only on family tradition and 26% stated that they have attended evening schools, courses and seminars, which may be related to the fact that 47.6% of the respondents do not use satellite services. This is where the advisory role of agronomists should come into play. This statement does not mean that the percentage of those who do not use this technology will drop to 0%, but if the benefits of this segment of digital agriculture were explained to them in detail, the percentage could be lower, because 67.5% of the respondents from our research stated that they have no problems using digital technologies in their work environment and 92.5% stated that they are familiar with the terminology, which indicates the competence of our agronomists. The most important finding from this survey was the willingness to train, pay for services and engage agronomists in the future. Most respondents (54.6%) are willing to participate in some form of education and training on satellite services, but only 9.6% of respondents indicated a willingness to educate themselves by working with agronomists. This is a particularly worrying finding, especially since 96.3% of agronomists from our survey see themselves as a crucial factor in the process of digitalization of agriculture in Croatia. So what can be done to change stakeholders' perceptions of the importance of our agronomists as their trainers? Firstly, emphasize the knowledge they have about digital agriculture and the expertise they can offer. Also, establish mentoring programs through online extension services, which 15% of respondents said was the preferred type of training, where agronomists could be the staff providing the service. The second research looked at the level of knowledge and competence of future agronomists, more specifically, students from a Greek university. The research was also conducted through a survey with a series of open and closed questions to a group of 108 students, 94.7% of whom were in their final years of education. To assess their competencies, 3 sets of questions were formed. The first group concerned the students' technocentric competencies, i.e. their ability to use digital technologies and their understanding of the principles of their operation. The second group of questions targeted future-oriented competencies, which refer to the ability to predict the future direction of this agricultural revolution and thus anticipate potential obstacles and challenges. The third and final category related to their ability to facilitate farmers' transition to adopting these technologies. The scale ranged from 1 (not at all) to 5 (very much). The following mean values (M) can be observed: Technology understanding ($M = 3.22$, $SD = 1.05$) with a high to medium mean score, indicating a low to medium level of techno-centric knowledge and competence. Other, more complicated competencies, such as risk mitigation competencies, scored the lowest mean score. For the techno-centric competencies group, the mean scores ranged from 2.85 to 3.53. For the third and final group, farmer-centric competencies, the mean scores ranged from ($M = 2.93$, $SD = 0.92$) for the Digital Technology Conversion Process competency to ($M = 3.31$, $SD = 1.00$) for the Empathy competency. A promising result was that the students' attitude towards digital agriculture was quite positive with ($M = 5.53$, $SD = 1.29$). Overall, the results of this research show a disappointing overall level of knowledge and competence among students at this university, despite their positive attitudes towards these technologies. Since Greek advisors in education seem to lack knowledge and competence in these areas, there is an urgent need to impart them to the next generation of agronomists. In contrast to our study, the subjects were not students, but a similar group of subjects can be compared to them. Agronomists who graduated in the last 10 years placed the highest value on acquiring knowledge from their studies ($M = 3.40$, $SD = 1.105$), in contrast to the results of the Greek university research, in which students' knowledge was rated as low. Agronomists who were familiar with the concept of digital agriculture also emphasized faculty as the most important source of additional knowledge.

6. CONCLUSION

In summary, it is worth mentioning that, although the sample size of this survey is small, and it can't represent the broader population of agronomists and stakeholders in Croatian agriculture, it can still offer a valuable insight in the demographic and socio-economic composition of individuals interested and involved in the process of Croatian agriculture digitalization. From the general population of the survey, comprising of 80 respondents, the following can be concluded: 92.5% of the population stated that they were familiar with the term digital agriculture, indicating a high level of awareness regarding this concept. One of the most crucial findings was the fact that 96.3% of the population stated that they perceive themselves as crucial actors (stakeholders) in the process of Croatian agriculture digitalization. This finding indicates that our agronomists have a heightened sense of responsibility to be the leading experts in this process. Also, the fact that 67,5% of the population stated that they don't have problems using ICT technologies in their work environment only confirms that our agronomists are more than capable of withstanding the pressure of this challenging process. Their willingness and initiation to be key actors is also shown through the main source of their education and knowledge for digital agriculture, where the Internet, as the primary source of education scored the highest percentage of 28,7%. The independent samples t-test and ANOVA were conducted to determine the significant differences between the segments in terms of consumers' socio-demographic characteristics and agronomists' knowledge about digital agriculture. Based on gender, male agronomists perceive themselves as more competent than their female colleagues in terms of the digitalization process. In contrast, for the importance of individual stakeholders in the additional education of agronomists, female agronomists expressed the highest emphasis on advisory services and employers, compared to their male colleagues. Further, agronomists who are employed in the profession, provided statistically significant results, compared to agronomists who are not, regarding the current ability to participate in the digitalization process, emphasizing personal interest and engagement, skills acquired in the workplace, internet sources and seminars as the primary source of education. Meaning, even outside of formal education sources, such as universities, our agronomists are keen to make an extra effort to better themselves, indicating a dedicated and professional approach to this digital revolution. The variable "Last year of completing the highest level of education" was compared to several hypotheses and the following was concluded: in regard of knowledge and skills of agronomists for current training to participate in the process of digitalization, according to agronomists who finished their highest level of education in the last decade, the highest emphasis was placed on education and skills from studies, compared to other groups. This could be correlated with the fact that in recent years digital agriculture is becoming the standard curriculum in high agricultural education institutions. Limiting factors, such as insufficient information and interest from farmers, poor cooperation of farmers with the local authorities and the Ministry of Agriculture, were given the highest statistical significance compared to other factors, again from agronomists who finished their education in the last decade. This group also might have a better insight into the problematics and obstacles that might occur because they are far more likely to be exposed in greater volume to the concept of digital agriculture than agronomists who finished their education 20 years ago and more. The same conclusion can be concluded for additional education through a seminar or course. Also, according to the perception of agronomists, these technologies are seen as necessary and useful for all stakeholders in agricultural production. Based on the findings presented in this research, several steps are recommended to improve the digitalization process with the highlight of including agronomists as the key factors. The first step would be to recognize the importance and necessity of formal education provided by high academic institutions. This can be accomplished by incorporating bachelor's and graduate studies which would enable future agronomists to stay updated on current trends while gaining understanding of the basic principles of these technologies. Next would be funding of research and projects where students and graduated agronomists can actively participate and develop their critical thinking and creativity, which in return can have innovative ideas enhancing the integration of digital agriculture even further. Also, training in the form of workshops, online courses for improving ICT proficiency and problem solving skills. Furthermore, there is a need for strengthening collaborations between all the actors participating in the process, like agronomists, farmers, local authorities, and the Ministry of Agriculture to highlight the enormous potential these technologies have to offer, but only if utilized properly. By equipping our agronomists with the necessary knowledge, skill set and tools, we as a collective, considering today’s times of uncertainty, can face these agricultural challenges head on and make a more sustainable and enduring food system.

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8. SUMMARY

A survey was conducted to analyse the current state of theoretical knowledge, the general perception of the ongoing digital transformation of Croatian agriculture and the assessment of respondents as potential key stakeholders. The survey, in the form of an online questionnaire, included a sample of 80 respondents (n = 80), who were agronomists, regardless of age and profession. The questionnaire consisted of a total of 35 open and closed questions. The first set of questions focused on obtaining demographic and socio-economic information about the respondents, which formed the basis for interpreting the rest of the data. For example, how the last year of completion of the highest level of education correlates with the perceived limiting factors of the digitalization of Croatian agriculture, the ability to participate in the process of digitalization of Croatian agriculture based on gender, etc. The data obtained from the online questionnaire was analysed using the statistical software package IBM SPSS Statistics V26. Percentages, arithmetic means, standard deviations and frequencies were used to describe the sample using descriptive statistics. The data was also analysed using parametric tests, such as t-test for independent samples and one-way ANOVA).

Key words: digital agriculture, agronomists, Croatian agriculture, t-test, ANOVA

9. SAŽETAK

Istraživanje je provedeno kako bi se analizirao trenutni stupanj teorijskog znanja, opća percepcija digitalne transformacije hrvatske poljoprivrede koja je u tijeku te kako sebe vide kao potencijalne ključne dionike. Anketa u obliku online upitnika imala je uzorak od 80 ispitanika (n = 80) koji su bili agronomi, bez obzira na dob i zanimanje. Upitnik se sastojao od ukupno 35 otvorenih i zatvorenih pitanja. Prvi set pitanja bio je usmjeren na dobivanje demografskih i socioekonomskih podataka o ispitanicima, koji su bili temelj za interpretaciju daljnjih podataka. Primjerice, kako zadnja godina završene najviše razine obrazovanja korelira s percipiranim ograničavajućim čimbenicima digitalizacije hrvatske poljoprivrede, sposobnost sudjelovanja u procesu digitalizacije hrvatske poljoprivrede na temelju spola itd. Podaci dobiveni iz online upitnika analiziran je pomoću statističkog programskog paketa IBM SPSS Statistics V26. Postoci, aritmetičke sredine, standardne devijacije i frekvencije korišteni su za opis uzorka pomoću deskriptivne statistike. Podaci su također analizirani pomoću parametarskih testova, kao što su t-test nezavisnih uzoraka i jednosmjerna ANOVA.

Ključne riječi: digitalna poljopriveda, agronomi, hrvatska poljoprivreda, t-test, ANOVA

10. LIST OF TABLES

11. LIST OF FIGURES

BASIC DOCUMENTATION CARD

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Faculty of Agrobiotechnical Sciences Osijek
University Graduate Studies, Digital Agriculture

Role of agronomists in agriculture digitalisation in Croatia

Dominik Tačković

Abstract
A survey was conducted to analyse the current state of theoretical knowledge, the general perception of the ongoing digital transformation of Croatian agriculture and the assessment of respondents as potential key stakeholders. The survey, in the form of an online questionnaire, included a sample of 80 respondents (n = 80), who were agronomists, regardless of age and profession. The questionnaire consisted of a total of 35 open and closed questions. The first set of questions focused on obtaining demographic and socio-economic information about the respondents, which formed the basis for interpreting the rest of the data. For example, how the last year of completion of the highest level of education correlates with the perceived limiting factors of the digitalization of Croatian agriculture, the ability to participate in the process of digitalization of Croatian agriculture based on gender, etc. The data obtained from the online questionnaire was analysed using the statistical software package IBM SPSS Statistics V26. Percentages, arithmetic means, standard deviations and frequencies were used to describe the sample using descriptive statistics. The data was also analysed using parametric tests, such as t-test for independent samples and one-way ANOVA).

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Dominik Tačković

Sažetak

Istraživanje je provedeno kako bi se analizirao trenutni stupanj teorijskog znanja, opća percepcija digitalne transformacije hrvatske poljoprivrede koja je u tijeku te kako sebe vide kao potencijalne ključne dionike. Anketa u obliku online upitnika imala je uzorak od 80 ispitanika (n = 80) koji su bili agronomi, bez obzira na dob i zanimanje. Upitnik se sastojao od ukupno 35 otvorenih i zatvorenih pitanja. Prvi set pitanja bio je usmjeren na dobivanje demografskih i socioekonomskih podataka o ispitanicima, koji su bili temelj za interpretaciju daljnjih podataka. Primjerice, kako zadnja godina završene najviše razine obrazovanja korelira s percipiranim ograničavajućim čimbenicima digitalizacije hrvatske poljoprivrede, sposobnost sudjelovanja u procesu digitalizacije hrvatske poljoprivrede na temelju spola itd. Podaci dobiveni iz online upitnika analiziran je pomoću statističkog programskog paketa IBM SPSS Statistics V26. Postoci, aritmetičke sredine, standardne devijacije i frekvencije korišteni su za opis uzorka pomoću deskriptivne statistike. Podaci su također analizirani pomoću parametarskih testova, kao što su t-test nezavisnih uzoraka i jednosmjerna ANOVA.

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