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THE DEMAND FOR DIGITAL SERVICES IN BULGARIAN AGRICULTURE: DETERMINANTS AND CHALLENGES IN FRONT OF DIGITAL AGRICULTURE

ABSTRACT

In the present study, the aim is to determine to what extent the demand for digital services in Bulgarian agriculture is developed and what are the factors that limit this process. This analysis examines the determinants of demand as a function of the interests and attitudes of users of digital services in the agricultural sector. It is often used as a tool for analyzing different groups of users, regarding the market status of certain services, as well as for assessing their ability to influence or be influenced by the market price. In general, there is a large difference between the production and management approaches applied on large and small farms. The size of the farms and the digital technologies they use are often related to the potential of the farmer to make investments and successfully grow his business. Larger farms have easier access to finance and can very quickly implement the digital farming approach, as long as they see a sense or motive to do so. For smaller farms, digitization does not create opportunities, on the contrary, it requires additional investments that are too much for them. High start-up costs, associated in some cases with the risk of insufficient return on investment, can become a serious challenge regarding the affordability of the technological component of digital agriculture.

KEYWORDS: Digital services, Artificial intelligence in agriculture, Demand of digital services, Digital farming

JEL: F15, F63, R18

INTRODUCTION

For centuries, agriculture has been a major human activity providing sustenance for the planet's population. The multi-functional and complex nature of modern agriculture determines its enormous importance in ensuring the nutrition of the society and remains a significant footprint on the environment and the depletion of natural resources. The global problem of feeding humanity despite the progress of science is still on the agenda (Kaloxylosa et al., 2012). There are still regions of the world where the population does not have access to food and raw materials to improve their lifestyle (Kandilov et al., 2017). Today, agricultural management

must solve the cardinal problem - "how to satisfy the food needs of the rapidly growing global human society with increasingly scarce resources?". Another important problem should be added to this question - "how to produce agricultural goods and services without exhausting natural resources to the limit?". In search of solutions to these problems, stakeholders in the sector have significantly transformed agriculture over the last century. In the last century, agriculture went through several stages of development, namely - an era of industrialization, followed by an era of green revolution, through an era of sustainable development and today we are witnessing the era of digitalization (Ivanov et al., 2009). These evolutionary stages in the development of agriculture are dictated by man's desire to feed himself without completely and systematically disrupting the balance of the earth's ecosystems. The partial success of the sustainable development approach gave reason to replace it with the digitization approach, the aim of which is to solve the identified problems in a more efficient way. Today's politicians rely on the proclamation of digitization as an effective tool for the future development of agriculture. There is more and more talk about how competitiveness will be increased through digitalization, how the efficiency of the use of production resources will be improved, how new industries will develop, saturated with new business models, delivering innovative products to the market (Karkh et al., 2019). Through digitization, new approaches to economic impact such as the circular economy and the bio-economy are sought to be applied (Fitch-Roy et al., 2019). The main challenges to the digitization of agriculture is that, despite massification in the production of the necessary hardware, it is still an expensive and inaccessible technology especially for the small farmer (Stoeva et al., 2021); digitalization requires specific skills on the part of the farmer (especially for older and conservative farmers) to help him take advantage of the wide variety of digital solutions;confuses the user and generates additional costs from hidden fees for the use of software or subsequent access to cloud services (Fidanska et al., 2021). Despite the mentioned challenges, the main contribution of digitization is indisputable, namely providing full control over the business processes that take place in the agricultural holding.

In the present study, the aim is to determine to what extent the demand for digital services in Bulgarian agriculture is developed and what are the factors that limit this process.

1. RESEARCH METHODOLOGY

The purpose of the proposed methodological approach is to organize scientific research effectively in identifying and involving farmers in the process of data collection describing the state of demand for digital services in the agricultural sector.

The analysis and identification of respondents in scientific research is a process of systematically collecting and analyzing qualitative information to determine and verify the factors determining the demand for digital services in agriculture (Von Braun, 2003). This analysis examines the determinants of demand as a function of the interests and attitudes of users of digital services in the agricultural sector. It is often used as a tool for analyzing different groups of users, regarding the market status of certain services, as well as for assessing their ability to influence or be influenced by the market price (Borisov, P., T. Radev, 2020).

Place of conducting the research. The territory of the Republic of Bulgaria is divided into 6 planning areas (NUTS 2) - North-West, North-Central, North-East, South-East, South-Central and South-West regions. When determining the region for conducting the research, we have preferred the division of our country according to the NUT2 classification, as they are tailored to the specific conditions affecting the production activity in the industry, and hence the preferences for various digital services on the part of farmers. Farms whose farmers are included as a target group in the survey are located in each of the planning areas, but equality in terms of the number of farms in the context of their territorial location is not sought.

Formation of the sample. The register of agricultural holdings, in which all agricultural holdings are entered as of 31.12.2023, was used as a source for forming the sample. The resulting population consists of 132,742 agricultural holdings. In forming the sample, the method of simple random sampling was used, and the constituent units were selected through non-returnable selection (Sajkova, 2002). The volume of the sample is 298 agricultural holdings, which manage a total of 45,641 ha, which is 1% of the used agricultural area in Bulgaria.

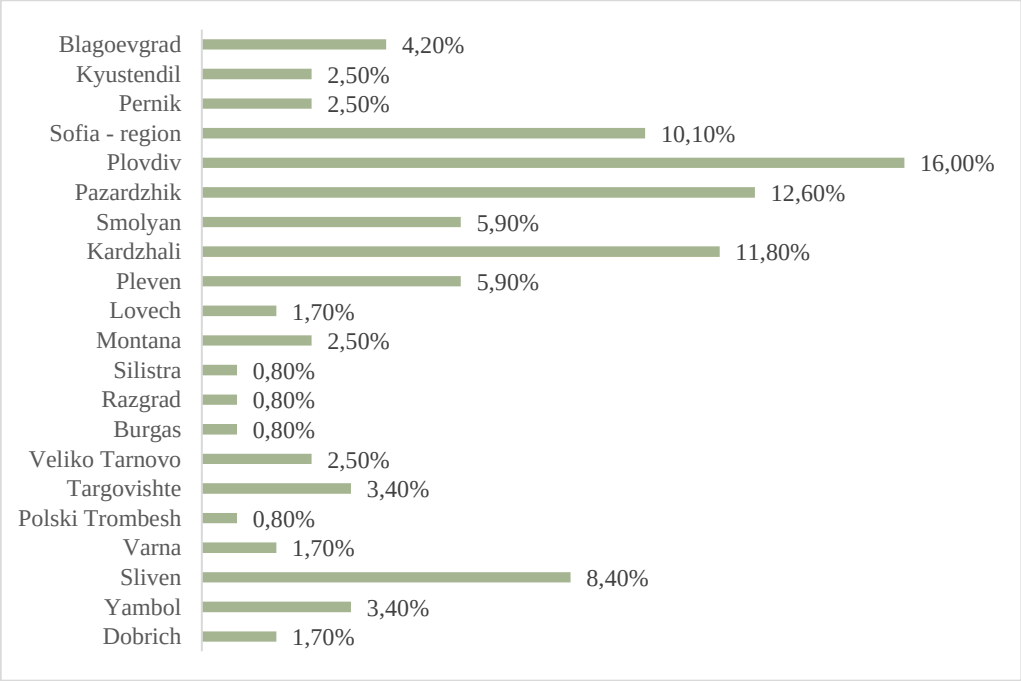
Questionnaire structure. To study the state of the factors determining the demand for digital services, 17 questions are included, aimed at obtaining information about: the general characteristics of the farms and the factors determining the demand as well as the obstacles to the demand for digital services in the sector.

2. ANALYSIS OF DEMAND FOR DIGITAL SERVICES

On the Bulgarian market there are suppliers of various services and equipment as well as software for both partial and complete transition to digital management of the agricultural holding. In this part of the research, we aim to profile what the demand for digital services is on the part of the Bulgarian farmer, as well as to determine the benefits and obstacles of the introduction of digitalization as a tool for effective agricultural management.

The distribution of farms according to their location is given in figure 1. From the data presented in this way, it can be seen that the largest share of surveyed farms are from Plovdiv region - 16%, Pazardjik region - 12.6%, Kardjali region - 11.8% and Sofia region - 10.1%.

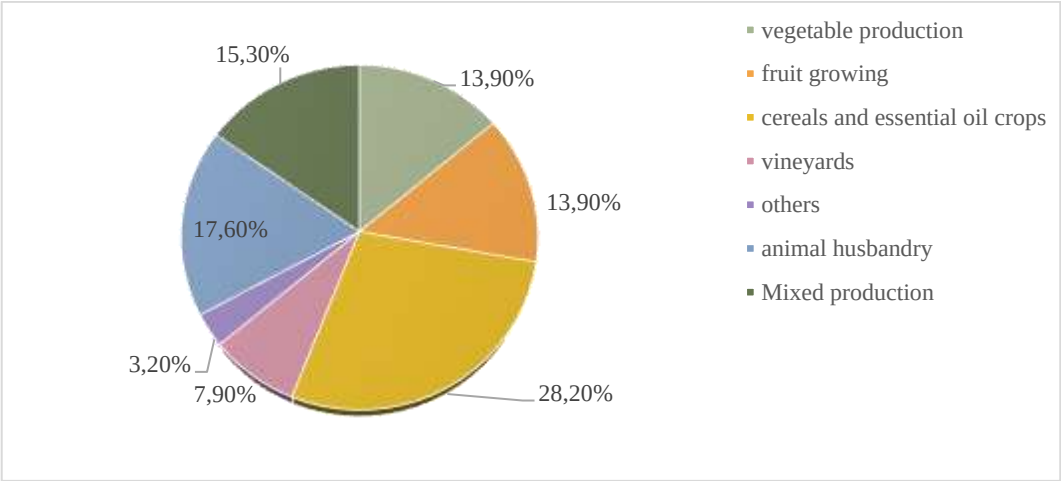
Figure 1. Territorial distribution of the studied holdings



Source: data from a survey of 298 farms, 2023.

The production specialization of the surveyed farms is given in figure 2. The data show that in the studied set of farms, those specializing in the cultivation of grain-cereal and essential oil crops predominate - 28.2% of the total surveyed sites. Livestock farms follow with 17.6% of the total surveyed farms. Farms with vegetable specialization also occupy a significant share of the surveyed farms - 13.9%.

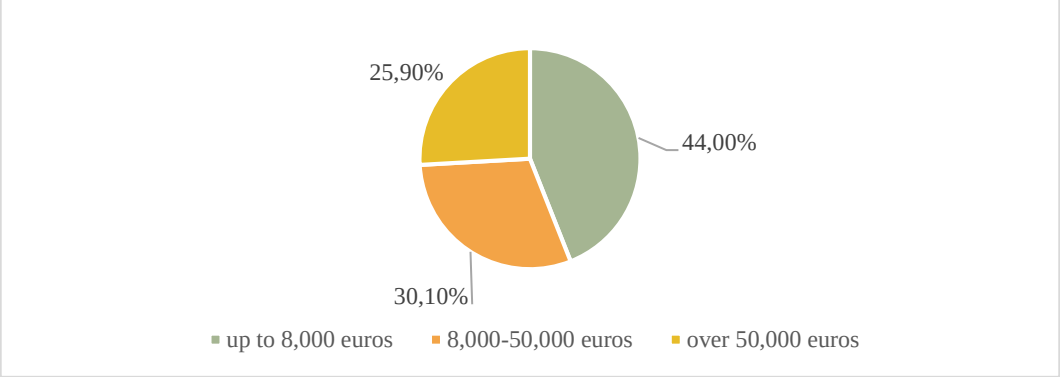
Figure 2. Specialization of the studied farms



Source: data from a survey of 298 farms, 2023.

The next criterion by which the agricultural holdings in the studied population were identified is their size. Figure 3 shows the graphic analysis of farms according to this criterion. The graphic analysis of the survey data shows that small farms (with a size of up to 8,000 euros) predominate, namely their share is 44% of the total surveyed sites. Next, as a significant group, are medium-sized farms (with a size of 8,000 to 50,000 euros), whose share is 30.1% of the total surveyed farms.

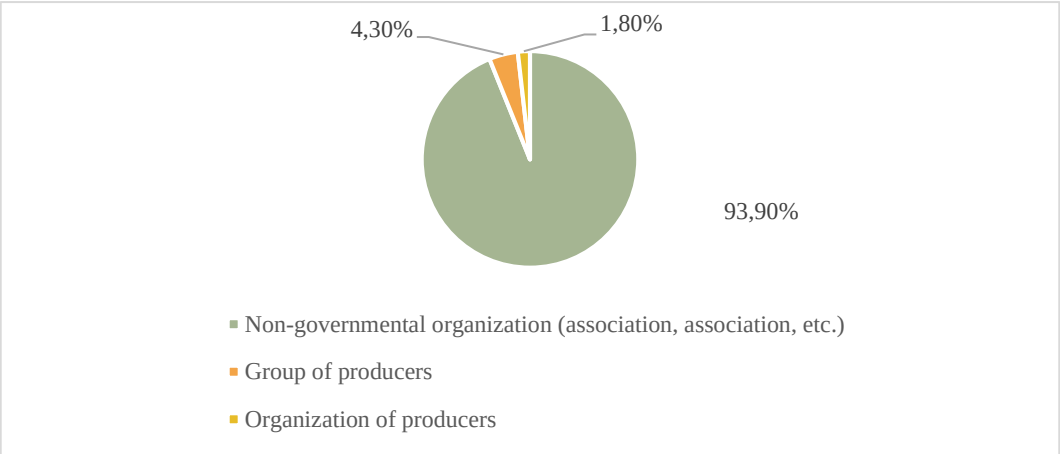
Figure 3. Economic size of the studied holdings



Source: data from a survey of 298 farms, 2023.

Another profiling criteria of the studied group of farms is their membership in various organizations. Figure 4 shows the percentage distribution of the surveyed farms. From the presented data, it is clearly seen that agricultural holdings prefer to join non-governmental organizations - 93.9% of them state that they are members of such organizations.

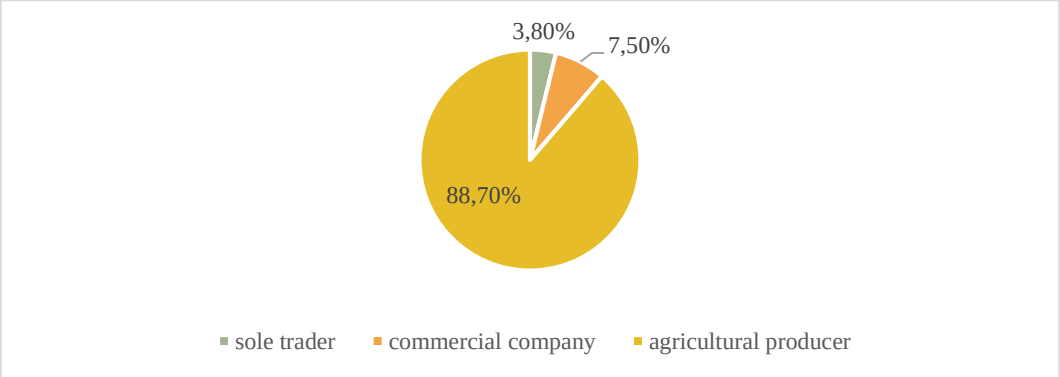
Figure 4. Distribution of farms according to their membership in associations



Source: data from a survey of 298 farms, 2023.

Figure 5 shows the distribution of surveyed farms according to their legal form. The results of the survey indicate that the most common form of property management of agricultural holdings is registration - a natural person, 88.7% of all surveyed holdings use it. Only 7.5 of the farms surveyed are registered as commercial companies.

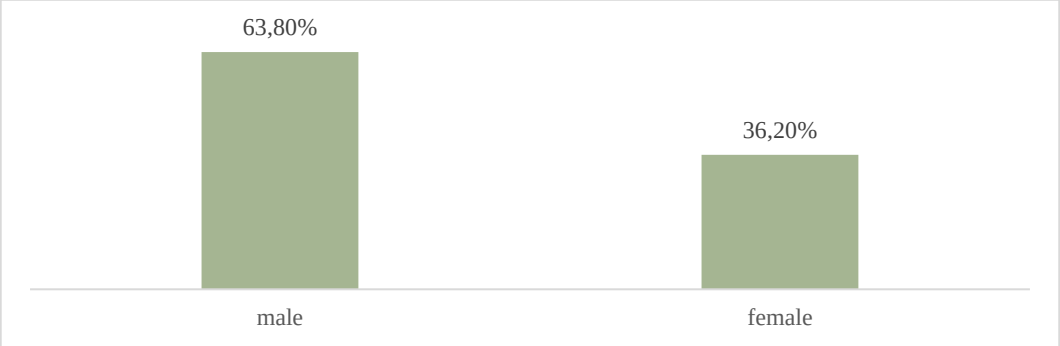
Figure 5. Distribution of surveyed farms according to their legal form



Source: data from a survey of 298 farms, 2023.

There are a total of 197 farmers surveyed. The main criteria for researching their profile are: - gender, age, education and experience in agrarian business. Figure 6 contains information about the gender of the surveyed farmers.

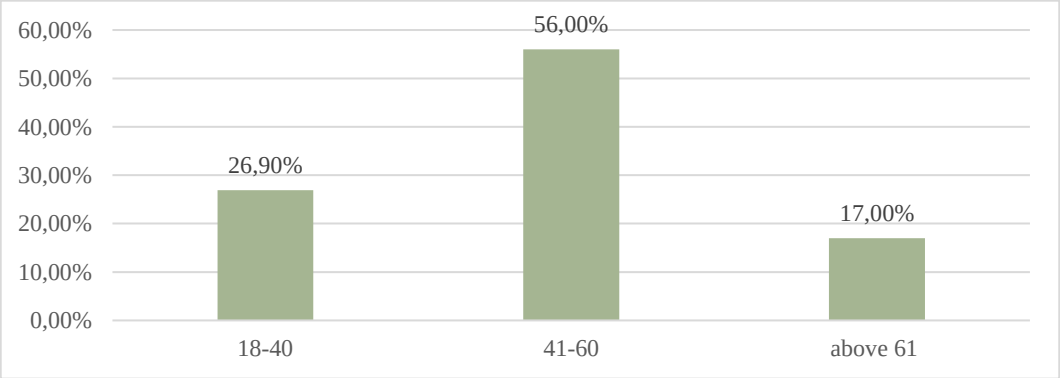
Figure 6. Distribution of respondents by gender



Source: survey data among 298 respondents, 2023.

The results of the survey indicate that more than half of the farmers fall in the age range of 41 to 60 years. The group of farmers with the age of 18-40 years follows, respectively, young farmers are 26.9% of the total respondents (see fig. 7).

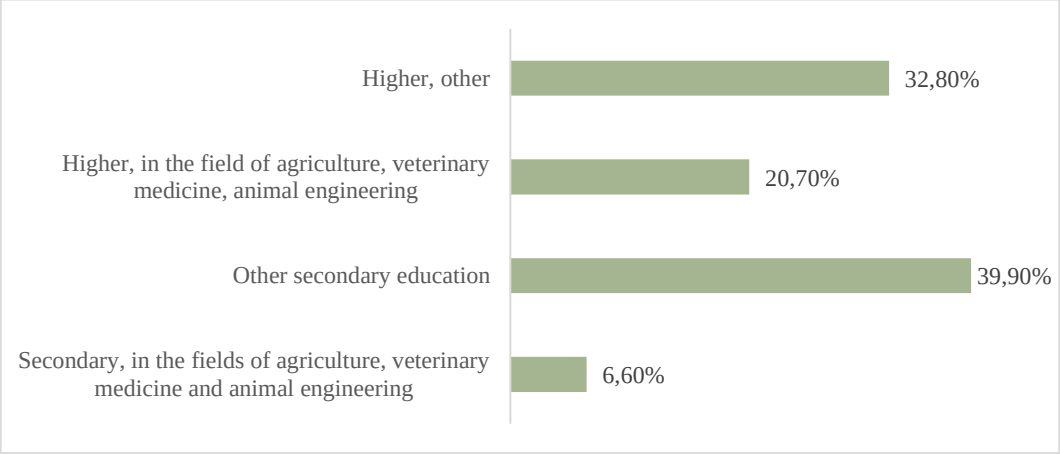
Figure 7. Distribution of respondents by age



Source: survey data among 298 respondents, 2023.

The next criterion by which the respondents were examined was their education. Figure 8 shows the distribution of respondents according to this criterion. From the graphic analysis, it can be seen that 39.9% of the respondents have secondary education, followed by those with higher education, respectively, they occupy 32.8% of all respondents. It is noteworthy that only 20.7% of the interviewed farmers have acquired a higher education degree in the field of agriculture, veterinary medicine and zoo-engineering.

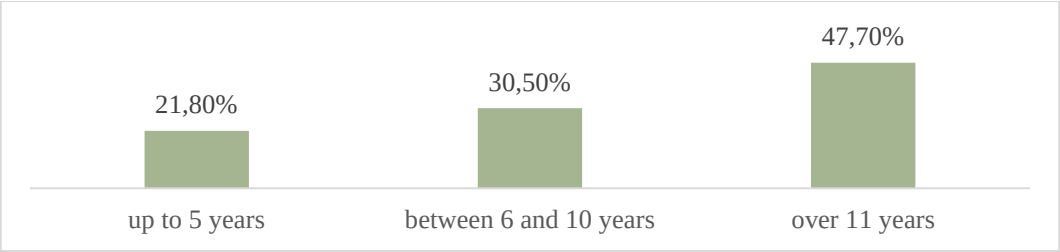
Figure 8. Distribution of respondents by type of education



Source: survey data among 298 respondents, 2023.

Another criteria for analysis of farmers is accumulated experience. According to the survey data, 47.7% of farmers have experience of more than 11 years in the field of agrarian business, 30.5% of farmers have experience between 6 and 10 years. The smallest is the group of farmers with up to 5 years of experience, only 21.8% of the total respondents (see figure 9).

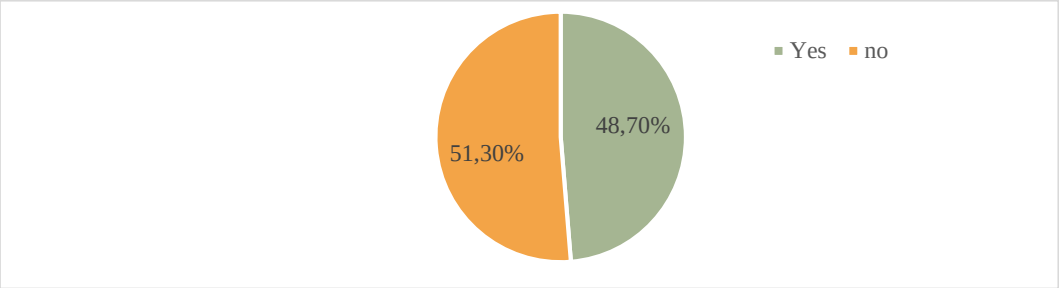
Figure 9. Distribution of respondents according to accumulated experience in the field of agrarian business



Source: survey data among 298 respondents, 2023.

Figure 10 presents information on the participation of farmers in the individual measures of the Rural Development Program. The data show that the share of those participating with project proposals for the individual measures of the PRDP prevails - 51.3% of all surveyed farmers. The most frequent measures that received funding are measure 121, measure 10, measure 6.1 of the RDP.

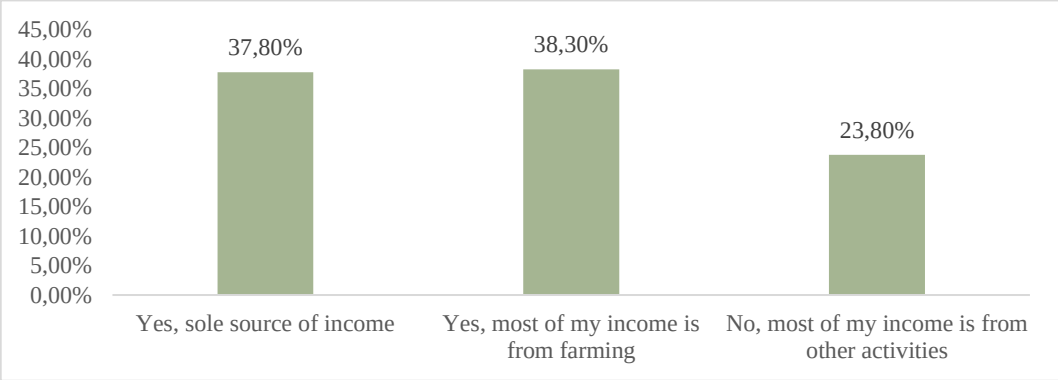
Figure 10. Distribution of surveyed farmers according to whether they participated in projects under any of the RDP measures in the last 5 years



Source: survey data among 298 respondents, 2023.

Another criteria for differentiating the group of surveyed farmers is the type of income sourceagricultural activity. Figure 11 shows the distribution of the responses received.

Figure 11. Distribution of respondents according to the role of agricultural business in the formation of their income



Source: survey data among 298 respondents, 2023.

From the presented data, it can be seen that the majority of farmers form their income from agricultural activity - 38.3% stated this. Next is the group of farmers who declare that agriculture is the only source of income for them and their family - 37.8% of all respondents.

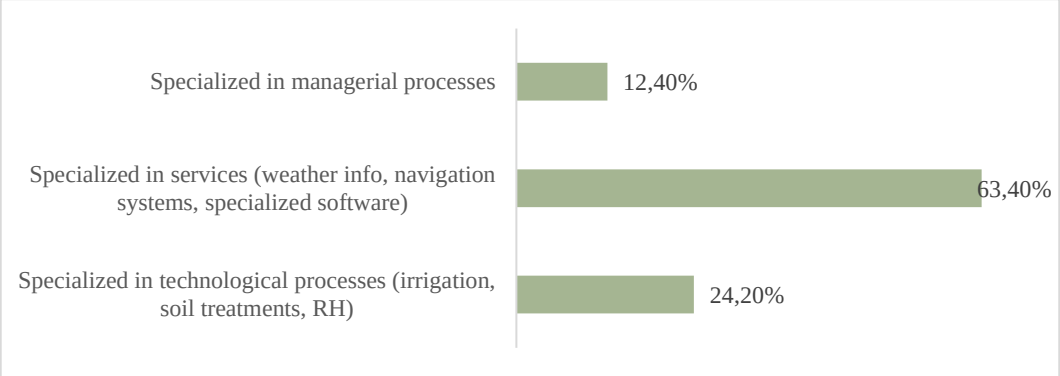
3. MAIN DETERMINANTS OF DEMAND FOR DIGITAL SERVICES

The following questions included in the survey aim to collect information about the main determinants of demand for digital services by farmers, as well as to identify the main obstacles limiting access to these services.

Figure 12 shows farmers' responses to the question "What digital services do you use in your business?". The data from the conducted survey indicate that most often farmers use digital services of the type - "specialized in weather info services, navigation systems, specialized software", 63.4% of the total surveyed persons. In the second place, farmers indicate that they

use digital services specialized in the management of technological processes, 24.2% of the total respondents indicated this type of service. In the last place, as a preferred digital service, farmers indicated the one that specializes in managing management services, 12.4% of the total respondents.

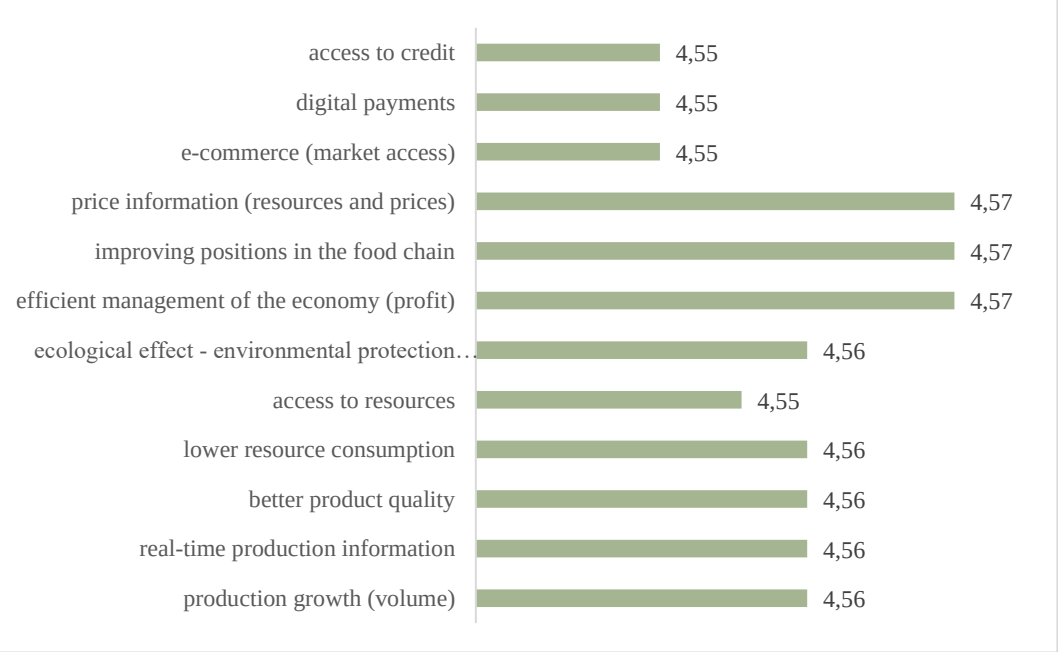
Figure 12. Digital services used by farmers



Source: survey data among 298 respondents, 2023.

The next question in the survey is "How do you rate the benefits of the digital services you use?". The purpose of the question is to collect information about the generated benefit from the use of digital services, when carrying out the daily activities of the farmer in nhis farm. Figure 13 shows the assessment of the benefits of using digital services in farm management. Farmers rate the following benefits as the most significant: (1) efficient farm management (average rating – 4.57); (2) improving positions in the food chain (mean score – 4.57) and (3) price information – mean score 4.57.

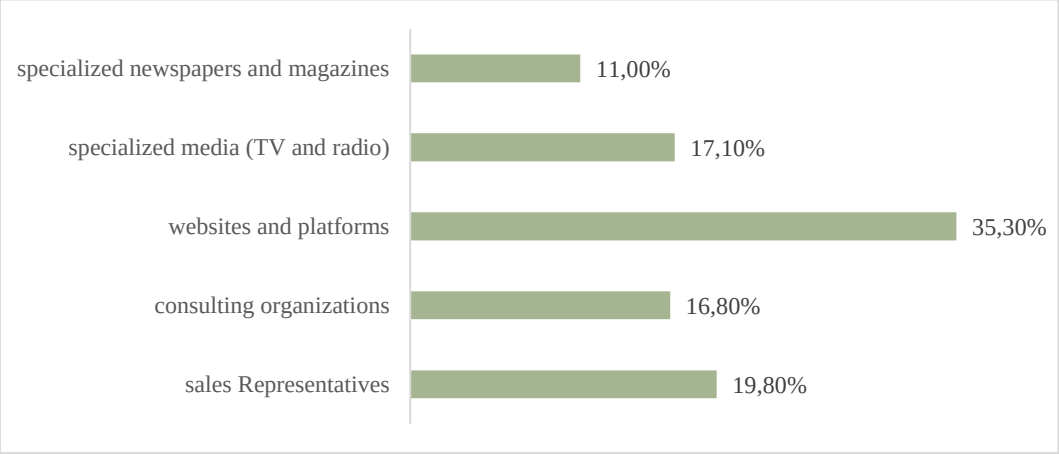
Figure 13. Evaluation of the benefits of using digital services



Source: data from a survey of 298 respondents, 2023. (scale used from 1 to 5, with 1 being the weakest and 5 being the strongest)

The next question in the survey is "Where do you get information about digital services?". Figure 14 presents the percentage distribution of the answers received by the surveyed farmers. From the data thus presented, it can be seen that the majority of farmers learn about the offered digital services from the websites and platforms of the providers of these services - 35.3% of all respondents indicated this answer. The next most important source of information is the sales representatives of digital services - 19.8% of all surveyed farmers recognize them as a reliable source of information. Another reliable source for obtaining information is the specialized media - 17.1% of surveyed farmers trust them.

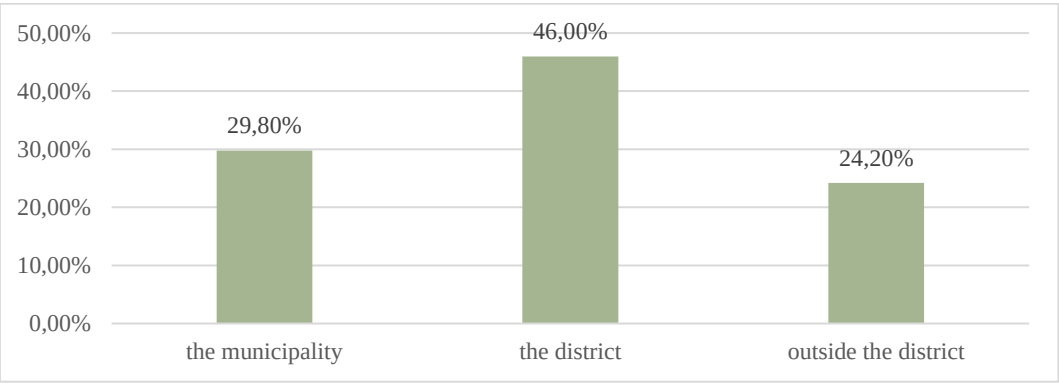
Figure 14. Preferred information sources about marketed digital services



Source: survey data among 298 respondents, 2023.

The next question included in the survey is "Where is the digital service provider located?". Figure 15 presents the information obtained from this question. From the information presented in this way, it can be seen that regional providers of digital services are used - 46% of the surveyed farmers indicate this answer.

Figure 15. Location of the digital service provider

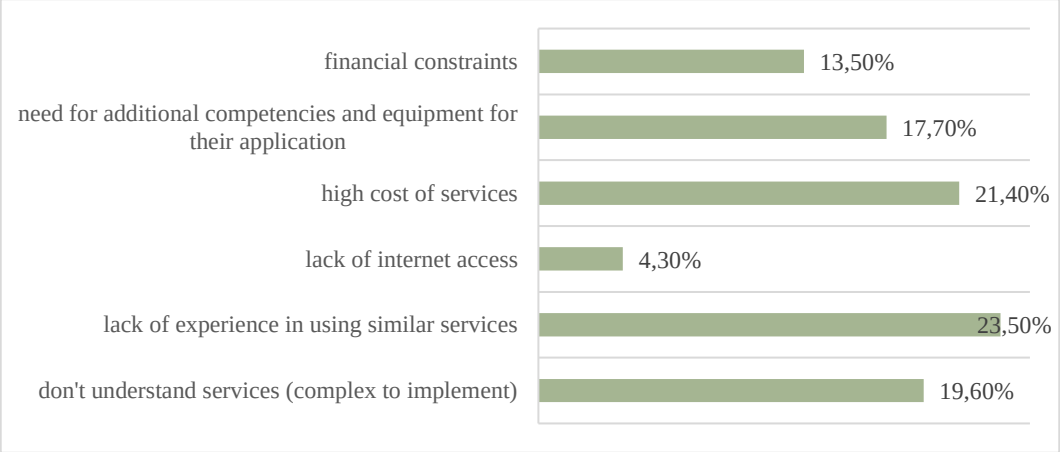


Source: survey data among 298 respondents, 2023.

By including the following question in the survey, the aim is to obtain information about the obstacles limiting farmers' access to digital services. Figure 16 provides information on the main barriers to using digital services. From the graphic analysis of the data, it can be seen that the main limiting factors are: (1) lack of experience in the use of digital services by farmers -

23.5% indicated this factor as the most significant problem; (2) the high price of the offered service – 21.4% of all surveyed farmers and (3) complexity of the digital service – 19.6% of the surveyed farmers stated that they do not use this type of service due to the complex nature of it.

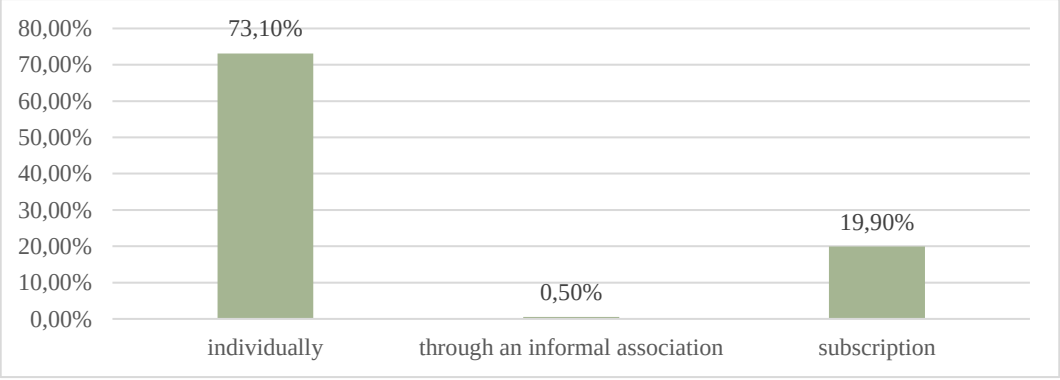
Figure 16. Barriers limiting access to digital services



Source: survey data among 298 respondents, 2023.

Another factor that was investigated in the conducted survey is the provision and sharing of access to the digital services offered in the sector. Figure 17 shows the distribution of the answers received by the surveyed farmers.

Figure 17. Access to digital services

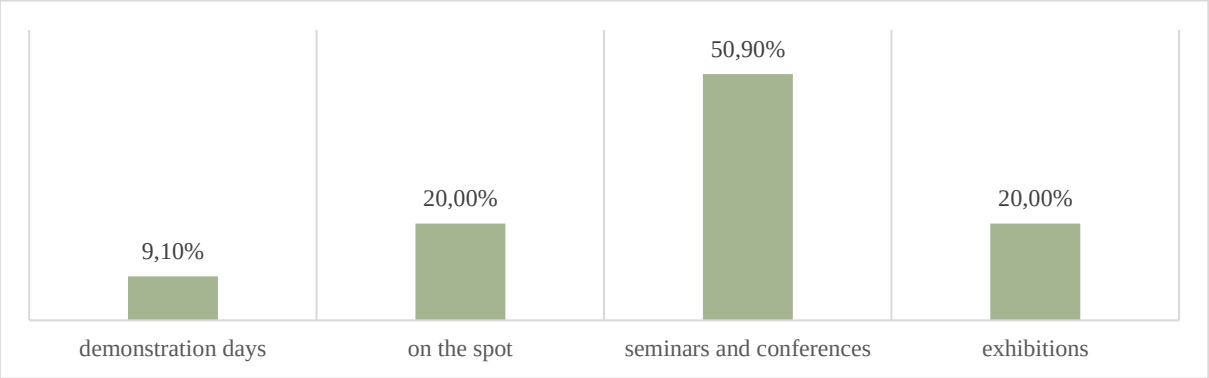


Source: survey data among 298 respondents, 2023.

From the data thus presented, it can be seen that farmers prefer to use digital services individually - 73.1% of the surveyed farmers stated this. Next is the group of farmers who use digital services on a subscription basis - 19.9% of all surveyed farmers.

The next question in the survey is "Do you participate in specialized information events related to digital solutions?". The data received sinceissues are presented in figure 18. Of all farmers surveyed, 50.9% stated that they participate in seminars and conferences dedicated to the issue.

Figure 18. Do you participate in specialized information events related to digital solutions (services)



Source: survey data among 298 respondents, 2023

4. IDENTIFICATION OF BARRIERS TO THE USE OF DIGITAL SERVICES IN AGRICULTURE

The adoption of digital farming technologies and systems is a challenging and dynamic issue for farmers. The evolution of digital services presents some critical challenges that require a clear strategy to support a smooth transition. Although digital agriculture is not a separate technological field as such, the question arises whether it should be considered holistically, namely as an entirely new legal category, or whether it should instead be analyzed solely in relation to the technological means used in its framework. In fact, the challenges associated with digital agriculture can be divided into two broad categories: (1) those inherent in the technological means used in digital agriculture (drones, robots, GPS, etc.), raising questions about technological control, human safety, civil liability and privacy, and (2) those emerging alongside the development of digital agriculture as an autonomous technological field.

The lack of broadband infrastructure in rural Bulgaria and connectivity to devices (for example, a tractor, computer, tablet or smartphone that records what is happening, or a device for privacy issues of satellite photography) providing access and ownership of data is one of the main issues for the accelerated implementation of the digital agriculture approach. In the context of big data and the lack of standards and limitations for data exchange between different systems, there are additional barriers and challenges that need to be addressed in the agricultural sector. Digital agriculture also raises questions regarding the conditions of interaction between farmers and digital technologies - especially regarding the lack of independent advisory services in this field and the unsatisfactory technological transfer of knowledge and skills. There is concern in society that digital agriculture will further worsen the employment situation in the field of agriculture, as the new unmanned technologies will form a significant number of employees who will have to flow into other economic sectors of the country.

Digital agriculture, as a technology dominated by data exchange, can create an extremely large volume of data, leading to a hunger for virtual space. The increasingly large-scale implementation of this approach to agricultural management will lead to the growth of the data

storage infrastructure (servers and support systems), which will reflect in two directions - (1) an increase in the consumption of electricity for the operation of the servers, which will lead to the creation of a number of problems such as - an increase in carbon emissions as a result of the increased consumption of electricity from server hubs, an increase in the price of electricity due to the increased consumption of this resource, etc. (2) increased competition among industries dependent on chip manufacturing and a significant increase in this component in digital systems. Today, in the context of a pandemic, the shortage of chips and other specific components embedded in the digital systems used by digital agriculture is increasingly felt.

A major challenge related to the systematic introduction of digital agriculture in Europe, and in particular in Bulgaria, is the need for intelligent systems based on decision-making algorithms. Intelligent processing and analysis of big data is a significant challenge due to the large amount of often unstructured, heterogeneous data generated by different devices that are used in farms of different sizes and specializations. This processing requires intelligent interaction between experienced data scientists and industry experts.

CONCLUSION

In general, there is a large difference between the production and management approaches applied on large and small farms. The size of the farms and the digital technologies they use are often related to the potential of the farmer to make investments and successfully grow his business. Larger farms have easier access to finance and can very quickly implement the digital farming approach, as long as they see a sense or motive to do so. For smaller farms, digitization does not create opportunities, on the contrary, it requires additional investments that are too much for them. High start-up costs, associated in some cases with the risk of insufficient return on investment, can become a serious challenge regarding the affordability of the technological component of digital agriculture.

Another societal challenge is that while companies providing precision agriculture technologies are getting bigger, they are also getting smaller, resulting in a monopolization of the digital services market. Today, some monopolies can be seen as a result of the concentration of data in the hands of one big player, who are beginning to diligently impose new market rules. This phenomenon leaves farmers and government authorities little room to negotiate prices for the acquisition of technology and related services, which can pose a significant threat to the viability of farms.

In addition, given the technical complexity of digital agriculture, its use and operation require the provision of consulting services specialized in data management. Such specific services would probably not be independent and could generate competition and fragmentation with respect to current agricultural advisory services providing comprehensive and free advice to farmers. Another worrying fact is the large number of diverse types of stakeholders in agriculture, ranging from large business, financial, engineering and chemical companies and retailers to industry associations and groups of small providers of specialist expertise. Interaction between these stakeholders can become a challenge in itself, given the current lack of common standards enabling real interoperability and clear and transparent communication between them.

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