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DIGITALIZATION AS A TOOL FOR RISK MANAGEMENT IN THE AGRICULTURAL SECTOR

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Abstract
Risk management is an integral part of the management process of any organization, including in the agricultural sector. The increasing adoption of digital technologies is becoming an essential part of the sector's activities. The aim of this publication is to analyze the opportunities for risk management in the agricultural sector through the introduction of digital activities at both macro and micro levels. Digitalization in agriculture is crucial for managing risks and reducing the negative impact of agricultural activities. It can improve primary production, supply chain, logistics performance, and reduce food losses and waste. However, digitalization may pose risks due to significant investment in digital solutions and lags behind other sectors. Traditional methods often fail to reduce risks, but digital technologies can transform communication channels, build infrastructure, and reduce errors in data entry. By implementing risk management strategies, farmers can obtain more benefits and free up resources for other sectors. At the micro level, new technologies, access to digital markets, and improved risk management are being implemented at the individual farm level, thereby contributing to the sustainable development of the agricultural sector. The publication includes the following main tasks: 1) a theoretical review of the key risks in the agricultural sector; 2) an analysis of micro and macro risks in the sector that can be managed through digital technologies; and 3) key findings and conclusions. The publication draws its information from both – theoretical sources and agricultural sector research.
Key words: agriculture, risk, digitalization, management
JEL: Q10, Q16, Q55

Introduction

Risk management in the agricultural sector is the subject of research by numerous authors, who most often categorize risks as internal and external (Jankelova, Masar, & Moricova, 2017; Georgieva, & Kirechev, 2017; D'Alessandro, Caballero, Lichte, & Simpkin 2015), random and systematic (Komarek, De Pinto, & Smith, 2020; Turvey, & Driver, 1987). In addition to systematizing and understanding the concept of risk, researchers focus on the impact on the sector or agricultural holding when a risk event occurs (Hardaker, Huirne, Anderson, & Lien, 1997; Stoyanova 2022; Kirechev, 2017). From the perspective of strategies and methods for risk management, there is a growing trend of incorporating digital technologies aimed at managing and minimizing risks in the agricultural sector.

On one hand the digitalization is a preposition for a risk management, but in on other hand the high level of digitalization is bringing a certain risk to the farms,

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according to the high investment of some of the digital solutions. Some of the authors stressed that in agriculture the digitalization is lagging behind and according to some other sectors as some of the industries is on very low level (Atanga, 2020; Romera, Sharifi, & Charters, 2024). The potential benefits of the digitalization are not fully used, which is can be monitored of the surveys made of some of the studies, where the main usage is on monitoring level. The digitalization by the farmers are mostly used to monitor the forecast of the weather and to check the level of the health of the crops or animals. These two usages are important for the risk management in the farms. According to the monitoring by digital tools can be collected historical data which is a key element for risk management assessment. The other perspective for usage of digital tools in agriculture is to prevent and protect the impact of agricultural activities on the environment (Rolandi, Brunori, Bacco, & Scotti, 2021). Including in the activities more precise usage of fertilizers and inputs brings less impact of the environment.

Šermukšnytė-Alešiūnienė & Melnikienė (2024) divide the digitalization of organizational, social, and technological aspects in several of their researches. The authors stress that the risk associated with a labor shortage in agriculture can be mitigated by digitizing certain processes and therefore avoiding the need for human intervention. If digital technologies can be applied, there will be considerable improvements in primary production, supply chain and logistics performance, as well as a decrease in food losses and waste (Bahn, Yeh, & Zurayk, 2021).

Furthermore, farmers are utilizing digitization to place their products on the market through digital marketing. Small farms that sell their goods directly to consumers frequently employ this technique. The tools used by them are connected to social networks that provide direct sales and product delivery right to the customer's door. Effective risk management is necessary for agricultural operations to produce sustainable results. Over the past 20 years, a growing number of possibilities have been investigated to decrease the negative effects on the financial outcomes of various risks, since the use of digital solutions is one way for monitoring, evaluating, and managing risks.

Methods and methodology

The aim of this publication is to analyze the opportunities for risk management in the agricultural sector through the introduction of digital activities at both macro and micro levels.

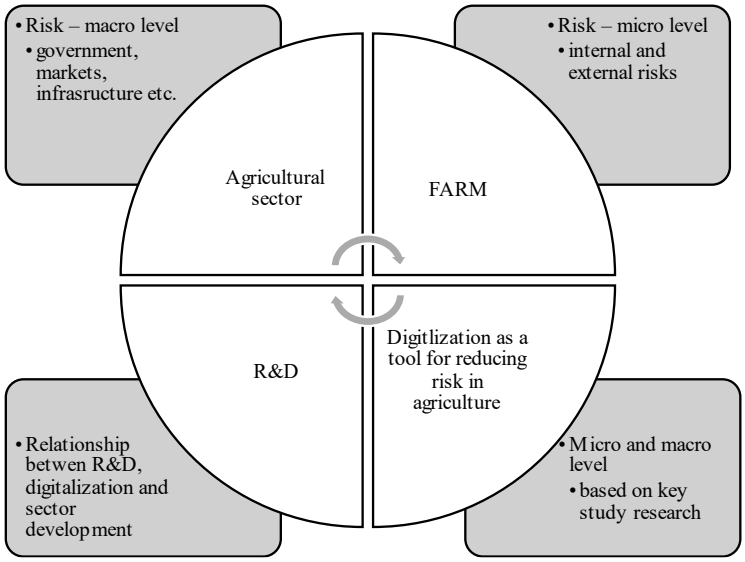

Figure 1. Methodological framework of the study

Source: own data

The publication includes the following main tasks: 1) a theoretical review of the key risks in the agricultural sector, 2) an analysis of micro and macro risks in the sector that can be managed through digital technologies, and 3) key findings and conclusions. The methodological framework is shown in the figure 1.

The results are based on theoretical research and case study of agricultural sector, which took place in 2023. It aims to revile the relationship between the level of usage of digital tools in the context of risk management. Case study includes one of the main and most important productions in agriculture- wheat, milking cows, vineyards and vegetables. The conclusions are generalized and do not pretend to be representative, but to point the focus of possible direction of development of the sector directed by the digital technologies.

Generally, the digitalization of different phases of agricultural risk management will be researched. The possible phases are presented in figure 2.

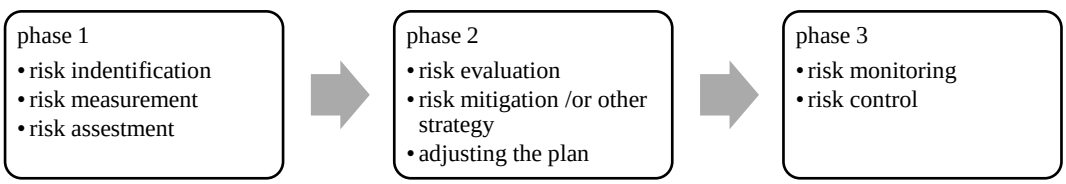

Figure 2. Main phases of risk management

Sources: adaptation by Tummala, R., & Schoenherr, T. (2011)

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Results and discussion

Because of the unique nature of the agricultural sector, risks accompany every process (Fleisher, 1990). Traditional methods do not always achieve the desired reduction in the impact of risk events. The goal of new technologies is to make management decisions more accurate and timelier, which will benefit not only businesses but also society and the environment.

Digital technologies in the context of risk management can be classified into the following levels, which contribute to the sustainable development of the agricultural sector:

Macro level:

- By transforming traditional communication channels and document management into an electronic environment, both individual farmers and institutions benefit. Some digital services provide convenience through cadastral maps, precise surveying, and parcel delineation, among others; This level also includes building infrastructure and connections between institutions and end-users, working databases and information repositories, electronic resources, and more; Additionally, the use of electronic forms, notifications, and other tools can reduce the risk of errors in data entry.

All these services positively impact the sector's development and reduce the likelihood of risks by:

- Reducing the risk of information delays, streamlining document flow, increasing transparency in procedures, minimizing human error, and reducing the need for human involvement, freeing up resources for other sector needs, both in terms of administrative capacity and for system users – such as farmers, organizations, and others.

Agricultural sector and individual farm level (micro level)

1) New technologies,
2) Access to digital markets,
3) Production processes, storage, transport, and product realization,
4) Risk management.

Results of a case study

Farms that are mechanized and use new technologies are also more likely to adopt digitalization. Grain production is one of these sectors. The availability of capital and resources contributes to this trend, allowing these farms to adapt to the new reality. This includes the use of applications to monitor activities across the entire

chain, as described in the methodology. Furthermore, while the majority of farm owners are over the age of 50, a closer look at social characteristics reveals the presence of younger household members who drive the adoption of digital solutions. The typical profile is of a young, educated household member who is not directly involved in the farming operations, often working outside the agricultural sector, but acts as a “consultant”, building a bridge to new realities.
The opposite is also true – small farms managed by elderly people, often retirees, are lagging behind and are often unable to implement any digital services.
Looking back at historical data and statistics, the sector's progress in adopting digital solutions is clear. However, it remains unclear how far the sector's capacity and willingness to adopt digital solutions can go. The data shows some progress, but not at its full potential. One important takeaway is that digitalization is moving faster than the sector's ability to fully comprehend and justify the need and feasibility of implementing these technologies.
The case study participants assessed the risk's likelihood and potential consequences, which will be used as a basis for a potential digital solution that will be covered in more detail later in this publication (table 1).

Table 1. Type of common risks in studied farms

Risk	Possibility to occur	Consequences if the risk occurrence
Product risk (several categories)	85%	45%
Climate risk	100%	85%
Labor risk	85%	60%
Other risk	60%	40%

Source: own data

The risks shown in the table 1 are the most frequent ones that arise in the farms under the study. In relation to digitization, farmers stated that digital tools for monitoring are essential for preventing dangers and taking appropriate action to implement on the farm. The largest farms mentioned that some of the procedures may be automated, which lowers the possibility of a labor shortage and also lowers the amount of inputs utilized since they are employed more precisely and at a lower cost.

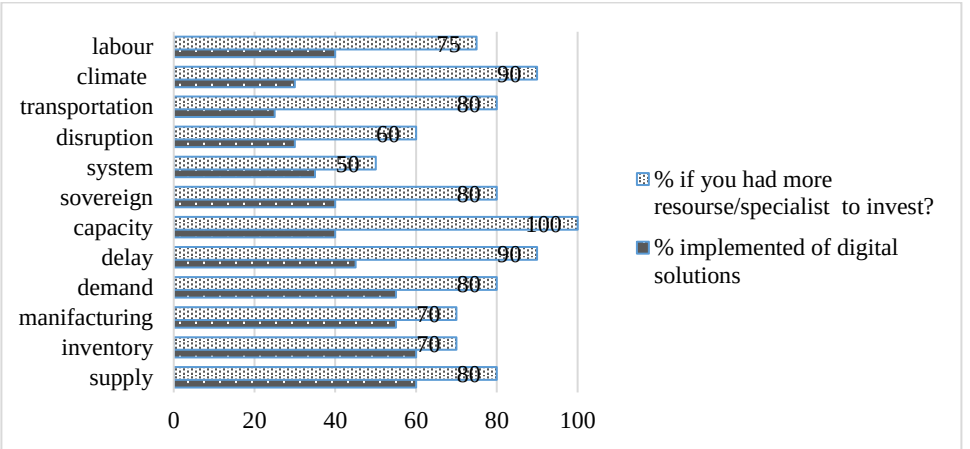

Figure 3. Implementation of digital solutions related to risk management and a willingness to adopt more digital solutions,

Source: own finding

Most common digital solutions applied in by the farms, which are pointed a s possible tool for risk reduction is related to environment conditions, trading, precise agriculture, production processed, digital implementation of inputs, autonomy of agriculture practices, monitoring of the health of the crops/animals and etc. Figure 3 presents the gathered information of actual status of implemented digital solutions and a possibility of increasing the level of digitalization related to investments and specialists in the field of digital solutions.

Digitalization and Research & Development in Support of the Agricultural Sector

An increasing number of scientists are conducting research on novel crop varieties and the adaptability of plant and animal breeds using digital solutions. Digital twins are one technique being used, which shows a crop's resilience and performance under various climatic conditions in a shorter amount of time. Choosing the right variety to produce minimal deviations from expected results and reduce the risk of yield loss is the main component of risk management. Scientists are also studying the impact of digital solutions aimed at environmental protection, proving their effects and minimizing the risks associated with agricultural activities (Harizanova-Bartos, Stoyanova, Petkova, Metodiev, Harizanova-Metodieva, Sheiytanov, & Dimitrova, 2021; Branzova, 2022). Often, this involves technologies that detect the need for specific agro-technical actions, ensuring they are timely and applied only in areas that require them. One of the many effects of this approach is detecting diseases in certain fields, allowing for precise application of treatments only in affected zones, thus reducing the negative impact of chemicals. In livestock farming,

digital solutions also act as a springboard for reducing the risk of human error related to disease detection in animals, enabling the necessary protocols to be activated to limit the spread of infections.

Main findings and conclusions

The implementation of digital solution in agriculture as took for reducing risk would require a much higher degree of coordination than is currently observed in agricultural sector, and possibly the need for central coordination entities. Risk management in the agricultural sector is a complicated and multifaceted issue that includes both internal and external risks. The high level of digitalization in agriculture may pose risks due to the significant investment in digital solutions, digitalization lags behind other sectors, with some industries performing poorly. The primary application of digital tools in agriculture is to monitor weather forecasts and crop health, which are critical for risk management. Digitalization can also help to mitigate and protect the environmental impact of agricultural activities. Digitalization can also help prevent and protect the environmental impact of agricultural activities. Digitalization can also improve primary production, supply chain, logistics performance, and reduce food losses and waste. Farmers are also using digital marketing to place their products on the market, promoting sustainable results.

The agricultural sector faces risk due to its specific activities. Traditional methods often fail to reduce these risks. Digital technologies can help manage these risks by transforming communication channels, building infrastructure, and reducing errors in data entry. These services reduce information delays, streamline document flow, increase transparency, minimize human error, and free up resources for other sectors. At the individual farm level, new technologies, access to digital markets, and improved risk management can further enhance the agricultural sector's development.

As a conclusion can be summarized that digitalization is key factor for successful risk management and the farmers can obtain more benefits by implementing risk management strategies to reduce the negative impact of the produce, but still the usage is not in full scale.

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