The digitalisation of agriculture: The case of the South Bohemian Region

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Abstract: For rural areas, the digitalisation of agriculture has great potential in terms of production efficiency, and regional competitiveness, and also significantly complements the objectives that lead to sustainable development. In addition to these positives, digitalisation can have an impact on the differences between those who implement elements of digitalisation and those who do not. For example, there may be a gap between small and large enterprises due to differences in capital endowment. How do agricultural enterprises or private farmers in the South Bohemian Region perceive the issue of digitalisation in agriculture? To what extent are elements of digitisation already implemented?
The aim of the paper will be to find out how farmers in the South Bohemian Region perceive the digitalisation of agriculture. The current state of implementation of digitalisation in agriculture will be determined through a pilot survey based on qualitative research. Furthermore, the expected benefits and challenges for farmers will be identified. In the end, a picture will emerge of how a group heavily involved in the appearance and creation of the rural area will perceive this development trend.

Keywords: Agriculture, Digitalisation, Grounded theory, Rural area, South Bohemian Region, Czech Republic
JEL Classification: O13, Q10, Q55

1 Introduction

The development and diffusion of digital technologies encounter the reality of everyday life in modern societies. The ongoing digitalisation based on automation, robotics, artificial intelligence (AI) and smart tools plays an important role in transformations of various processes and systems, including the agri-food system (Forney, Dwiartama and Bentia, 2023). The agriculture is expected to undergo intensive digitalisation with the hope that the changes brought by the implementation of various sensors and intelligent machines will enable precise farming and better timely decision-making based on data collected by the equipment in the fields followed by modelling leading to accurate predictions on when to plant, seed, spray, or harvest the crops (Lajoie-O'Malley et al., 2020). The reliability of precise smart farming is supported not only by one technology, but a toolkit of various technologies combined, e.g., the aforementioned sensors, but also GPS, machine learning, AI, 5 G, internet of things, cloud computing, as well as robotics (Ingram and Maye, 2020; Lowenberg-DeBoer and Erickson, 2019; Numa, Wolf and Pastore, 2023). Rural areas are going through a deep technological modernization and digital transformation that affects the primary sectors, not only agriculture but also forestry, to fishery (Ferrari et al., 2022; Kostrikova and Yafasov, 2022).

The European Union recognizes the potential of this transformation to bring a renaissance to the European agricultural sector and support its efficiency, competitiveness, and sustainability while addressing challenges such as food security and climate change through the adoption of new technologies (European Commission, 2023). Currently, there are two major trends in agricultural transformation worldwide. Apart from digitalisation, it is ecologisation that includes organic and sustainable farming. Interestingly, both trends are perceived as either antagonistic or convergent (Schnebelin, Labarthe and Touzard, 2021). Considering the fact, that there are different business models within the agricultural practice that tend rather to an intensification of farming leading to higher yields, yet with negative effects such as increased pollution, resource depletion, soil degradation and biodiversity loss, or to alternative farming focused on tackling sustainability issues coming at price with lower yields, the transition presents a challenge in finding the feasible balance. The results may vary in complexity and complementarity of various approaches (Plumecocq et al., 2018). While many recognize the role of digitalisation in enabling the transition towards a sustainable future in agriculture and rural areas, there is also some scepticism and doubts about its unrevealed consequences including the economic, environmental, social, ethical, and institutional impacts and relations (Rijswijk et a., 2021; Shepherd et al., 2020). The potential

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contribution of agricultural digitalisation to the United Nations´ Sustainable Development Goals remains unknown. Furthermore, there is the issue of ensuring responsible ways of digitalisation (Metta et al., 2022). Whatsoever, the advancement of technologies seems inevitable in order to produce more feed and food sustainably for a growing population on a planet going through climate change and a demographic explosion that may lead to an unprecedented hunger crisis (Shepherd et al., 2020; Numa, Wolf and Pastore, 2023).

South Bohemian Region (Czech Republic) can be characterized as a rural area with the important role of primary sector including agriculture, forestry and fishery. South Bohemia has great potential for the development of a regional circular bioeconomy due to existing activities with a vision of building linkages and value chains by connecting traditional resources and branches with new high-value-added sustainable technologies. However, there is also an emphasis on waste management and utilization of non-traditional resources (Szarka et al., 2023).

The aim of this paper is to examine, how representatives of conventional agriculture within the South Bohemian Region perceive the development of the process of its digitalisation, to what content they participate, and which benefits or risks they see in further implementation of digital technologies in farming including the expected (or observed) effects on yields and environment. For this purpose, two research questions were set as follows:

1) How do the representatives of conventional agriculture perceive the current state of digitalisation in agriculture?

2) Which changes, opportunities and threats of digitalisation in agriculture do they expect in future?

2 Methods

The aim of the paper is to find out how farmers in the South Bohemian Region perceive the digitalisation of agriculture.

The subject of the analytical part of the paper is a pilot survey, which is based on a qualitative approach, since due to the nature of the pilot survey, the aim is to create a new understanding of the topic or a new theory (Disman, 2011). The inspiration for the qualitative pilot survey was grounded theory, considered one of the most widely used qualitative research methods aimed at creating new theories (Strauss and Corbin, 1997; Oktay, 2012). The main reason for this is that the resulting theory can be tested with other research methods that will be part of further research in this area (Oktay, 2012). The most appropriate use is to analyse a process in which participants construct meaning from intersubjective experience. It is equally important to respect key assumptions about the social reality under study (Suddaby, 2006).

The chosen method for data collection is semi-structured interviews. Prior to the actual data direction, the questions were categorized into three discussion themes.

- Basic ideas about the digitalisation of agriculture
- Current status of digitization of agriculture
- The future of agriculture in the context of digitalisation

Selected farmers from the South Bohemia Region were chosen as respondents. A total of 4 interviews were conducted. The survey achieved a satisfactory spatial distribution, as a total of three districts of the South Bohemian Region - Strakonice, Písek, and Jindřichův Hradec. Transcribed interviews were used for open coding of the data. Codes were assigned to sections of text, which were then categorised and interpreted according to their relevance to the phenomenon (Strauss and Corbinová, 1999).

3 Research results

The open coding resulted in sub-codes which were then categorised into the following categories: Associations with the term "digitalisation of agriculture", Reasons that lead enterprises to digitalisation, Personal experience, Economic and environmental benefits of digitalisation, Threats and challenges, Most affected sectors, The role of the state.

3.1 Associations with the term "digitalisation of agriculture"

The opening question in the interviews was about the associations that respondents generally associate with the digitisation of agriculture. Respondents' perceptions are homogeneous. All interviewees associate digitalisation in agriculture with modern technology. The next mentioned were mainly specialized software. In one case, artificial intelligence was also mentioned as an important element shaping the transition to digitalised production. *"By that, I imagine the use of modern technology, some software and artificial intelligence"* (Martin, 20.9.2023). *"I imagine the connection of those computers with those machines, technology, something like that"* (Petr, 26.9.2023).

The views of half of the respondents that digitalisation represents a form of saving the industry or popularising it in the context of a new generation can be considered an interesting contribution. *"Digitalisation is also a form of popularization of agriculture so that we can pull those younger people back into a relatively conservative industry, which itself is as conservative as it can be"* (Barbora, 21.9.2023)

The issue of generational change was also mentioned in connection with the question of whether it is necessary to digitise agriculture. The age structure can also be a barrier here, as the respondent states. *"Digitalisation of agriculture is only possible to the extent that most employees can handle it and most employees are often over 40 years old"* (Martin, 26.9.2023) Conversely, digitalisation may attract younger people to work in the sector. *"If intelligent people are going to enter this agriculture, they need it to be as digitised as other worlds are digitised because our kids just live with these modern technologies"* (Terezie, 21.9.2023).

In the ensuing discussion, it was necessary to specify with what frequency respondents encounter the sub-elements of digitisation. Artificial intelligence was mentioned in a total of three cases. In one case, it was even specified that it is significantly used by the State Agricultural Intervention Fund. Robotics was encountered by all respondents. In two cases, it was mentioned that it is currently most significant in dairy cattle farming. In a total of three cases, respondents were able to describe 5G. Only one respondent had encountered IoT in agriculture.

3.2 Reasons that lead enterprises to digitalisation

When asked what reasons generally lead enterprises to digitise their activities, all respondents stated the same. There is a shortage of people in agriculture and modern technologies are not labour intensive. *"First of all, I would say it's a lack of people, a lack of employees"* (Martin, 20.9.2023). In two cases, significant cost reductions were also mentioned. *"The other thing is like precision farming is reducing costs and increasing yields by applying those products in the best possible way"* (Martin, 20.9.2023). The same frequency, i.e. 2, was the opinion that the sector would be more attractive to the younger generation. *"It's just easier and less labour intensive and more "cool" for the upcoming generation. That's absolutely crucial*" (Terezie, 21.9.2023).

3.3 Personal experience

The personal experiences of the respondents with digitalisation are varied, but the common denominator is that all of them have encountered and used digitalisation in their enterprises. In two cases, the software in use is specific to manufacturing or agricultural machinery. *"I have computers in my machines. I use some things, but I haven't quite got it all the way through. I've just bought a tractor that already has automatic guidance. I don't have to drive it, but I might buy more machinery for it next year..."* (Petr, 26.9.2023). Communication with the state was also mentioned in two cases. *".....all communication with the state at the moment is digitalised. We have been running on the ELPIS portal for a long time and this year the AMS portal and the GTFoto portal have been introduced"* (Terezie, 21.9.2023). Land management was also mentioned where digitization helps significantly. In total, there were two statements from respondents. *"Several companies came with offers. We will make it more user-friendly and more for you so that you can have more information about your own land..."* (Barbora, 21.9.2023). The link to precision agriculture was also mentioned once.

3.4 Economic and environmental benefits of digitalisation

All respondents interviewed agree that digitalisation can lead to greater revenues. In two cases it was also specified that it is a tool that is still subject to significant management decisions. *"I think every other tool that is used to lead or to move the business in some way is exactly what you make it"* (Barbora, 21.9.2023). The responses are similar in the case of the environmental impact of digitalisation. All interviewees underline the positive impact on the environment. *"It can* (have positive environmental impact). *It depends on how these people know how to use it. It's due to precision. It's more controllable than the human factor"* (Petr, 26.9.2023). *"I think that by allowing you to have that data multiply, absolutely multiply, the digitisation can at that point benefit environmental protection absolutely significantly"* (Terezie, 21.9.2023).

3.5 Threats and challenges

In a total of three cases, the challenge of changing the conservative mindset in agriculture and the reluctance of the older generation in particular to embrace innovation was mentioned. *"At the moment, I think the thing about agriculture is that a relatively large percentage of people who work in agriculture are so not capable of that digitalisation"* (Barbora, 21.9.2023). *"The biggest challenge I think will be just to reduce those costs of acquiring those technologies and to teach that to the older generation or to wait until they are replaced"* (Martin, 20.9.2023). Equally numerous was the view that all technology is vulnerable to external interference and threats. The concern that people may start to over-rely on technology was mentioned. *"It's still just a machine, and it's good to remember that you have to take care of living things, living animals, plants and nature"* (Barbora, 21.9.2023). *"It threatens me that a mistake can be made just like the human factor"* (Petr, 26.9.2023). The challenge of the high cost of these technologies was also mentioned once. In one case, the

threat regarding the lack of know-how in the future was also described. *"The threat is, as I mentioned, there are already about 2% of people in agriculture, and if there will be even fewer people, due to digitalisation, I would see it as a threat that there will not be enough people who have the know-how"* (Martin, 20.9.2023).

3.6 Most affected sectors

All the respondents agreed that crop production - fruit and vegetable growing - is the most affected by digitalisation. *"...I think it is vegetables and just labour-intensive plants"* (Terezie, 21.9.2023). *"...if those modern farming machines take hold, it will be in the growing of plants"* (Martin, 20.9.2023). Dairy production was identified as the second area most affected by digitalisation in a total of three cases. *"...it's going to go to the industries and the places that have that cash flow and who know that they're going to get those amounts back to make it worthwhile, which is exactly anything that is labour intensive in terms of quantity and human labour, and that's exactly vegetables and milk"* (Barbora, 21.9.2023).

3.7 The role of the state

The last category is the role of the state in the digitalisation of agriculture. All respondents report that the state supports digitalisation and actively introduces new features. It was pointed out that subsidies are mainly targeted at precision agriculture. It was also mentioned that there are strict conditions and many farmers do not get access to subsidy funds. *"Well, given that I mentioned subsidies that didn't come out this year, but they are counted on, I would say that the state and therefore the EU is probably supporting digitalisation, but I didn't notice that there was any really like massive support"* (Martin, 20.9.2023). In two cases, the view was expressed that there is a lot of potential to improve the state's interaction with farmers in terms of support and approach. *"We meant well and it worked out as it always does" (Terezie, 21.9.2023). "...it's the people who are trying to do it right that will take it the most, and that it's terribly counterproductive in the end, but like we'll hope and trust that they can balance it out and that it will get better..."* (Barbora, 21.9.2023).

4 Conclusions

This era can be characterized by rapid technological advancements that shape the transformation of various industries and societies. The digitalisation of agriculture, driven by cutting-edge modern technologies, data utilization, and connectivity of the digital and real world, is an upcoming phenomenon that changes agricultural practices towards precise farming and smart agribusiness that enhances both efficiency and sustainability. Greater yields, improved firm economy, popularization of agriculture and better working conditions for farmers, as well as reduced environmental impact, are promising outcomes of the ongoing digitalisation process recognized by the representatives of conventional agriculture in the South Bohemian Region.

The farmers perceive many benefits derived from the implementation of modern technologies, software, and even artificial intelligence in agriculture. They have been currently introducing several digital technologies and features, including the Internet of Things sensors, drones, robotics, computers used in manufacturing and machinery, systems of navigation and automatic guidance, software for land management, as well as digital portals, some of which are used for the communication with state administration. The technologies utilized by the representatives of conventional farming related to crop farming, livestock management and manufacturing processes help them with the overall economic performance and overcoming problems such as lack of labour force, optimizing costs, increasing revenues, yields, and reducing environmental impacts. All respondents perceive crop production as the most affected agricultural sector by digitalisation followed by dairy production. They realize that the state is supporting the digital transformation of agriculture, mainly through subsidies on precision farming, but mentioned strict conditions and rules that many farmers can not meet.

As for the future expectations, some of them are already thinking about introducing new digital technologies. Concerns included the challenges related to a conservative mindset, the reluctance of the older generation and the lack of know-how of middle-aged people when it comes to innovation and handling modern systems and technologies, initial costs of acquiring those technologies, and the threats in the form of over-relying on technologies and vulnerability to external influences. The farmers note that the state administration has the potential to transform agriculture if it interacts more with the practitioners and supports them adequately.

Acknowledgement

The authors solemnly declare that all respondents have signed a *"Consent to Participate in Research"* and have given permission for their first name to be used. At this point, the authors would like to thank all respondents for being willing to provide valuable information and their personal experiences.

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