Effects of Digitalization and Intangible Assets in the Crop Production Sector

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Abstract. In economic research, the introduction of digital innovations in agriculture is identified as a critical factor for changing business models in terms of creating economies of scale, improving productivity and efficiency within a single farm, and creating and capturing value in the agricultural sector. The present study attempts, on the one hand, to systematize the effects of digitalization processes in relation to the crop sector from available research. On the other hand, it analyses empirical data of crop farms through the lens of digital transformation. An econometric analysis was carried out, using data from enterprises from the crop growing sector that carry out costs related to innovation activities. The scope of the study covers a period of five years.

1 Introduction

Contemporary agriculture faces a number of challenges, among which the digitalization of the sector and the introduction of digital technologies in production and management activities. Possible solutions require the creation of new business models in the context of digital transformation in managing competitiveness, working with clients, maintaining sustainable and environmentally sound production, and adequate economies of scale. The challenges and structural changes which the sector faces reflect not only on the viability of the individual agricultural producer, but also on the country as a whole. A key tool for solving these growing concerns with the presence and effective use of resources, the formation of more sustainable food systems, improvement of the business efficiency and competitiveness of the farm is digitalization or the access and use of digital innovation and the related digital technologies. Widely discussed in literature, innovations are a major factor leading to a more successful fight with competitors and creation or acquisition of competitive advantages allowing the adaptation to a constantly changing environment.

Digitalization is a technological process of application of digital innovations [1], impacting business processes and the creation and capturing of value in the economic unit and the economy as a whole. Digitalization through application of advanced modern technologies at each level of the production chain transforms traditional agriculture into a modern one. “Digitalization induces system transformation.” [2].

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The practical implementation of new and cutting-edge digital technologies, such as cloud, big data, artificial intelligence, Internet of Things (IoT) and various micro and nanoelectronics and robotics to improve the quality and decrease the cost of the product, simplification of the operations, enhancing business models or generating new business opportunities is related to digital transformation [3]. Its application and digitalization facilitate the search for strategies to improve the production process and growth of businesses, acceleration of the productivity in rural regions and the adoption of clean and sustainable technologies [4]. Hence, it may be inferred that digital transformation leads to a change in the traditional models and processes in agriculture (switching to precise and intelligent one), which may bring economies of scale, product quality management, predicting market prices in the sector and realization of a more efficient and competitive production along the entire chain.

Smart and precise agriculture employ contemporary digital technologies focused not only on automatization of the processes (precise agriculture), but also to finding effective solutions applicable to the whole value chain (smart agriculture), including all activities along the supply chain, such as marketing, e-platforms for consumer relations, placement, food tracking, waste management. The decisions are taken on the basis of different types of data derived from digital technologies: big data, GPS, GIS, drones, cloud calculations and storage, IoT, etc. to create value. Thus, stakeholders have a better access to information and resources, they may add value for consumers, or create better relations with the end clients and potential new partners, which will lead to changes in the cost structure, secure new income flows, and improve the overall firm performance. In this way, digital transformation and the application of digital innovations transforms (in)directly each and every element (according to the model indicated by Osterwalder, 2005 [5]) of the existing business model, which modifies the stages of the agricultural value creation chain: pre-production (investment of resources), production, harvesting and processing, realization and distribution.

Therefore, we may conclude that digitalization and modern technologies offer opportunities to farms to receive more economic and social benefits, directly related to improvement of the ecosystem. In scientific literature, digitalization effects are most often grouped into three large areas – economic, social and environmental [2, 4, 6-7, among others]. Other authors think that the part of the social area, related to the process of organization, must be separated as an individual area [2].

In Table 1 we present systematized information about the effects of digitalization by areas of their expression.

Table 1. Effects of digitalization in agriculture.

Economic effects	**Social effects**	**Environmental effects**
• Cost reduction (through automatization of processes, sharing and/or second use of resources, and recycling • Increased investment in innovations • Diversification of production • New income flows from using digital platforms and servitization • Adding and monetizing value • Improving: - operative efficiency (client and time management)	• Enhancing and facilitating coordination and cooperation (e-platforms): - with new stakeholders; - with clients; - with local authorities • Richer and easier access to information • Easier and faster identification of the changes in the attitudes and needs of consumers	• Second use of resources • Recycling • Processing • Shared assets • More efficient use of resources and more precise application of raw resources – seeds, manure, nutrients, energy, land, water • More efficient management of the operations at all stages of the value chain

- resource efficiency - productivity - sustainability - food quality - product security - trackability of deliveries - marketing - wholesome efficiency of the producer - competitive ability • Forming economies of scale and range • Vertical integration • Autonomy in farm management • Financial risk • Enhancing coordination, cooperation and shared responsibility • Change in the contract power • Changes in prices and market opportunities • Market concentration and power • Decrease of information asymmetry	• Easier access to market (lower barriers) • Building communities, identity and sense of inclusion • Easier access to trainings and acquisition of skills • Shared responsibilities • Welfare improvement • Sharing resources, production, information • Autonomy • Strive to equality, sustainability, achieving synchronicity and trust • Monitoring and transparency	• Reducing the damage to the environment and climate • Improving the health of plants and soil • Biodiversity • Prevention • Proactivity

Source: Own contribution based on [2, 4, 6-7]

It is apparent that the digitalization of business processes and the possibility to "feel" the effects of digitalization require from the traditional producer to innovate the existing business model. Thus, digital transformation turns into an unavoidable condition for sustainable creation of new value for the shifting needs of consumers and for its capturing (at least for a larger part of it) by the modern agricultural producer. At a microlevel, this is related to transformation of business results, and at a macro level [7-8] – with altering relations between market players, shifting competitive environment and dynamics of the agricultural value chain.

Agriculture, as a traditional sector, faces the challenges of the modern digital era with regard to the ways of sustainable creation and capturing of value. Key factors for tackling these challenges are investments in new digital technologies and software experience [9], which will allow the sector to become more flexible and adaptive to the new market conditions. The authors have also found that for the digitally mature market agents, the investments in intangible assets are twice to thrice as high as the average for the industry, which contributes to lifting the levels of whole profitability and improvement of the firm output compared to non-digitalized participants. The positive relation between investments in digital innovations and the firm output has been confirmed in the works of Nguyen-Anha et al. (2022) [10], Rizaev and Kadirov (2022) [11], Zhai et al. (2022) [12], Klerkx and Rose (2020) [13], Bellakhal and Mouelhi, (2020) [14], Martín-Peña et al. (2020) [15], Ribeiro-Navarrete et al. (2021) [16], Kroll et al. (2018) [17] and many others.

The aim of the present study is to analyze empirical data from crop producers on the basis of a theoretical review on the literature about digitalization in the sector through the scope of digital transformation. In addition, we examine intangible assets related to the investment activity of crop production farms and selected indicators for their financial output.

2 Data and methodology

The innovations in crop production are related to new developments in the R&D activity in the area of creating new sorts of seeds, plants, methods of growing and cultivating crops, new systems for monitoring, prevention, prognosis, as well as management and connectivity systems. They are expressed in the financial reports of the firm in the section of intangible assets, because according to IAS 38 [18] "intangible assets are scientific or technical competences, the design and introduction of new processes or systems, licenses, intellectual property, market knowledge, or trademarks. Typical examples are computer software, patents, copyright, client lists, installment quotas, franchising, client and supplier relations, client loyalty, market share and market rights". Therefore, for the purposes of this analysis, the value of costs for intangible assets is accepted as an innovation indicator.

From the literature review it is clear that investment in digital innovations is a key requirement, if the producer aims to increase the productivity and economic output, as well as sustainability and lead a successful fight with the growing competition in the sector. In Table 2 we have included some of the most commonly used indicators in research literature for measuring firm results.

Table 2. Indicators for measuring firm output in research literature.

Information source	Indicators
H. Kroll, Dj. Horvat, A. Jäger, Effects of automatization and digitalisation on manufacturing companies' production efficiency and innovation performance [17]	Labor productivity Total factor productivity Sales per new product Digitalization – a proxy for uses of digital systems for management of supply chain and virtual reality Automatization – a proxy for uses of automation technologies and warehouse management system Firm size (number of firm employees) Export orientation Manager's gender Training Innovation activity (Investments in R&D)
S. Ribeiro-Navarrete, D. Botella-Carrubi, D. Palacios-Marqu´es, M. Orero-Blat, The effect of digitalization on business performance: An applied study of KIBS [16]	Firm performance (measured as the firm's future financial situation) Firm size (number of firm employees) Manager's age Manager's gender Use of digital tools and social networks Use of social network updates Training in new digital tools
R. Bellakhal, R. B. A. Mouelhi, Digitalisation and Firm Performance: Evidence from Tunisian SMEs [14]	Sales volume Sales growth Internationalization (export)
J. Ferdaous, and M. M. Rahman, The effects of intangible assets on firm performance: An empirical investigation on selective listed	Innovation performance Intangible assets Earnings per share Market to book value

manufacturing firms in Dse, Bangladesh [19]	Firm size Leverage Assets turnover ratio Market price per share
T. Nguyen-Anha, Ch. Hoang-Duca, L. Nguyen-Thi-Thuya, V. Vu-Tienb, U. Nguyen-Dinha, N. To-Thea, Do intangible assets stimulate firm performance? Empirical evidence from Vietnamese agriculture, forestry and fishery small- and medium sized enterprises [10]	Firm age Firm size Debt ratio Liquidity Labor investments R&D investments Land rent Region PCI (Provincial Competitiveness Index) PCI Labor
H. Zhai, M. Yang, K. C. Chan, Does digital transformation enhance a firm's performance? Evidence from China [12]	ROA ROE Firm size Cost (production cost and total revenue ratio) Multiplier of own capital Innovation (NL of 1 plus number of patents) Turnover of total assets Quality of internal control State of ownership Duality of CEO Board size Year Industry

In order to achieve our aim, we have analyzed the following indicators selected from economic research:

Presence and size of intangible assets – first, we examine the relative share of the enterprises which have incurred intangible asset costs. During the analysis we have used the whole size of the intangible assets indicated in the balance sheets of the firms. Out of all enterprises, only two have announced R&D costs over a period of four or five years; one enterprise – for two years (2018 and 2019), and one firm for one year (2017). We can consider their size as not relevant to the data analysis of the costs for concessions, patents, licenses, trademarks, software, because their absolute value is small.

ROA and ROE – widely used and preferred indicators in economic research, for measuring annual economic results. In the present study we use them for the needs of comparative analysis.

Total assets – we use the value of the total sum of the assets per balance value as an indicator for the size of enterprises. The aim is to track the presence of intangible assets according to the size of enterprises.

Labour productivity – we select the indicator in view of tracing the differences in productivity on the basis of employees depending on the presence of intangible assets.

Empirical data

In order to analyze and acquire better understanding of the process of digital transformation at a micro level we have examined enterprises operating in the crop production area. More specifically, according to the Statistical classification of economic

activities [20], enterprises fall within Sector A, section 01, groups 01.1, 01.2, 01.3. The study includes small, middle and large enterprises in the Republic of Bulgaria over a five-year period – 2017-2021. It started with 77 enterprises in 2017, as at the end of 2021 their number dropped to 69 firms. For the purposes of this research, we have divided the enterprises into two groups, depending on the presence of intangible assets in their balance sheets.

3 Results of the empirical study

The distribution of enterprises according to the presence of intangible assets shows a prevailing number of firms which do not report intangible assets in their balance sheets over the whole five-year period. (Table 3)

Table 3. Distribution of enterprises according to the presence of intangible assets, 2017-2021.

Year	Number of Farms		
	no intangibles	with intangibles	Total
2017	43	34	77
2018	40	29	69
2019	41	32	73
2020	39	29	68
2021	41	28	69

Less than half of the enterprises in the sector, 43% on average, incur costs which may have been allocated to digitalization. The data show a reduction of the number of enterprises in the reviewed period, as their relative distribution is retained.

When examining the size of intangible assets, we have noticed a low size of costs at an average of 54.14 thousand BGN. (Table 4).

Table 4. Descriptive statistics of the size of intangible assets (intangibles)*

Variable	Mean	Std. Dev.	Min	Max	Observ.
Intangibles					
overall	54.13907	154.202	1	1058	N = 151
between		151.6206	1	1052	n = 55
within		63.29221	-284.6609	331.3391	T-bar = 2.74545

*Only enterprises which report intangibles their balance have been included

We also notice a significant dispersion around the mean value of the intangible assets, both at the level of individual firm by year, and between the separate enterprises. We may note that individual characteristics of the firms are a less important factor for the observed deviation, compared to the between-group one.

The obtained results inform that the enterprises which invest in intangible asset also have a larger total assets size – they show on average 1.5 times more assets are in absolute value for this period (Figure 1). Therefore, with the growth of the asset size we observe investments in intangible assets.

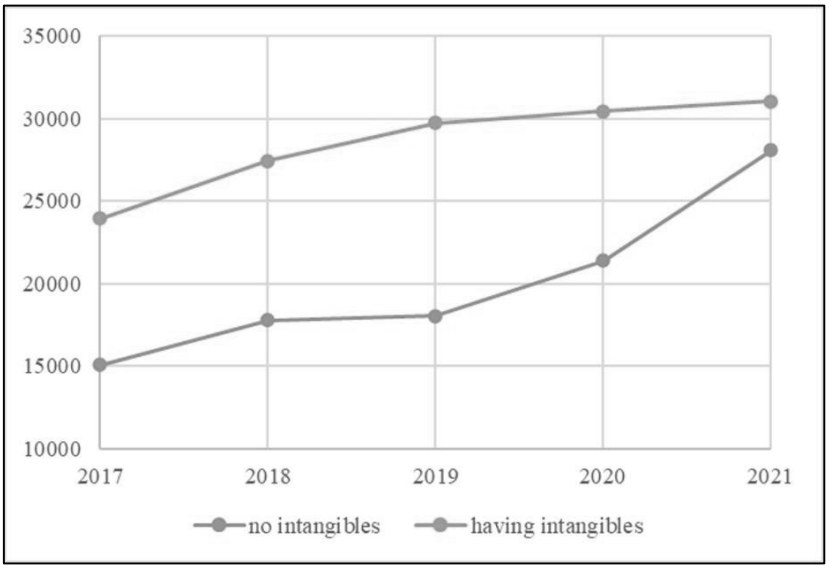
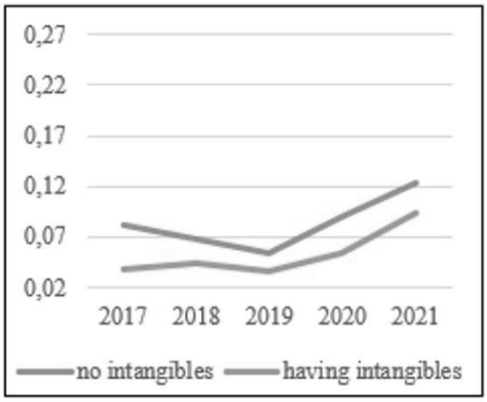


Fig. 1. Distribution of the enterprises by total asset size.

Next, we trace the distribution of the indicators for farm financial performance – ROA and ROE in the two groups of enterprises. (Figure 2 and Figure 3).



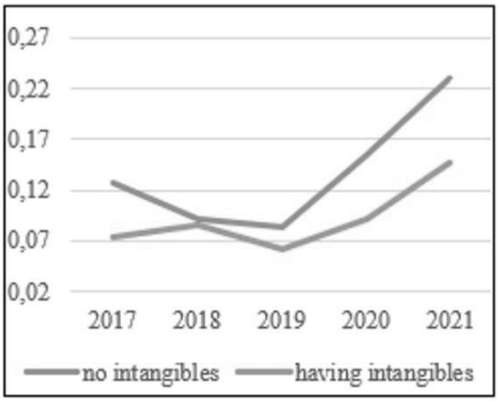


Fig. 2. ROA of crop farms.

Fig.3. ROE of crop farms.

For the two indicators, the distribution clearly shows a lower farm financial performance in terms of ROA and ROE of the enterprises which report intangible assets in their balance sheets. Expectedly, the values of the ROA coefficient are lower, however, for the two indicators the enterprises without intangible assets show 1,5 to 1,6 times better results. We may suppose that this result is due to the bigger single costs for investment. In a subsequent examination, during a modulation of the dependencies between the intangible asset costs and financial performance indicators, it is recommended to track the impact of the lag variables. In economic research, there is no uniform understanding about the influence of digitalization on the performance and growth of enterprises. Anderton, Botelho and Reimers (2023) [21] question the effects of digitalization – from the viewpoint of whether digitalization actually secures huge profit in the productivity for the enterprises, or they have a sideshow effect with a limited impact. In the study, the authors reach the conclusion that digitalization and investment in digital technologies may not be used by all enterprises as "a 'one-size-fits-all'

strategy to improve their productivity“, and the results rather attest to the limited effect for most enterprises which cannot “adequately reap its productivity gains“.

When comparing the labour productivity of the two groups of enterprises, we observe significant annual increase of the productivity in enterprises which report zero investment in intangible assets (Table 5).

Table 5. Labour productivity.

Year	Labour productivity		
	no intangibles	with intangibles	Total
2017	72.563302	105.2259	86.985747
2018	85.421296	114.40981	97.604875
2019	149.35147	121.52525	137.15367
2020	137.8076	105.74018	124.13179
2021	235.61174	114.62069	186.51392

In 2021 versus 2017, the net income of one employee increased over three times, as in 2019 it exceeded the labour productivity of the enterprises investing in intangible assets.

When we examine the labour productivity of the enterprises with intangible assets, we notice a higher productivity by 2019, whereas in the next two years it was registered at a lower level. At the same time, the total labour productivity for all enterprises showed a rising trend. The results allow us to state that the growth of net income of one employee is due to a great extent to non-innovative enterprises.

4 Conclusion

Digitalization and the implementation of digital technologies has occupied a central position in economic research in recent years. Digitalization of crop farms is in its initial stage, as there are still insignificant investments for digitalization of the business processes. In view of a broader understanding of the benefits of digitalization, the current article summarizes and systematizes data from economic research about the effects of digitalization in three directions – economic, social and environmental, whereby empirical data from crop farms have also been analyzed.

In summary, we may note that the obtained results attest to a considerable relative share of crop farms – 43%, which report in their balance intangible asset costs that include digitalization investment. At the same time, the indicated investment in assets is characterized by a low mean value (54.14 thousand BGN), of which the investment in digital technologies occupy an even smaller share.

We can also point out that the enterprises which invest in intangible assets also have a larger size of total assets, yet with respect to the realized financial performance and labour productivity we have observed lower values, compared to non-innovative enterprises.

The data clearly show lower values of ROA, ROE and the net income of one employee in the firms, which report intangible assets in their balance sheets. Moreover, throughout the observed period we have noticed a significant annual increase of labour productivity in enterprises which had zero investment in intangible assets.

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References

1. L. Klerkx, E. Jakku, P. Labarthe, J. Life Sci. **91**, 100315 (2019)
2. S. Rolandi, G. Brunori, M. Bacco, I. Scotti, Sustainability **13**, 5172 (2021)
3. J. Fernandez-Vidal, F. A. Perotti, R. Gonzalez, J. Gasco, J. Bus. Res. **152**, 29–41(2022)
4. J.A.J. Mendes, Dimensions of digital transformation in the context of modern agriculture, Sustainable Production and Consumption, (2022), [Online] https://doi.org/10.1016/j.spc.2022.09.027 [Accessed: 13 June 2023]
5. A. Osterwalder, What is a business model?, (2005), [Online] http://business-model-design.blogspot.com /2005/11/what-is-business-model.html [Accessed: 13 June 2023]
6. L. Broccardo, A. Zicari, F. Jabeen, Z. A. Bhatti, Technol. Forecast. Soc. Change **187**, 122146 (2023)
7. C.O. Klingenberg, V.A. Júnior, J. Antônio, G. Müller-Seitz, Impacts of digitalization on value creation and capture: Evidence from the agricultural value chain, Agricultural Systems **201**, 103468 (2022)
8. X. Pham, M. Stack, Bus. Hor. **61**, 1, 125–133 (2018)
9. R. Balzer, A. Vojtková, *Chapter 7 Creating Value in the Digital World*, (103-124, 2023), in Ebook: Editors: Martin Užík, Christian Schmitz, Sebastian Block, Financial Innovation and Value Creation: The Impact of Disruptive Technologies on the Digital World (Publisher: Springer Cham, Series Title: Financial Innovation and Technology, 2023), [Online] https://doi.org/10.1007/978-3-031-22426-3
10. T. Nguyen-Anh, Ch. Hoang-Duc, L. Nguyen-Thi-Thuy, V. Vu-Tien, U. Nguyen-Dinh, N. To-The, JIK **7**, 100194 (2022)
11. N. Rizaev, S. Kadirov, IOP Conf. Ser.: Earth Environ. Sci. **1068**, 012028 (2022)
12. H. Zhai, M. Yang, K. C. Chan, Technology in Society **68**, 101841 (2022)
13. L. Klerkx, D.C Rose, Global Food Sec. **24** 100347 (2019)
14. R. Bellakhal, R. B. A. Mouelhi, Digitalisation and Firm Performance: Evidence from Tunisian SMEs, EMNES Working Paper No **36** (2020)
15. M. L. Martín-Peña, J. M. Sánchez-López, E. Díaz-Garrido, J. Bus. Ind. Mark. **35**, 3, 564–574 (2020)
16. S. Ribeiro-Navarrete, D. Botella-Carrubi, D. Palacios-Marqu´es, M. Orero-Blat, 2021, J. Bus. Res. **126**, 319–326 (2021)
17. H. Kroll, D. Horvat, A. Jäger, Effects of automatisation and digitalisation on manufacturing companies' production efficiency and innovation performance, Fraunhofer ISI Discussion Papers - Innovation Systems and Policy Analysis, No. 58 (2018), [Online] http://nbn-resolving.de/urn:nbn:de:0011-n-4873361
18. International Accounting Standards 38, [Online] https://balans.bg/normativen-akt/mss-38 [Accessed: 14.06.2023]
19. J. Ferdaous, M. M. Rahman, American Journal of Business **34**, 3, 148–168 (2019)
20. Statistical classification of economic activities (NACE) 2008, [Online] https://ec.europa.eu/eurostat/web/products-manuals-and-guidelines/-/ks-ra-07-015
21. R. Anderton, V. Botelho, P. Reimers, Digitalisation and productivity: gamechanger or sideshow?, ECB Working Paper Series No **2794** (2023)