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DIGITALIZATION OF THE FRUIT AND BERRY PRODUCTION IN LATVIA

Ieva Nora Gediņa[1], Mg.sc.pol., Ms. Soc. Sc. M.;

Sandija Zeverte-Rivza[2], Assoc.Prof., Dr.oec.

[2]Latvia University of Life Sciences and Technologies, Celteh Ltd

Abstract. The current global developments that require an increase in efficiency, productivity, and sustainability are affecting fruit and berry growers. Without strategic initiatives at the governmental, non-governmental, and farm levels, the sector might fall behind in the global race for competitiveness. The goal of this study is to examine digitalization solutions in fruit and berry production and analyse whether and how they will impact the economic performance and competitiveness of Latvian farms working in this specific agricultural sector. To achieve this aim, both quantitative and qualitative research methods were applied, including theoretical analysis of digitalization solutions in agriculture, sectoral analysis, and gathering empirical data from Latvian fruit and berry producers, NGOs, researchers, and technology industry representatives. The results suggest that digitalization leads to increased efficiency and productivity, contributing to competitive advantage of Latvia's agricultural holdings growing fruits and berries. However, numerous recommendations by stakeholders and the authors have been developed in order to accelerate the process.

Key words: digitalization, agriculture, fruit and berry production, productivity, efficiency.

JEL code: O13

Introduction

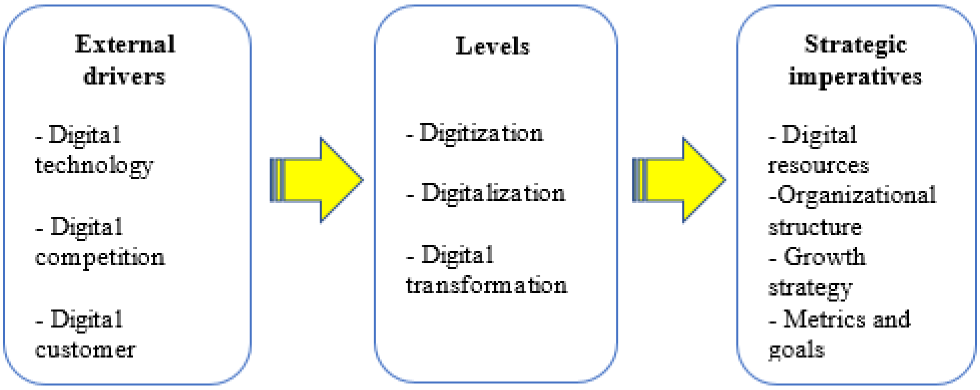
With increasing world population and the consequent strains on finite amount of land, fresh water reserves and natural resources, the agri-food system is expected to face various challenges in near future, raising the issues of efficiency, innovation and sustainability high on the global agenda. Agriculture is a field where digital technologies have a potential to increase the precision of production, stimulate innovation and transform the accustomed way of doing business, leading to new business models and improved efficiency of business processes (Hartmann et al., 2021).

While exploring the subject, scholars often navigate between terms *digital transformation and digitalization*, at times also referring to *digitization*. The overarching term of digital transformation encompasses "strategic transformations targeting organizational changes implemented through digitalization projects, with the goal of enabling major business improvements" (Warner & Wagner, 2019, as cited in Caputo et al., 2021). As Verhoef et al. (2021) note, this is a multidisciplinary phenomenon – it requires alterations in strategy, organization, IT, supply chains and marketing. Meanwhile, digitalization, represents "a wide sociotechnical process and implies the integration of multiple technologies into aspects of daily social life" (Brennen & Kreiss, 2016, as cited in Caputo et al., 2021). Within this research, both terms are applied. Digital transformation is perceived on the strategic level – as the overarching change of how a firm employs digital technologies to develop a new digital business model, while digitalization is referring to more specific initiatives, application of technologies. Within this context, authors often talk about digitization – transition from analogue information to a digital format (Caputo et al., 2021). As the Figure 1 reveals, digitization can be perceived as the first step towards digital transformation.

Scholars commonly cite various technological advancements as driving the process of digitalization, including broadband internet, smartphones, cloud computing, speech recognition, online payment systems and cryptocurrencies. Additionally, the advent of big data has given rise to technologies like artificial intelligence, blockchain, IoT, and robotics, highlighting the necessity of digital transformation for businesses. These innovative technologies have significantly altered the competitive landscape, intensifying

[1] E-mail: nora.gedina@gmail.com
[2] E-mail: sandija.rivza@llu.lv

global competition and often giving an advantage to digitally-savvy, younger companies (Verhoef et al., 2021).



Source: Verhoef et al., 2021

Fig. 1. **Flow model of digital transformation**

With increasing global population, traditional farming tends to take a heavy toll on the natural resources of the world. As overpopulation advances, technologies can help to minimize external inputs and increase efficiency, productivity and sustainability (Graziano da Silva, 2022). While information and communications technology (ICT) is becoming faster, cheaper and more accessible globally, the argument of digital advances tackling environmental problems and climate change gains more solid ground and the technologies become more widespread. The Netherlands have seen a major growth – in 2007 only 15% of the nation's arable land was cultivated, using precision technologies, while in 2017 it was already 65% (Carolan, 2017, as cited in Rotz et al., 2019). From a global perspective, as the SMARTer Report states, by 2030 the agricultural crop yields will increase by 30% and will save over 300 trillion litres of water and 25 billion barrels of oil per year, contributing to CO2 emissions, as well. In order to reach these advances, Smart Agriculture has to be applied in the form of such technologies as satellite imaging, geographic mapping, machine to machine connectivity, sensor-based technologies and advanced data analytics that could lead to practices that are more productive, sustainable and precise (SMARTer Report 2030, GeSI, 2016).

Table 1

The use of ICT tools and their impact on the production technologies

ICT tools	Impacts
Precision agriculture: • connectivity between machines and equipment • sensors and satellites • advanced data analytics • ICT-enabled genomic sequencing of livestock, seeds and plants.	Monitoring, tracking, real-time data via mobile apps or messaging enhances efficiency of resources – water, fertilizer, nutrition, equipment and others.
Information and communication platforms: online platforms and apps that gather data and transform it into valuable information, thereby facilitating the decision-making process.	Providing the right information throughout the food chain reducing food waste at production, distribution and consumption.
Farm management technologies: automation and optimization of general farm practices and back-office IT.	Enhanced productivity: higher crop yield and income potential (monitoring soil and livestock, forecasting, early detection of problems).
Traceability and tracking systems: smart logistics allow better tracking of food as it is stored and transported.	Advanced analytics and forecasting allow for preventive cautions to environmental shocks and build resilience.

Source: The SMARTer Report 2030; GeSI, 2016

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According to theoretical analysis, precision farming solutions are some of the most successful digitalization initiatives implemented in Latvia's agriculture, particularly solutions that focus on real-time monitoring, measurement, and response to crop, field, and animal variability, which optimizes input returns and conserves resources (Rivza et al., 2019). The use of sensors is becoming more prevalent, as indicated by international projects like ATLAS (*Agricultural Interoperability and Analysis System*) and the initiatives of the Association of Latvian Organic Agriculture. Various IoT sensors are being applied for crop monitoring, irrigation, plant protection, and other purposes, alongside initiatives like Data Driven Dairy Decisions for Farmers. Robotics is also an area witnessing innovation, with the development of an automated robot weeder equipped with sensors and lasers under the Latvian University of Life Sciences and Technologies, and other logistics robotics projects currently in progress (Osadcuks, 2020).

Nevertheless, researchers and practitioners point at various difficulties, particularly for small and medium-sized enterprises (SMEs), to implement ICTs and digital initiatives. These difficulties include unclear objectives, unmanageable risks, a lack of digitally advanced workforce to fully utilize ICTs, a shortage of management skills among workers needed to transform workplace practices, and insufficient resources to support digitalization initiatives (Pierenkemper, Gausemeier, 2021). Furthermore, inadequate funding for ICT initiatives, a scarcity of qualified personnel, and insufficient development of digital infrastructure in rural areas are commonly cited as the primary barriers to digitalization in agriculture (Rivza et al., 2019). In addition, practitioners have noted that digital solutions are often designed for standard situations and may not be adaptable to the diverse operational and production processes encountered by SMEs, which may require expensive adaptations (Zalane, 2021).

This paper proceeds as follows: the second section reveals a concise description of materials and data employed in order to conduct the study; the following section is devoted to the main findings of the study; and the final section summarizes the findings and recommendations for the digitalization of fruit and berry subsector.

Materials and methods

In order to verify the hypothesis, the authors undertook several research tasks. These included a theoretical analysis of digitalization solutions in business and more specifically in agriculture; a sectoral analysis of Latvia's agriculture industry and its fruit and berry sub-sector; and gathering empirical data from producers to evaluate the current state and potential for digitalization within this sector. Following a descriptive research design, the theoretical discussion was based on scientific articles from Web of Science and Scopus databases, while quantitative data were obtained from the databases of Eurostat and Central Statistical Bureau of Latvia, complemented with qualitative data provided by semi-structured interviews from a variety of stakeholders.

The semi-structured interviews were conducted with the following participants: Juris Ducens (LLC *Silvermoon*), manager of a recently established small-sized highbush blueberry orchard; Gundars Karklins (LLC GUKA), a long-established owner and manager of black currant orchard and member of board at the cooperative society *Bio Berries Latvia*; Gints Strazdins (agricultural holding *Kurpnieki*), owner and manager of an apple and honeysuckle orchard, horticulture lead at the Association of Latvian Organic Agriculture; Janis Lindermanis, co-manager at LLC *Skoru darzi*, sales and business developer at various other tech companies (*Anatomy Next, Alternative Plants, Defibrillator Baltics*); Inga Laksa, co-founder and co-owner of LLC *Will Sensors*, which is a Latvian-founded company that offers sensors for measurement, detecting, counting, warning, safety, control and monitoring, cloud solutions, for agricultural sector among others; Maira Dzelzkalaja-Burmistre, Vice-Chair of the Board at the NGO *Zemnieku Saeima*

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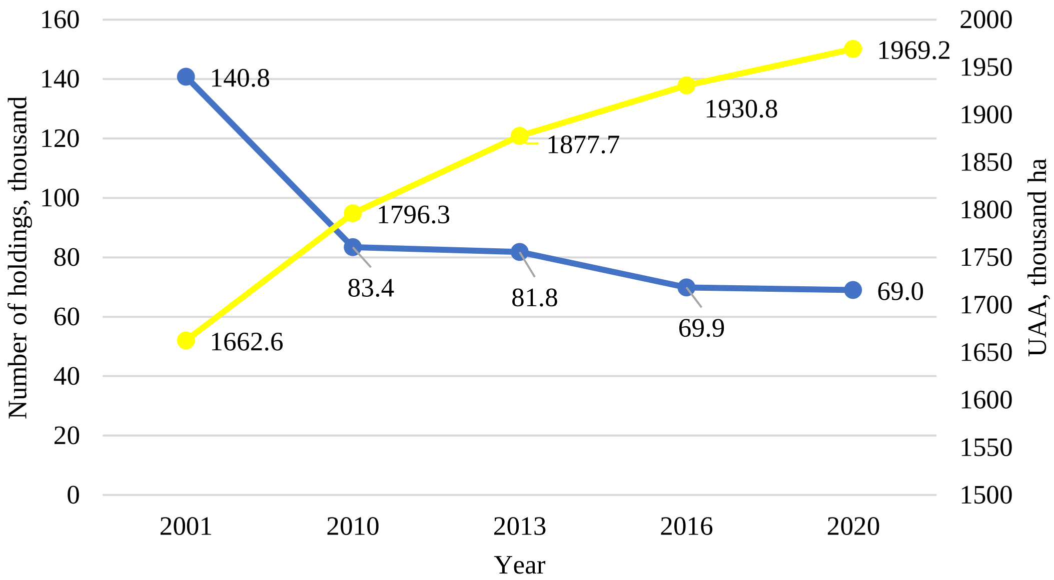
(*Farmers' Parliament*); and on the research side – Sarmite Strautina, Member of Scientific Council, Lead Researcher at the Unit of Genetics and Breeding at the Institute of Horticulture, Latvia University of Life Sciences and Technologies. The carefully selected respondents hence included researchers, representatives of conventionally and biologically oriented NGOs, representatives of orchard management and innovative hi-tech companies. Each interview was organized around a pre-determined set of open questions, however, allowed the interviewee the flexibility to explore specific issues further.

Concentrating on a particular subsector within a specific country provides an opportunity to delve deeply into its intricacies. However, this approach may also serve as a research limitation, constraining research outcomes as they cannot be readily generalized and applied to other sectors in different geographical locations.

Research results and discussion

Since the first Latvia's post-independence agricultural census in 2001, there has been a noticeable trend of consolidation, with a decreasing number of economically active farms and a consistent increase in utilized agricultural area (UAA). As of 2020, there were 69 thousand economically active farms, representing a 17.3% decrease over a decade. Conversely, the UAA in Latvia has grown by 9.6% (equivalent to 172.8 thousand ha) during the same period, as depicted in Figure 2. The decline in the number of agricultural holdings was particularly rapid between 2001 and 2010, when 40.8% of farms diminished. This implies a rise in average UAA managed per holding. The census indicates an average of 11.8 ha per holding, whereas the last year's data shows that, on average, one farm manages 28.5 ha – more than twice the previous amount.



Source: authors' construction based on the data of Central Statistical Bureau of Latvia

Fig. 2 **Agricultural holdings and UAA in Latvia, 2001-2020**

In addition to the aforementioned trend, there has been a notable increase in the economic size of farms, measured by standard output[3]. Since 2010, there has been a 6.3% decrease in the number of small holdings, which now constitute 85.2% of all agricultural holdings in Latvia. However, these small holdings account for only 22.7% of the total agricultural area.

[3] Standard output (SO) is used to classify agronomic holdings by size. It is the average monetary value of the agricultural output at farm-gate price, in euro per hectare or per head of livestock (Official Statistics of Latvia, 2022). According to the EU's classification, holdings with SO up to 14.9 thousand euro are small, from 15.0 to 99.9 thousand euro are medium-sized, and over 100 thousand euro are large (Standard Output, [s.a.])

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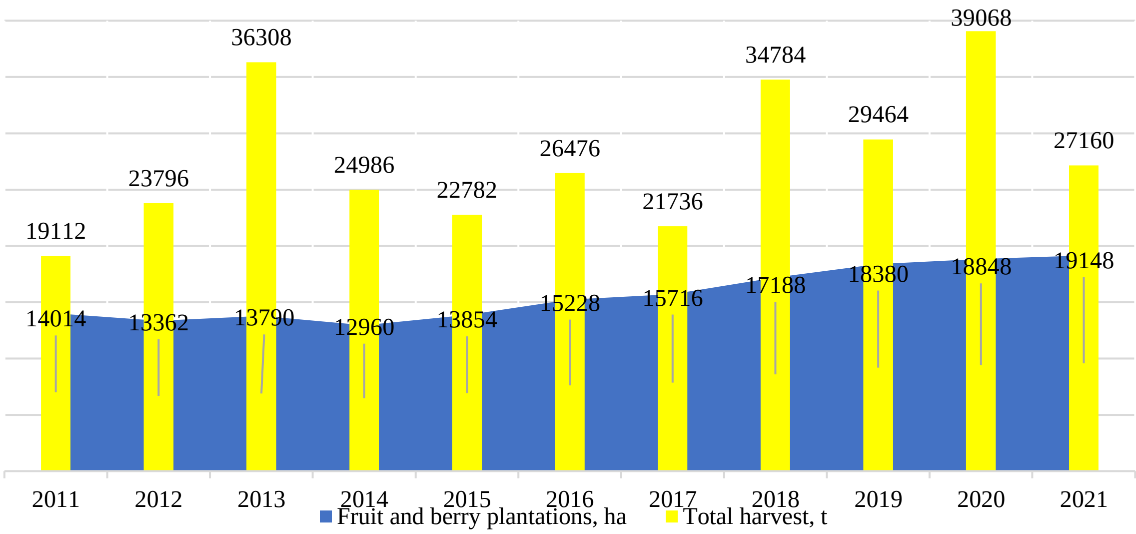
On the contrary, farms with a large standard output in 2020 managed over half (51%) of the total UAA in Latvia, according to Official Statistics of Latvia in 2022. While the consolidation of resources has advantages, upholding of farms that are less than a hectare is important for Latvia's rural areas. A sharp decrease brings along high unemployment and deepens the divide between urban and rural areas (Rivza et al., 2019). A similar trend, albeit on a larger scale, can also be observed within the research subject of this paper – the fruit and berry growers of Latvia. The number of farms decreased from 67,892 in 2001 to 1,171 in 2010, and slightly increased to 1,227 in 2020, as per Agricultural Censuses conducted in 2001, 2010, and 2020. Simultaneously, the average area per fruit and berry farm increased from 0.37 ha in 2005 to 0.55 ha in 2016 (a growth of 49%) (Pilvere, 2021).

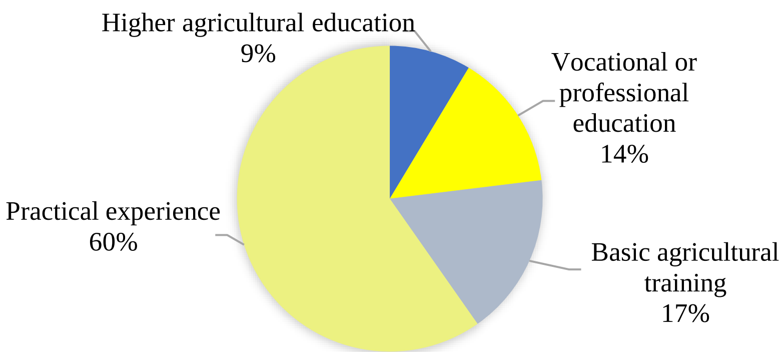
Alongside an increase in plantation hectares, the harvest data covering the past decade reveal an uneven, yet growing yield by fruit and berry holdings (Fig. 3) illustrating the influence of weather conditions and other aspects providing the volatility of the harvest.



Source: authors' construction based on CSB Statistical Database, LAG080

Fig. 3 **Area (ha) and Total Harvest (t) of Plantations in Latvia, 2011-2021**

Meanwhile, the demographic data of fruit and berry specialization indicates that these agricultural holdings are primarily managed by individuals aged between 45 to 64 years (51.1%), followed by those aged 65 and above (25.4%), with the remaining 23.5% being younger farmers.



Source: authors' construction based on CSB Statistical Database, LSK20-I13

Fig. 4 **Managers of fruit and berry agricultural holdings by level of education and training, 2020**

When evaluating education and training, 60% rely on practical experience, while the remaining farmers have received agricultural training at various levels (CSB's Agricultural Census and Statistical Database

LSK20-113). A comparable trend is reflected at the EU level, where 68.3% of all agricultural managers rely solely on practical training, and less than 1 in 10 (8.9%) have received full training.

Fruit and berry cultivation belong to a resource-intensive agricultural specialization that generates relatively high income per hectare. A successful harvest is dependent not only on soil fertility weather conditions but also input of resources, including technology and workforce availability. Although industry representatives object towards calculating average yields, the CSB data show that per specific cultures the output has increased immensely. Such are red currants and black currants, the yield of which has risen by 63% over the period from 2010 till 2019. Strawberry yield has grown by 58% and apple trees – by 23%. However, there are still several factors preventing the realization of the full yield potential, including diseases and pest infestations, frostbite to early blossoming orchards, a lack of sufficient plant protection products, degraded soil, imprecise fertilization activities, birds damaging the harvest, old varieties that are less resilient to weather changes, resulting in decreased storage capabilities and shelf life, as well as short harvesting time coupled with a lack of workforce (Pilvere, 2021). Many of these issues could be addressed through digitalization solutions. This highlights the need for tools to enhance competitiveness of enterprises in the fruit and berry sector, particularly SMEs.

In general, the European Union has prioritized digitalization and emphasized its importance by placing it alongside the green transition on top of the political agenda. The von der Leyen Commission has made significant efforts in this direction. The European Green Deal, including the Farm to Fork Strategy, the Bioeconomy Strategy, and the Digital Europe Programme, are examples of policy programming documents that reflect this strategic direction (Zeverte-Rivza & Gudele, 2021).

According to the Digital Economy and Society Index (DESI), which was introduced in 2015 to monitor digital progress and development, there is a considerable gap between the digital frontrunners of the EU and those member states that are lagging behind. As the index shows, particularly SMEs should be facilitated on their way towards cutting-edge technologies (DESI, 2021). Overall, Latvia ranks 18th out of the 28 member countries in the DESI index, and Denmark, Finland, Sweden, the Netherlands, and Ireland are the top five countries in terms of digitalization. Latvia scores well in the categories of digital public services and connectivity, while still falling behind in integration of digital technologies and skilled human capital. Even though commitment towards digital innovations is highlighted both in the National Development Plan and the Latvian Digital Transformation Guidelines 2021-2027, data retrieved from European Commission indicate that the EU average index has caught up with Latvia's performance and exceeded it in 2021. Both Lithuania and Estonia are ahead of Latvia within the DESI index.

Latvia lags behind also on the OECD level, and the organization is encouraging the country to focus on digitalization as a key enabler of innovation and growth – to promote digital innovation to address Latvia's societal and economic challenges; increase research funding to ICT-related projects, including RIS3 projects; raise the quality of research through competitive-based funds, higher private co-financing and systemic ex post evaluation; and assess the activities of the IT Cluster, the IT Competence Centre and other ICT-related bodies and clearly define their perspective roles (OECD, 2021).

While evaluating agricultural sector, there is evidence that farmers, their organizations, researchers, and policymakers have a theoretical understanding that digitalization is essential for innovation and growth. However, implementing information and communication technologies and digital initiatives has proven challenging, particularly for SMEs. Various obstacles such as farmers' skills, lack of funds, limited awareness of benefits, poor communication between stakeholders, and absence of specific solutions for the subsector have been identified. Nevertheless, the data analysis and semi-structured interviews reveal a willingness to explore precision farming and data-driven decision-making to reap the benefits of digitalization.

Table 2

Main viewpoints expressed in semi-structured interviews

Current situation	Main challenges and risks	Main opportunities and strengths
The subsector is small – it employs <1% of the entire UAA, which also applies to total output. Furthermore, it is a specific and challenging sector due to high level of manual work (Dzelzkaleja-Burmistre).	Lack of financing is mentioned as the prime drawback of digitalization. However, "R&D in precision agriculture is on the rise globally, and eventually solutions will become cheaper" (Strautina).	Existing scientific infrastructure and cross-sectoral cooperation that between agricultural and technology research units presents an opportunity (examples of good practice already within agricultural machinery, sensor systems, robotic applications, IoT systems models, machine learning, weeding and logistics robots and other areas) (all respondents).
26% growth in UAA employed by the subsector (2015-2020) has mostly occurred on the account of increase in organic orchards, which have a particular export potential. "A conventionally-grown berry will not out-compete the Polish harvests" (Strazdins).	Lack of digital skills (DESI Index) against the backdrop of ageing average farm managers (all respondents). Agriculture stands out as a rather conservative sector that requires simple and understandable [digitalization] solutions (Laksa).	Highly developed broadband coverage (OECD reports) – Latvia's major strength in the path towards further digitalization (all respondents).
The fruit and berry subsector is showing signs of consolidation alongside an increase in employed UAA. Hence, cooperatives are on the rise, allowing farmers to invest in technologies that would otherwise be out of reach (Karklins).	The economic size of farms and geographically scattered farming enterprises discourage digitalization. Clusters of same-culture farms would decrease fragmentation within the subsector (Dzelzkaleja-Burmistre).	General level of agricultural education and training is agreeable. Further strengthening of higher and vocational educational programms holds a potential to enhance skills (Ducens).
Latvia stands out in terms of remote area payment submission and control (close cooperation between public administration, farmers and NGOs) (Dzelzkaleja-Burmistre).	Informal or grey economy not only contributes to low levels of productivity, but also discourages farm managers to seek efficient digital solutions (Lindermanis).	Currently on the national policy-making level major support is allocated to biodiversity issues. Instead, increasing support for farm and production modernization, including digital agri-food technologies, would allow Latvia to contribute more to EU's Green Deal (Dzelzkaleja-Burmistre).
On a farm-level dairy and cereal farming have made more progress in terms of digitalization. Examples of good practice within the particular subsector include anti-frost irrigation systems in connection with meteorological stations and warning systems, also employed to control diseases and pests (Dzelzkaleja-Burmistre).	Access to funding appears to be a crucial aspect. While innovation through projects is highly praised, it is at the same time noted that allocated resources do not match the demand. The budget for farm modernization in 2022 was 64 million euros, while submitted projects required 134 million euros (Dzelzkaleja-Burmistre).	Communication upholds an untapped potential within the subsector, bringing various audiences such as public administration, farmers, technology developers and distributors, NGOs and scientists together (Strautina, Lindermanis, Laksa).
On the post-harvest management level, more investments are seen either in medium and large companies (Laksa) or within cooperatives due to the small economic size of farms (Dzelzkaleja-Burmistre).	Unfamiliarity of advantages of digital solutions (lack of widely communicated examples of good practice). (Strazdins). General perception that technological advances are expensive and complex (Laksa).	Lack of workforce, costs of resources and further climate change which might intensify presence of pests and diseases, will contribute towards demand for nationally and locally developed and adopted digitalization solutions (Ducens, Dzelzkaleja-Burmistre).

When evaluating potential future scenarios, respondents share a common notion that adapting to change is generally difficult, however, all interviewees highlight the importance and inevitable development of subsector's digitalization. The pace of this potential development is seen differently, and, in addition, other sectors like dairy or grain production are seen as pioneers of the field also within the upcoming decade.

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"New digital solutions are inevitable. One must only hope that our subsector will keep up with it financially-wise and skill-wise. Generation change is an important aspect [..]. Average age of farmers is not decreasing – both Latvia and Europe are familiar with this problem" (Strazdins). Some viewpoints were harsher, stating that openness to digitalization will determine the issue of survival within the subsector. "Digital technologies will enter mainly due to labour shortage and high costs. Another reason is climate change. Sensors and forecasting abilities will allow us to adapt to the climate that, in Latvia's case, will bring more pests. We will need digital assistants as much as possible for forecasting and decision-making" (Dzelzkaleja-Burmistre).

As for now, increasing prices have already contributed to the rational understanding that digital technologies might decrease expenditure, although further communication of best practice is recommended. "Often we used to see large-scale grain producers investing in auto steer tractors that employ satellite signals. However, when it comes to simple and even cheap solutions, like a sensor that closes the water tap and could provide considerable savings in longer run, we repeatedly hear that it is unnecessary. Frequently farm managers perceive digitalization as shiny new expensive gadgets that will require a totally new approach and adaptation; however, notable improvements can also be achieved through digitalizing the existing equipment or making the already installed sensors to provide coordinated insight into processes" (Laksa). A general country-wide and cross-sectoral problem is lack of long-term thinking, concludes Lindermanis, who is representing not only farming, but also technology start-up industry. "In a way we are discouraged from thinking in long-term. For example, agricultural insurance is a practically non-existent business niche. Well, there are options, however, the cost-benefit ratio is discouraging, which also explains why young people do not find agriculture appealing".

The farmers stress concrete and practical aspects, like a need for digital solution for the complex soil, leaf and water analysis, as well as digital tools to support plant fertilization. "An algorithm that would take into account the weather, stage of the plant's development, the specific variety and results of analysis could not only significantly facilitate daily work, but also enable more precise management and save resources, such as time or minerals, eventually also increasing productivity" (Ducens). This, however, brings up again the cost-benefit ratio for small and medium-sized farms. When evaluated against the potential return of investment, many such initiatives stay as wishful thinking.

Several suggestions have been put forward in order to help the subsector to move towards digitalization. Based on scientific publications, data analysis, and information gathered from interviews, the recommendations might cater to a broad audience including farm managers, technology developers and distributors, as well as non-governmental and governmental organizations. However, some of the suggestions provided by the respondents were highly specific, yet valuable, and therefore they will be detailed out first. Some are referring to the agricultural sector in general, some – merely to fruit and berry production.

1) Targeted support to cooperatives, since they work towards strengthening the fragmented voice of farmers. One particular direction could be the development of monitoring and logistics systems, as well as marketing platforms (Karklins).
2) Information is fragmented on many issues: specific solutions and support possibilities. Collecting it on a single platform would be beneficial (Laksa).
3) Facilitating cooperation between farms and scientific institutions would be mutually beneficial (Lindermanis).

4) Addressing distributors of digital technologies as an audience that can encourage digitalization through post-purchase consultations (Dzelzkaleja-Burmistre and Lindermanis).
5) Increasing support for producers (equipment, ICTs etc.) at the expense of biodiversity, which currently is a strategic priority on CAP 2023-2027 for Latvia (Dzelzkaleja-Burmistre).
6) Instead of focusing on well-researched areas, target support for cultures that are typical and perspective in Latvia, like quinces or raspberries to cover the knowledge gap that might be arising due to lack of interest in these cultures by international scientists (Strautina).
7) Work towards decreasing employee turnover in the state institutions, which could contribute to the continuity (Ducens).

With a more overarching view, the following recommendations for the entire sector were developed.

1) First and foremost, the issue of digital skills and competences has to be addressed on all educational levels, involving the existing vocational, higher education and life-long education framework and boosting cooperation with the NGOs of the sector, the IT Cluster, the IT Competence Centre and other ICT-related bodies.
2) Increase funding to agricultural holdings aimed at carrying out digital infrastructure and equipment modernization projects within the fruit and berry subsector. At the same time, a simplified administrative procedure is advisable.
3) Increase research funding to ICT-related projects and boost their quality through higher private co-financing and detailed post-evaluation.
4) Digitalization is about extracting and using data to be analysed and converted into information that can be used to facilitate the growth of the agricultural holding. In this aspect there is untapped potential within the sector in general – automatization and digitalization tools that have been purchased, are not being exploited to their full capacity. Here the issue of communication between technology developers, distributors and farmers has to be addressed. The author recommends involving NGOs as a mediator and facilitator of the process.
5) Enhancing networking among the stakeholders – a more intensive sharing of the examples of best practice on regional, national and international levels is needed in order to urge farm managers to explore digital options.
6) Encouraging clustering within cooperatives that would enhance the economic power of the growers of specific cultures.
7) Review the current support mechanisms that address the consequences of COVID-19 within the agricultural sector. A reconsideration of rather boosting tools that contribute to long-term change (development of applications, platforms, specific digital tools etc.) than allowances and compensations is advisable.
8) In addition to the current *ALTUM* option, increase access to loans, especially for SMEs, who intend to implement digital tools and systems.
9) Although the ageing of farmers implies a complex problem, a nation-wide campaign with an aim to boost the reputation of farming, the gains of the profession and the possibilities it opens, would be advisable.
10) Further contributions to vocational and higher education programmes are vitally important. In order to boost the skills of the future professionals, cross-disciplinary study courses introducing the students with the principles of robotics, programming and other digitalization-driven aspects could contribute to creating a digital mindset for future farm managers.

11) On the state level it would be important to keep encouraging such private digital initiatives as *Grow with Google* which tackles lack of skills.

12) Despite the rather optimistic evaluation in DESI, keep investing in national digital infrastructure in order to boost connectivity and reduce the digital divide between urban and rural regions.

Conclusions

1) While digitalization has been extensively studied in academia, there is a lack of in-depth research on the status quo, challenges, and facilitators of digital transformation in the fruit and berry subsector of Latvia's agriculture. This paper achieved to fill the gap by providing insights into the current state of digitalization and identifying the factors that can contribute to its successful implementation. The carefully selected list of interviewees represented stakeholders who can address the issue from the viewpoint of farmers, NGOs, the industry that offers solutions in digitalization, as well as scientific institutions that work towards the enhancement of digitalization within the particular subsector. In addition, the chosen agricultural holdings differ in size, specialization, region, and level of experience of the manager. The viewpoints of an organic farmer and farmers whose holdings are part of a cooperative were also included. As age is also often considered a barrier to digitalization, diverse opinions were represented by including interviewees in their late 30s, 40s, and 50s.

2) The research managed to outline the current digitalization situation within the fruit and berry subsector, as well as accumulate knowledge, establish facts and generate conclusions that might serve policy-makers, organizations and practitioners, facing the exponentially increasing evolution of new technologies. The results support the hypothesis that digitalization leads to increased efficiency and productivity, contributing to competitive advantage of Latvia's agricultural holdings growing fruits and berries.

3) These holdings have a potential to advance from basic to moderate, and from moderate to advanced digital usage. However, the availability of funding and skill level are significant factors that need to be addressed to achieve more efficient, sustainable, and accurate fruit and berry production in Latvia. To help the subsector towards digitalization, various recommendations have been provided in the previous section.

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