The use of digital technologies in Austrian farms

DISUCO Working Paper 4

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Abstract

Digitalisation in agriculture has been a topic of interest in many countries. An extensive literature review in Germany, Switzerland and Austria revealed that there are numerous articles in research papers and grey literature for Germany and Switzerland; Austrian agriculture, however, is rarely covered in the economic literature. In 2022 we conducted a survey among more than 500 Austrian farmers to investigate experiences with digital applications in various areas of production and marketing of Austrian farmers. The results indicate that different farms and different farm types are adopting these new technologies at different paces. The results give an overview of the deployment, investment and operating costs of digital technologies. Digital tools supporting decision making and facilitating administrative tasks are frequently used in Austrian agriculture. E-Government plays an important role in this respect. To a lesser extent digitally enhanced equipment and machinery are used. The analysis shows that digitally affine farmers can reap more benefits from these pervasive technologies.

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1. Introduction

The EU has adopted the goal of reducing its greenhouse gas emissions by 55% by 2030 compared to 1990 and becoming climate neutral by 2050. In the context of these challenges, the European Commission has developed the European Green Deal, a growth strategy to make the EU " a fair and prosperous society, with a modern, resource-efficient and competitive economy" (COM/2019/640 final).

Implementing the European Green Deal requires fundamental changes in many areas, including agriculture, that can be supported by digitalisation. The communication "Digital Compass 2030" (COM/2021/118 final) defines agriculture as one key area for digitalisation in the EU. The use of digital farming technologies can increase the efficiency of agricultural production and thus enhance sustainability and competitiveness of the sector. This is also reflected in the CAP for the period 2023 to 2027 (Regulation (EU) 2021/2115).

The Austrian CAP strategy (BML, 2023) emphasises the importance of innovation and digitalisation in agricultural production, and includes support for comprehensive broadband expansion, the establishment of new digital trading platforms for agriculture, and the promotion of the necessary knowledge development in the field of digital technologies.

2. Literature Review

Digitalisation in agriculture has been a topic of interest in many countries. An extensive literature review in Germany, Switzerland, and Austria revealed that there are numerous articles in research papers and grey literature for Germany and Switzerland; Austrian agriculture, however, is not yet covered in the economic literature. There is only one survey about the adoption of digital technologies in Austria that was carried out in 2021, but the detailed results are only available for the institution that commissioned the survey (Mayr, 2021).

With regard to the literature on digitalisation in Switzerland and Germany, the situation in Switzerland is captured very well. A very elaborated survey among Swiss farms was conducted with farm type specific questionnaires in 2019. The number of farmers responding to written surveys was high enough to allow for representative results for the whole sector. In Germany many surveys on various aspects of digitalisation were conducted. A screening of the surveys shows that overviews of the whole sector give some impression on the role digitalisation plays for the sector, but digitalisation is very specific when it comes to single farms. Digital technologies on milk producing firms are quite different from farms specialised in crop farming or when farms are asked about their usage of digital technologies on smartphones.

The literature review is presented in the **Fehler! Verweisquelle konnte nicht gefunden werden.** where the sources are summarised, and the main topics are addressed. The literature survey does not go into details because digitalisation is a development that is pervasive. Practically all production processes and aspects of management, procurement and sales today rely on digital technologies, and they are therefore present at any production step. Nevertheless, different farms and different farm types are adopting these new technologies at different paces, as shown in the next chapters.

3. Data

The data presented here were collected in the course of a survey in the first quarter of 2022. The survey was based on a questionnaire that was designed to minimise the respondents' time while at the same time covering the broad spectrum of digitalisation in agriculture.

The survey was conducted by LBG Österreich GmbH Wirtschaftsprüfung & Steuerberatung. The clients of this company keep business management records, which are the basis for the annually published "Green Report" on the income situation in agriculture. They were invited by LBG and personal consultants to participate in an online survey. In many cases, the questionnaire was conducted in the presence of the consultant during the annual book-keeping closing meetings. As they had been trained beforehand, the quality of the responses was expected to be very high and there were only a few incomplete questionnaires.

The goal of the 97 questions included in the questionnaire was to investigate experiences with digital applications in various areas of production and marketing of Austrian farmers. Three categories of digital farming technologies were investigated in the survey: general farming technologies, technologies specific to crop farming, and technologies specific to livestock farming (see Table 1). Also farmers with little experience with digital applications were invited to participate since their answers are important to analyse the barriers of digitalisation. The aim was to determine the benefits of digital technology in the agricultural practice.

Overall, 532 farmers answered the questionnaire. With 258 farms (44%) the largest share is made up of farms specialising in livestock farming, further 167 (30%) are engaged in crop farming, 98 (18%) operated as mixed farms (i.e., engaging both in livestock and crop farming), and 9 (2%) had other activity fields, most notably forestry.

Table 1: Categories of digital farming technologies

General farming technologies	Technologies specific to crop farming	Technologies specific to livestock farming
eAMA	Digital steering and tracking systems or weed control equipment	Barn camera
Online purchase of operating resources and services	Part-width section control or individual nozzle control	Sensor-based animal health monitoring
Electronic management solutions or electronic field books	Site-specific sowing and/or fertilisation	Feeding robots or digital feeding systems
Smartphone apps	Autonomous weed and/or pest control	Milking robots
Online services on tablet or PC	Sensor-controlled irrigation	Manure cleaning robots
Social media presence	Alert services for plant protection	Sensor-based animal health monitoring
Own website		

4. Results

4.1 The usage of digital tools in agriculture

The most widely adopted general digital solutions among all farms included online services, smartphone apps, and eAMA[1] (Figure 1). Around 83% of farms utilised online services, e.g., weather updates and pricing information, on computers or tablets. Smartphone apps or eAMA (e.g., facilitating online recording of farmland data or RinderNET, the obligatory register of cattle) were employed by each 82% of the farms. For eAMA, livestock farms showed the highest adoption rates (91%), followed by mixed farms (79%) and crop farms (71%). However, another 8% of crop farms plan to use eAMA in the next years. Conversely, online services were most frequently used by crop farms. Smartphone app usage demonstrated similarity across all types of farms.

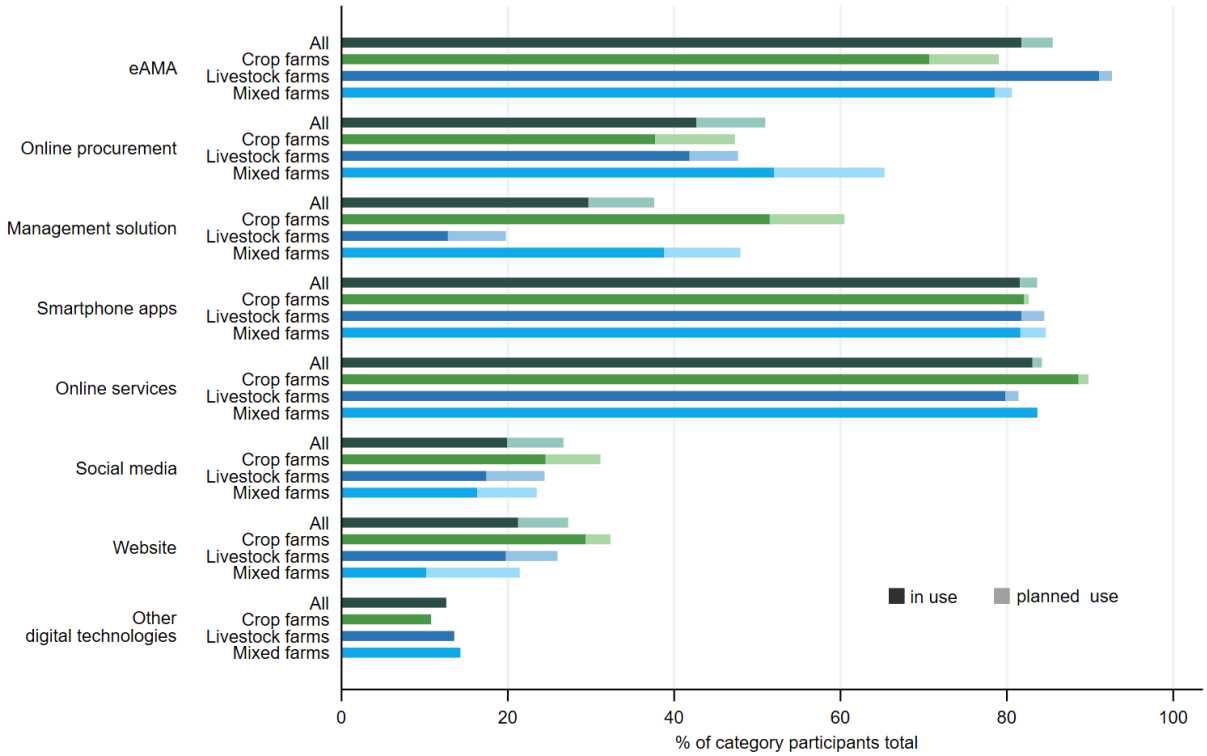
Approximately 43% of farms used online platforms for input or service procurement. About 30% adopted electronic management solutions or electronic field books ("Ackerschlagkartei"). Each 8% of the responding farms plan to use online procurement platforms or electronic management solutions in the next years. Each about 20% of the farms established an online or social media[2] presence. Among them, around 25% leveraged these platforms not only for visibility but also as booking or shopping portals as did about half of those maintaining an own website. Many Austrian farms are providing "Holiday on Farm" services or direct sales of their products and some of them combine such activities. 7% and 6% of the respondents respectively intend to establish an online or social media presence in the future[3].

[1] On the website eAMA, farmers and companies can manage process applications, notifications, queries, and other administrative processes electronically.

[2] Mostly Facebook or Instagram.

[3] In Annex III, a detailed overview of the implementation time of the various digital farming technologies is provided.

Figure 1: Use of general digital farming technologies

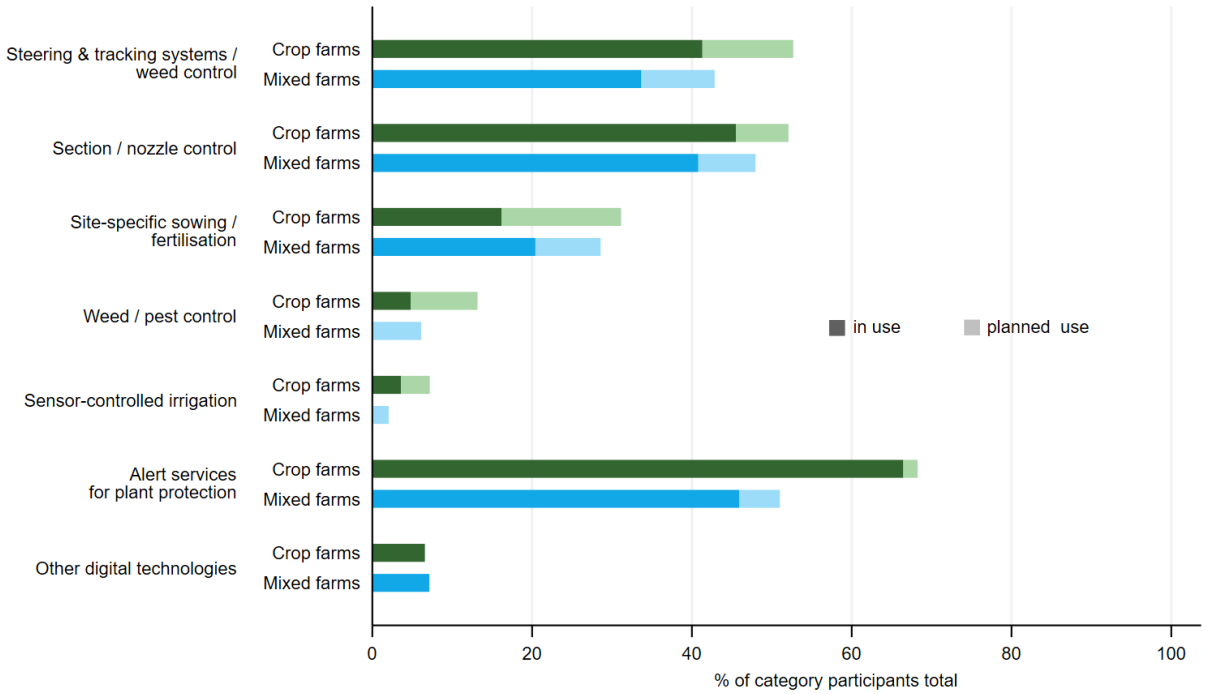


Source: own illustration. – Other digital technologies: no requested information on planned use.

Use of specific digital solutions for crop or livestock farming is generally lower than of general digital farming technologies. While 95% of all farms reportedly use at least one general digital farming solution, only four fifth engaging in crop farming and only half of those engaging in livestock farming use at least one specific technology.

With respect to digital technologies specific for crop production, alert services for plant protection are most frequently used so far (by 67% of crop farms and 46% of mixed farms; see Figure 2). Part-width section control or individual nozzle control have been adopted by 46% of the crop farms and 41% of the mixed farms. 41% of the crop farms and 34% of the mixed farms use steering and tracking systems or weed control equipment. This technology experienced a continuous increase in adoption in recent years, another 11% of crop farms and 9% of mixed farms plan its implementation. Site-specific sowing and/or fertilisation has been implemented by 16% of the crop farms and even one fifth of the mixed farms. Also for this technology, the use gradually increased over the past years; another 15% of crop farms and 8% of the mixed farms report plan to use it in the future. Autonomous weed and/or pest control as well as sensor-controlled irrigation are rarely used (5% and 4% respectively for crop farms; no implementation in mixed farms). Yet, 8% of the crop farms plan to use autonomous weed and/or pest control in the next years.

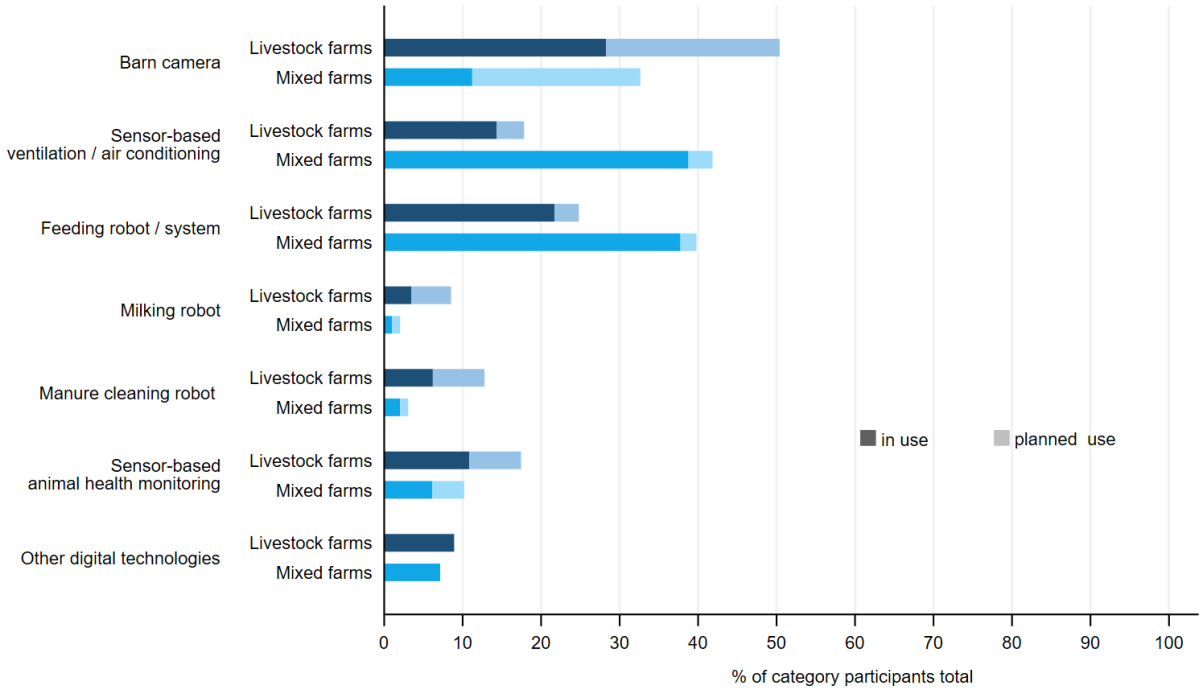
Figure 2: Use of digital crop farming technologies



Source: own illustration. – Other digital technologies: no requested information on planned use.

With respect to livestock farming, barn cameras are the most relevant digital technology (Figure 3). Currently, 28% of livestock farms have already installed a barn camera, another 22% plan their implementation. The second-most relevant technology comprise feeding robots or digital feeding systems that are employed by 22% of livestock farms. Sensor-based ventilation and/or air-conditioning as well as sensor-based animal health monitoring have been adopted by 14% and 11% of the livestock farms respectively; an additional 7% plans to use sensor-based animal health monitoring in the future. Milking robots or manure cleaning robots have only been implemented by 3% and 6% of livestock farms respectively. However, for both technologies another 5% and respectively 7% of the farms plan adoption. Mixed farms differ considerably from mere livestock farms in terms of technology implementation: Sensor-based ventilation/air-conditioning and/or feeding robots/digitally controlled feeding systems are already used by almost 40% of the mixed farms. Although stable cameras have only been adopted by 11% of the mixed farms, another 21% plan their implementation.

Figure 3: Use of digital livestock farming technologies



Source: own illustration. – Other digital technologies: no requested information on planned use.

4.2 Costs of digital tools

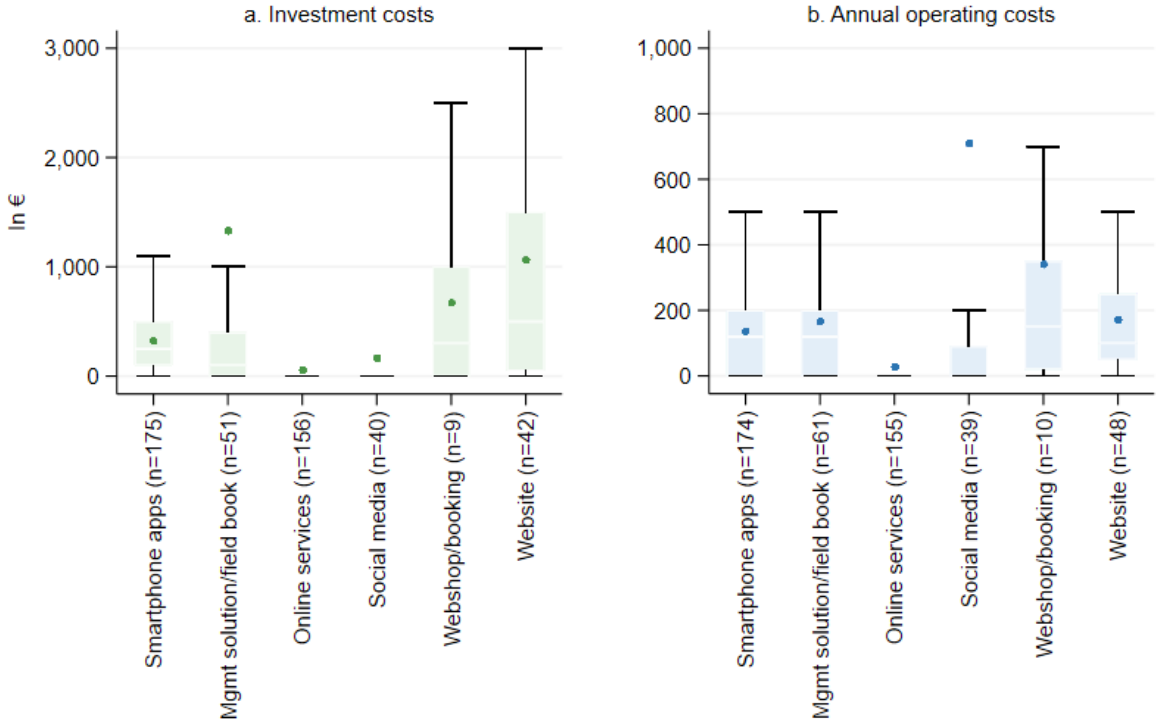
In the following section, the investment and annual operating costs are described for the three categories of technologies: general digital technologies, digital technologies for crop farming, and digital technologies for livestock farming. For the specific technologies, reported costs were normalised by farms' standard output to ensure comparability, since their costs might differ with the size of the farm[4]. Due to the skewed distribution of the reported investment and maintenance costs and the presence of clear outliers for most technologies, median values are reported.

The investment costs of general digital farming technologies are moderate (Figure 4a). For online services and social media, the median reported acquisition costs are 0. For electronic management solutions or field books, the corresponding costs are 100 €, these costs also exhibit a stronger variation compared to those of online services and social media. Smartphone applications, web shops and websites are characterised by comparably higher investment costs, with medians ranging between 250 and 500 €. Particularly with respect to web shops and websites, also a higher spread in costs becomes apparent.

[4] The standard output refers to "the average monetary value of the agricultural output at farm-gate price" (Eurostat, 2023). Small farms with a standard output below € 5,000 were excluded.

Figure 4b shows that operating costs are lowest for online services and social media (with a median of zero). For the other technologies, the median of reported operating costs ranges between 100 € (websites) and 150 € per annum (web shops).

Figure 4: Investment costs and annual operating costs of general digital farming technologies

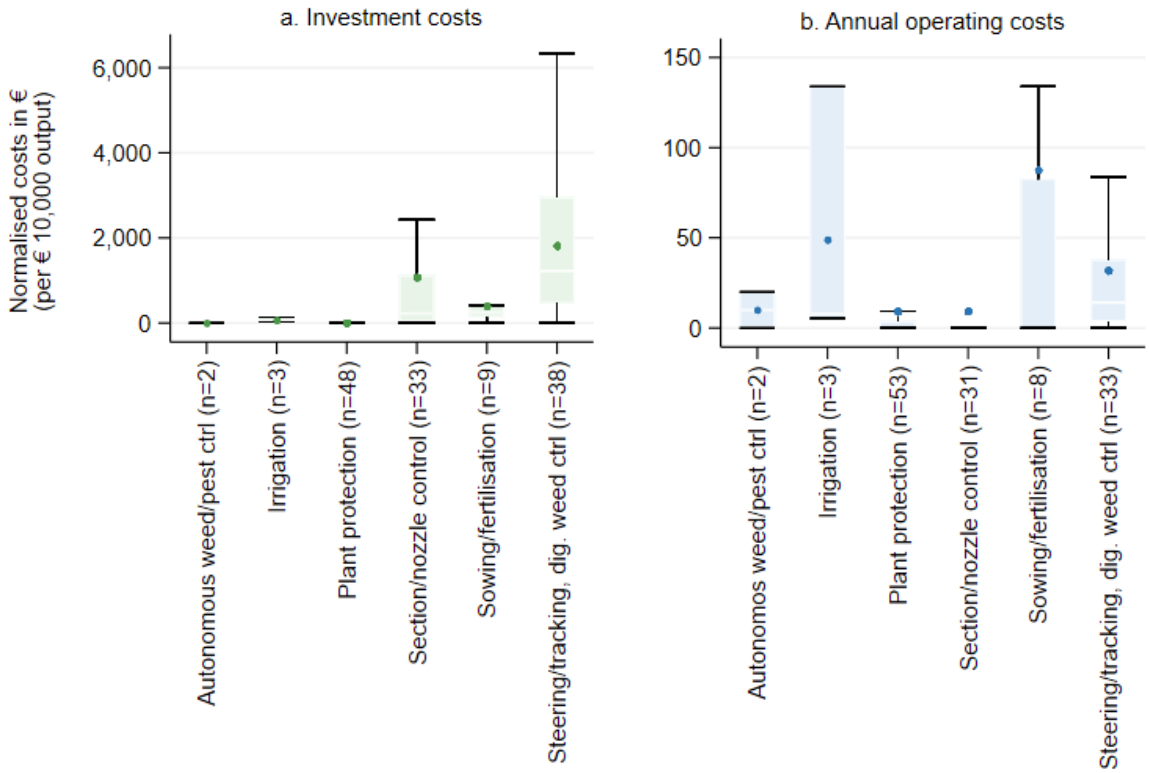


Source: own illustration.

For digital technologies specific to crop farming, the median reported investment costs tend to be higher than those of the general digital solutions, with the exception of warning services for plant protection showing a median of 0. Also for autonomous weed/pest control zero costs were reported, but information on costs was provided by two respondents only (see Figure 5a). With a median of 1,220 € per 10,000 € of standard output, the highest reported investment costs showed for steering and tracking systems or digital weed control; for part-width section control or individual nozzle control and site-specific sowing and/or fertilisation the median investment costs were 2155 € and 250 € per 10,000 € of standard output, respectively.

Median reported annual operating costs were 0 for warning services for plant protection, part-width section control or individual nozzle control, as well as for site-specific sowing and/or fertilisation (Figure 5b). For the other technologies, the median of reported annual operating costs ranged from 8 € (digitally supported irrigation) to 14 € (digital steering and tracking systems or weed control equipment) per 10,000 € standard output.

Figure 5: Investment costs and annual operating costs of digital farming technologies specific to crop farming

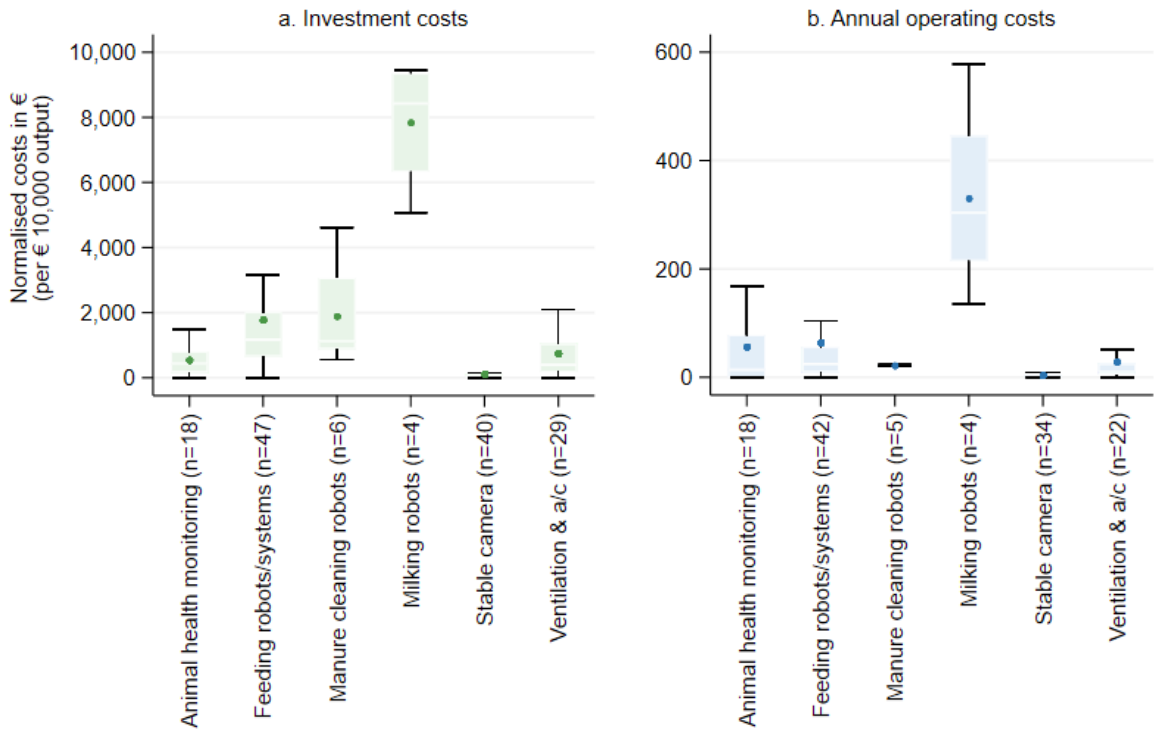


Source: own illustration.

Digital solutions for livestock farming are characterised by the highest upfront costs, both in absolute terms and in relation to farms' standard output. As shown in Figure 6a, barn cameras exhibit the lowest median investment costs (48 € per 10,000 € standard output). The median investment costs for sensor-based ventilation and/or air-conditioning as well as sensor-based animal health monitoring were approximately 400 € per 10,000 € standard output, respectively. For feeding robots or digitally controlled feeding systems and manure cleaning robots, the median reported acquisition costs were between 1,110 and 1,170 € per 10,000 € standard output. With a median of 8,400 €, the highest upfront costs were reported for milking robots.

Annual operating costs were also highest for milking robots (median: 304 € per 10,000 € standard output; see Figure 6b). For barn cameras, median operating costs were zero; for the other technologies, they ranged between 10 € (sensor-based ventilation and/or air-conditioning) and 24 € (feeding robots or digitally controlled feeding systems) per 10,000 € standard output.

Figure 6: Investment costs and annual operating costs of digital farming technologies specific to livestock farming

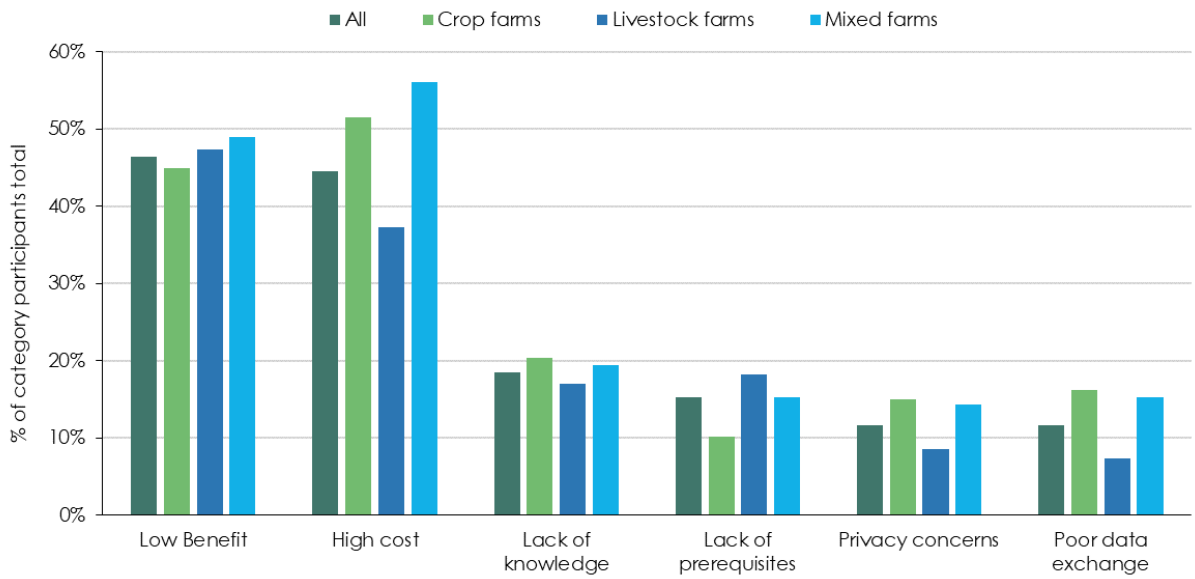


Source: own illustration.

4.3 Barriers to digitalisation in agriculture

Perceived high costs and low benefits emerged as the primary barriers to the implementation of digital technologies, both for crop and livestock farms (Figure 7). Across all farm types, 58% rated high costs and 45% rated low benefits as a barrier. A lack of knowledge was reported an obstacle by 18% of the farms. 15% of farms identified implementation problems due to a lack of requirements (such as a sluggish internet connection); data protection concerns and limited options for data exchange between individual applications were reported by 15% each. In the context of crop farms, barriers related to high costs, lack of knowledge, data security and inter-connectivity were reported more frequently compared to livestock farms. The opposite was true for the obstacles of insufficient requirements and low benefits.

Figure 7: Barriers for the implementation of digital technologies

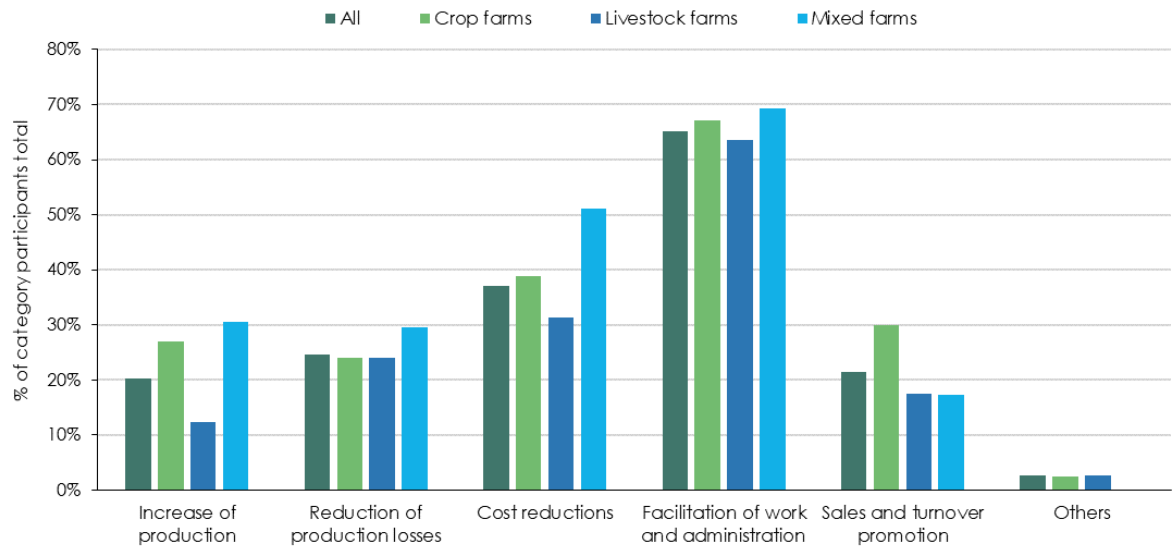


Source: own illustration. Multiple responses were possible.

4.4 Benefits of digitalisation in agriculture

With respect to general digital farming technologies, 65% of all farms in the survey indicate that these general digital solutions for farming would ease work and administrative tasks, and 37% of all farms view them as potential cost-saving measures. Furthermore, these technologies are perceived to play a role in mitigating production losses (25%), boosting sales (21%), and increasing production (20%). The ranking of the reported benefits resembles for crop, livestock and mixed farms.

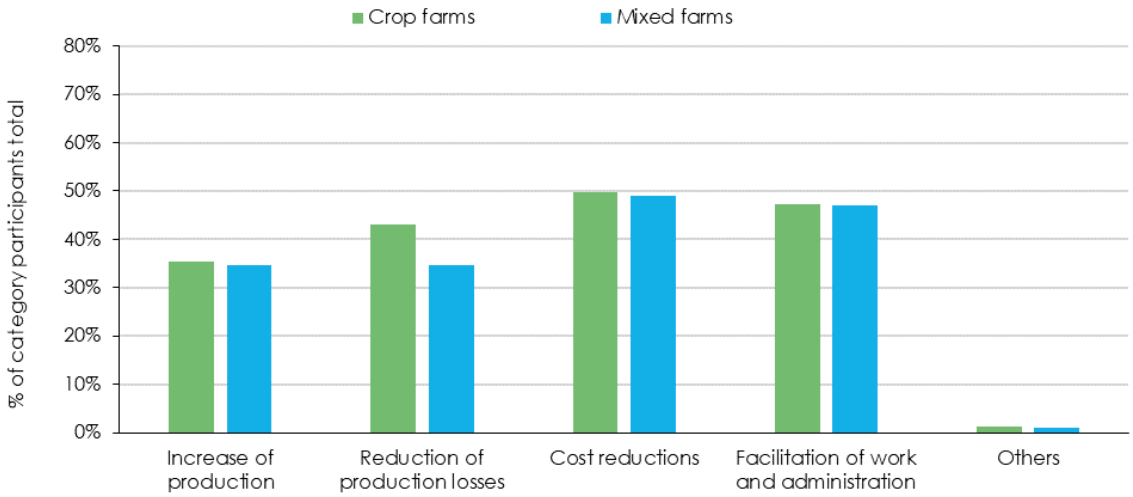
Figure 8: Benefits of general digital technologies in agriculture



Source: own illustration. Multiple responses were possible.

Regarding digital solutions specific to crop farming, the most frequently benefit reported by crop farmers were cost reductions (50%), followed by the facilitation of work and administration (47%), and reductions of production losses (43%; see Figure 9). Production increases were reported by 35%. These perceptions resemble for crop farms and mixed farms; only the category "reductions of production losses" is considered somewhat less relevant by mixed enterprises (35% instead of 43%).

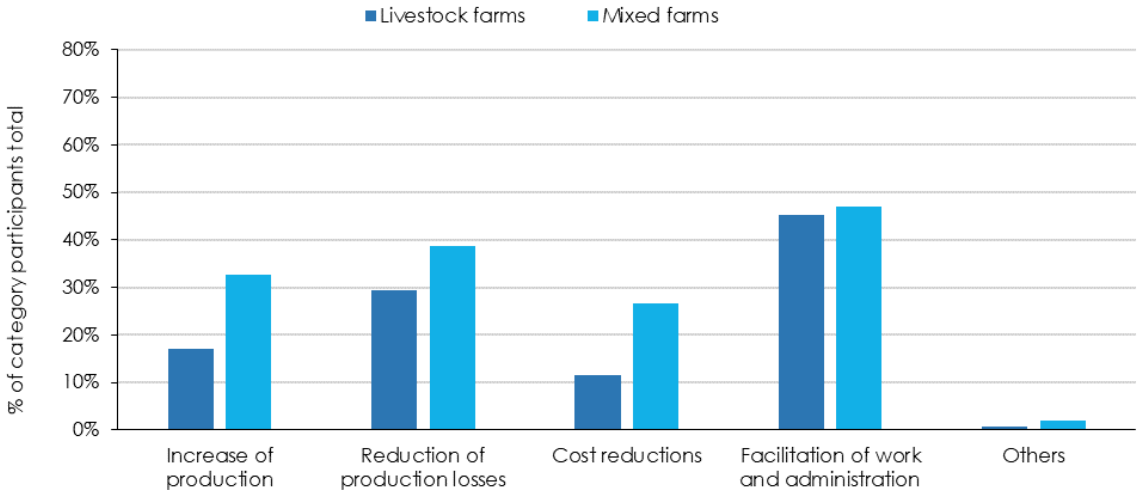
Figure 9: Benefits of digital technologies specific to crop farming



Source: own illustration. Multiple responses were possible.

For digital technologies specific to livestock farming, facilitation of work and administration was the most frequently reported benefit (45% of livestock and 47% of mixed farmers; Figure 10). Reductions of production losses were considered as benefit by 29% and increased production by 17% of livestock farmers, whereas cost reductions were reported by only 12%. Mixed farms perceived considerably higher benefits in terms of reduced production losses (39%), production gains (33%) and cost reductions (27%) than pure livestock farms.

Figure 10: Benefits of digital technologies specific to livestock farming



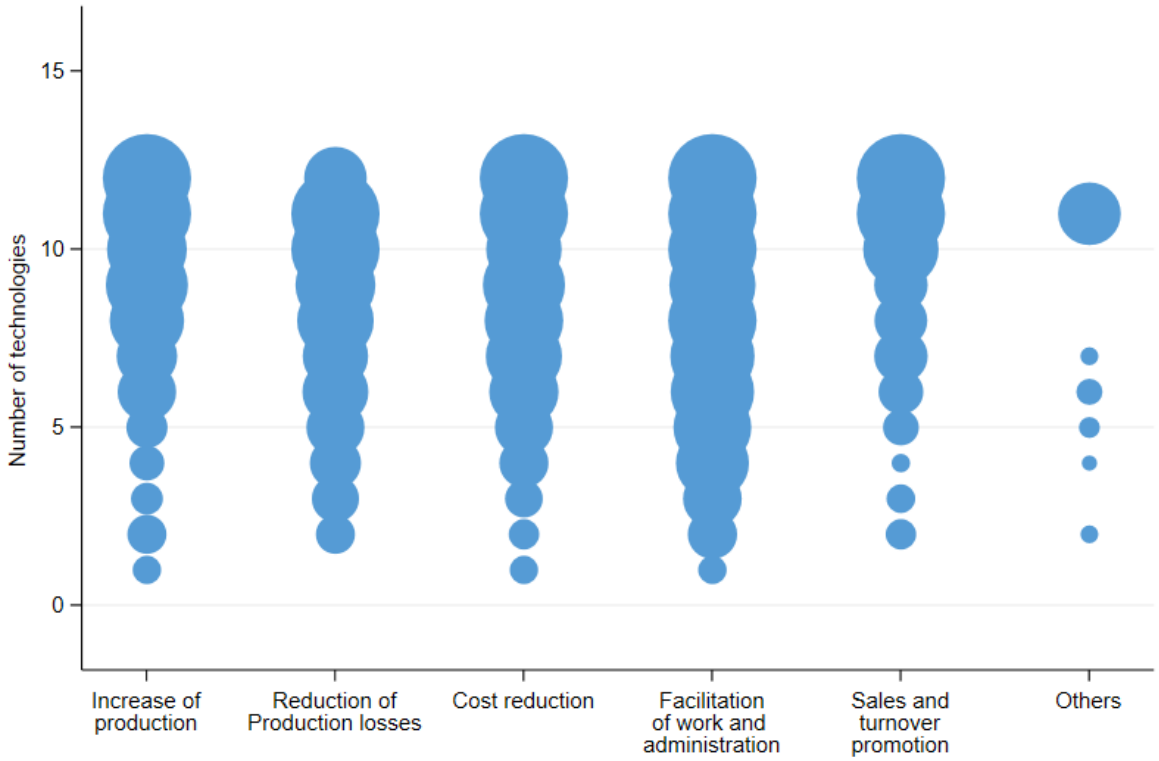
Source: own illustration. Multiple responses were possible.

The literature on Industry 4.0 and automation emphasises the importance of using digital tools throughout the production process to enable multiple machines and technologies to connect and interact (Fatorachian and Kazemi (2018), Sony and Naik (2020), Ghobakhloo and Iranmanesh (2021)). Connectivity between machines and technologies results in a significant increase in efficiency, leading to faster and more efficient task completion, ultimately driving substantial productivity improvements. On the contrary, digital interactions among numerous machines or technologies during the production process can significantly minimise errors. The ability of machines to communicate and share information with each other facilitates error reduction and enhances work quality. Additionally, the implementation of various digital technologies and tools promotes the scalability of a firm. By digitally connecting various components of the production environment, the firm can expand its operations more effortlessly. The same principle applies to farms – as the farm expands, additional machines can be employed to handle the extra workload.

In summary, the cooperative capacity of several digital machines can enhance a farm's digitalisation process to reach its full potential. This facilitates a more efficient and effective approach to working, enhances work quality and ensures greater scalability. The survey provides no information on the connectedness of the technologies used, however, Figure 11 illustrates the correlation between the number of technologies implemented by farmers and the

frequency of benefits reported from digitalisation. The findings suggest that the adoption of various technologies has a positive impact on the benefits for farmers' production processes. The greater the use of technologies, the more frequently farmers claim to reap rewards from implementing digital tools. This relation is particularly pronounced in the area of production and sales growth as well as cost reduction. All aspects directly affecting the productivity of farmers. This aligns with the theory that the productivity-enhancing effects of digitalisation can only be fully realised through digitalisation of the entire production process.

Figure 11: The number of benefits and the number of technologies used



Source: own illustration.

5. Summary and Conclusions

In this paper, we present a comprehensive analysis of the utilisation of digital technologies within the Austrian farming sector. The analysis is based on an extensive survey conducted among more than 500 farmers in 2022. The results indicate that different farms and different farm types are adopting these new technologies at different paces. This is not surprising as in many cases investments in digital technologies are very expensive and investment cycles in agriculture are relatively long.

General digital farming technologies so far show considerably higher adoption rates than specific technologies for crop or livestock farming. This holds particularly true for eAMA, representing a form of e-government, but also for smart phone apps and online services. Digital crop

farming technologies were implemented by a higher share of farms than digital livestock technologies, which might also be attributed to relatively higher costs of the latter. In particular, digital steering and tracking systems or weed control equipment and site-specific sowing and/or fertilisation show increased implementation in recent years. This reflects that the Real Time Kinematic (RKT) signal was made available free of charge, which ensures a very high accuracy and permanent reproducibility of positions essential for precision farming.

With respect to digital crop farming technologies specialised farms show higher adoption rates compared to mixed farms; with respect to livestock farming differences in adoption rates are less clear-cut.

The highest barriers for the adoption of digital farming technologies lie in (expected) low benefits and concerns about high costs, while the benefits are found in the facilitation of administrative work as well as in cost reduction.

Farm policy is supporting widespread use and new investments in digital farming. Making farmers more productive is an important objective. By providing complementary services like training, research, and infrastructure such as RTK signals the cost for adopting these new technologies are lowered for farmers. However, due to the high cost of many digital technologies the widespread adoption in Austria is hampered. It might therefore be expected that precision farming technologies, such as variable rate fertilisation and seeding, will be adopted more eagerly than others because specialised firms offering machinery services have better market opportunities in crop production regions compared to areas focussing on livestock production. These companies offer services that are too expensive for individual farmers to afford. By purchasing these precision farming services farmers can nevertheless reap the benefits of digitalisation.

An important aspect not covered by the survey is the expectation that digital technologies yield public benefits by reducing nutrient losses and the need for synthetic plant protection services. Farmers can compare the potential monetary savings from the reduced use of fertilisers and plant protection substances with the additional effort related to the implementation of smart farming practices. The farmers' valuation of potential environmental benefits depends on their environmental attitudes.

From an environmental policy perspective, one should be aware that precision farming may entail more benefits to the general public than to the farmers who apply them. It is therefore important to conduct further research on these topics because site- and region-specific aspects may vary, and information obtained from international literature may not be transferable to Austria.

Annex I. Detailed Literature Review

Table 2: Detailed Literature Review on digitalisation in agriculture

Author(s)	Method	Region(s)	Content
Ammann, J., Umstätter, C., & El Benni, N. (2022)	Delphi survey (n= approx. 25 experts)	CH	Overview of methods and technologies used in outdoor vegetable production.
Ammann, J., Walter, A., & El Benni, N. (2022)	Online survey (n=150 of which 41 teachers and 109 students of a farm management vocational programme)	CH	Overview of methods and technologies used in agriculture and approaches to assess future use.
Barnes, A. P., Soto, I., Eory, V., Beck, B., Balafoutis, A., Sánchez, B., Vangeyte, J., Fountas, S., van der Wal, T., & Gómez-Barbero, M. (2019)	Interviews in person or by telephone (varies per country 134 to 200 farmers)	BE, GR, UK, NL, DE	General overview of methods and technologies used in agriculture in a multi-country comparison.
Block, J., Michels, M., & Mußhoff, O. (2021)	Online survey (n=161 farmers)	DE	The way smartphones are used for risk management.
Bovensiepen, G., Hombach, R., & Raimund, St. (2016)	Survey (n=100 farmers)	DE	Little specific presentation of digitisation.
Drescher, L., Zeller, H., Eisenmann, M., & Daude, S. (2022)	Online survey (n1= 8 farmers who actively pursue PR for (their own) agriculture on social media n2= 5 farmers with social media presences)	DE Bavaria	Approaches and working methods of people who are present on social media.
Ehlers, M.-H., Huber, R., & Finger, R. (2021)	Delphi survey (n=? experts)	Europe	Outlook on the development of digitalisation in Europe.
Gabriel, A., & Gandorfer, M. (2000)	Online survey (n=2,390 farmers)	DE Bavaria	General overview of methods and technologies used in agriculture.
Gabriel, A., Gandorfer, M., & Spykman, O. (2021)	Online survey (n=591 farmers)	DE	General overview of methods and technologies used in agriculture.
Groher, T., Heitkämper, K., & Umstätter, C. (2020)	Questionnaire (n=1,497 farmers)	CH	Overview of different digital methods and technologies used in animal husbandry and the characteristics of the farms.
Groher, T., Heitkämper, K., & Umstätter, C. (2020)	Questionnaire (n=2,657 Farmers)	CH	Overview of different methods and technologies used in agriculture and the characteristics of farms.
Groher, T., Heitkämper, K., Stark, R., & Umstätter, C. (2020)	Written questionnaires (n=2,900 farmers)	CH	Technologies used in the dairy industry in great detail.
Groher, T., Heitkämper, K., Walter, A., Liebisch, F., & Umstätter, C. (2020)	Questionnaire (n=827 farmers)	CH	Overview of different precision farming methods and technologies used in agriculture and the characteristics of farms.
Grothkopf, C., & Schulze, H. (eds.). (2021)	Survey (n=156 dairy farmers)	DE	Overview of different precision farming methods and technologies used in agriculture and the characteristics of farms.

Gscheidle, M. (2022)	Written survey (n=329 agricultural training enterprises and agricultural cooperatives)	DE	General overview of methods and technologies used in agriculture and assessment of structural change.
Kühl, J., Reckleben, Y., & Schulze, H. (2021)	In-depth interviews (n=30 farmers)	DE	How are digital technologies used on the farm and what are the barriers?
Langer, G., & Schukat, S. (2022)	Survey (n=193 dairy farmers)	DE	Overview of different digital methods and technologies used in the dairy industry and the characteristics of the farms.
Mayr, J. (2021)	Telephone survey (n=1,010 farmers)	AT	Attitudes towards new (digital) technologies and need for training
Michels, M., Fecke, W., Ahlefeld, P. J. W. von, Mußhoff, O., Heckmann, A., & Beneke, F. (2019)	Online survey (n=97 Farmers)	DE	Willingness to pay for tuition.
Michels, M., Fecke, W., Feil, J.-H., Mußhoff, O., Pigisch, J., & Krone, S. (Eds.). (2019)	Online and telephone-based survey (n= 829 farmers)	DE	General overview of the use of the internet in agriculture.
Michels, M., Weller von Ahlefeld, P. J., & Mußhoff, O. (Eds.). (2019)	Online survey (n=134 contractors)	DE	Suitability of navigation systems for agricultural machinery use.
Paustian, M., & Theuvsen, L. (2017)	Online questionnaire (n=277 farmers)	DE	Overview of methods and technologies used in crop production and assessment in terms of farm characteristics.
Recke, G., Janßen, M., & Albers, A. (2020)	Online survey (n=1,041 consumers)	DE	Demand for online shopping offered by farmers.
Reichardt, M., & Jürgens, C. (2009)	Interviews (n=201 teachers, counsellors, industry representatives)		General overview of precision farming used in agriculture.
Roosen, J. (2017)	Interviews (n1=92 female and male farmers, n2= 10 female experts)	DE	General overview of methods and technologies used in agriculture.
Schulze Schwering, D., & Lemken, D. (2020)	Online survey n=285 farmers)	DE	Use of digital farm management systems in agriculture.
Schulze Schwering, D., & Spiller, A. (2019)	Online survey (n=371 farmers)	DE	Suitability of online shops for agriculture.
Sonntag, D. W. I., Wienrich, N., Severin, D. M., & Schwering, D. D. S. (2022)	Online survey (n= 279 farmers)	DE	Expected benefits and socio-economic factors of the use of precision farming methods.
von Hobe, C.-F., Michels, M., Fecke, W., Mußhoff, O., & Weller von Ahlefeld, P. J. (2019)	Online survey (n=168 farmers)	DE	Comparison of personal and digital communication.
Waltmann, M., Gindele, N., & Doluschitz, R. (2019)	Interviews (n=9 experts)	DE	Assessment of the advantages and shortcomings of digital methods in agriculture.
Westermann, J. (2022)	Online survey (n=151 farmers)	DE	Measurement of the degree of digitisation.

Annex II. Questionnaire

Digitalisation and Austrian agriculture

LBG Austria and the Austrian Institute of Economic Research (WIFO) are investigating the experiences made by farmers in Austrian with digital appliances in various areas of production and marketing. The research project is funded by the Austrian National Bank (OeNB).

Please take part in this survey even if your operation has hardly any experience with digital applications. Also in this case, your answers are very important. The aim is to find out how great the benefits of digitalisation actually are in practice.

Participation in this survey is voluntary. Your details will be treated as strictly confidential and will not be passed on to third parties under any circumstances.

Please direct any queries to Franz Sinabell (franz.sinabell@wifo.ac.at or 01-7982601-481)

WIFO ÖSTERREICHISCHES INSTITUT FÜR WIRTSCHAFTSFORSCHUNG

LBG Österreich
Steuerberatung • Wirtschaftsprüfung • Consulting

Production process

Please select all that apply:

□ My farm is involved in arable farming, fruit growing, vegetable growing or viticulture.
□ I keep animals for meat, milk or egg production.
□ Other production focus:

Management, purchasing and sales

Which digital solutions do you use or plan to use?

1. Do you use eAMA (e.g., online registration of areas, RinderNET, etc.)?

Please select only one of the following answers:

□ Yes

□ Not at present, use is planned

□ No or not relevant

I have been using it since:

Answer this question only if the following conditions are met: Answer was 'Yes' to question '3 [F01]'. (1. Do you use eAMA (e.g., online registration of areas, RinderNET, etc.)?

Please select only one of the following answers:

□ Before 2017
□ 2017
□ 2018
□ 2019
□ 2020
□ 2021
□ 2022

I plan to use it:

Answer this question only if the following conditions are met: Answer was 'currently not, use is planned' for question '3 [F01]'. (1. Do you use eAMA (e.g., online registration of areas, RinderNET, etc.)?

Please select only one of the following answers:

□ 2022
□ 2023
□ 2024
□ Later than 2024

2. Do you purchase inputs and/or services online?

Please select only one of the following answers:

□ Yes
□ Not at present, use is planned
□ No or not relevant

I have been using it since:

Answer this question only if the following conditions are met: Answer was 'Yes' to question '6 [F09]'. (2. Do you purchase inputs and/or services online?)

Please select only one of the following answers:

□ Before 2017
□ 2017
□ 2018
□ 2019
□ 2020
□ 2021
□ 2022

I plan to use it:

Answer this question only if the following conditions are met:

Answer was 'currently not, use is planned' for question '6 [F09]'. (2. Do you purchase inputs and/or services online?)
Please select only one of the following answers:

□ 2022
□ 2023
□ 2024
□ Later than 2024

3. Do you use a farm management solution and/or a digital field book (e.g., LBG Agrar, LBG Bodenwächter, LBG Feldplaner, etc.)?

Please select only one of the following answers:

□ Yes
□ Not at present, use is planned
□ No or not relevant

I have been using it since:

Answer this question only if the following conditions are met:

Answer was 'Yes' to question '9 [F03]'. (3. Do you use a farm management solution and/or a digital field index (e.g., LBG Agrar, LBG Bodenwächter, LBG Feldplaner, etc.)?
Please select only one of the following answers:

□ Before 2017
□ 2017
□ 2018
□ 2019
□ 2020
□ 2021
□ 2022

I plan to use it:

Answer this question only if the following conditions are met:

Answer was 'currently not, use is planned' for question '9 [F03]'. (3. Do you use a farm management solution and/or a digital field database (e.g., LBG Agrar, LBG Bodenwächter, LBG Feldplaner, etc.)?
Please select only one of the following answers:

□ 2022
□ 2023
□ 2024
□ Later than 2024

4. Do you use smartphone apps for operations (e.g., for weather, prices, newsletters, warning services, etc.)?

Please select only one of the following answers:

□ Yes
□ Not at present, use is planned
□ No or not relevant

I have been using it since:

Answer this question only if the following conditions are met:

Answer was 'Yes' for question '12 [F06]'. (4. Do you use smartphone apps for operations (e.g., for weather, prices, newsletters, alert services, etc.)?

Please select only one of the following answers:

□ Before 2017
□ 2017
□ 2018
□ 2019
□ 2020
□ 2021
□ 2022

I plan to use it:

Answer this question only if the following conditions are met:

Answer was 'currently not, use is planned' at question '12 [F06]'. (4. Do you use smartphone apps for operations (e.g., for weather, prices, newsletters, alert services, etc.)?

Please select only one of the following answers:

□ 2022
□ 2023
□ 2024
□ Later than 2024

5. Do you use weather services, price information, newsletters or similar on your tablet or PC?

Please select only one of the following answers:

□ Yes
□ Not at present, use is planned
□ No or not relevant

I have been using it since:

Answer this question only if the following conditions are met:

Answer was 'Yes' to question '15 [F12]'. (5. Do you use weather services, price information, newsletters or similar on the tablet or PC?)

Please select only one of the following answers:

□ Before 2017
□ 2017
□ 2018
□ 2019
□ 2020
□ 2021

□ 2022

I plan to use it:

Answer this question only if the following conditions are met:

Answer was 'not at present, use is planned' for question '15 [F12]'. (5. Do you use weather services, price information, newsletters or similar on the tablet or PC?)

Please select only one of the following answers:

□ 2022
□ 2023
□ 2024
□ Later than 2024

6. Does your business have a presence on social media (e.g., Facebook)?

Please select only one of the following answers:

□ Yes
□ Not at present, use is planned
□ No or not relevant

I use the following platforms:

Answer this question only if the following conditions are met:

Answer was 'Yes' to question '18 [F18]'. (6. Does your business have a presence on social media (e.g., Facebook)?)

Please select the answers that apply:

□ Facebook
□ Instagram
□ Twitter
□ LinkedIn
□ TikTok
□ Other:

I plan to use it:

Answer this question only if the following conditions are met:

Answer was 'currently not, use is planned' for question '18 [F18]'. (6. Does your business have a presence on social media (e.g., Facebook)?)

Please select only one of the following answers:

□ 2022
□ 2023
□ 2024
□ Later than 2024

Do you offer a web shop or booking facilities on social media?

Answer this question only if the following conditions are met:

Answer was 'Yes' to question '18 [F18]'. (6. Does your business have a presence on social media (e.g., Facebook)?)

Please select only one of the following answers:

□ Yes
□ No

7. Does your business have an internet page or website?

Please select only one of the following answers:

□ Yes
□ Not at present, use is planned
□ No or not relevant

I have been using it since:

Answer this question only if the following conditions are met:

Answer was 'Yes' to question '22 [F20]'. (7. Does your business have an internet page or website?)

Please select only one of the following answers:

□ Before 2017
□ 2017
□ 2018
□ 2019
□ 2020
□ 2021
□ 2022

I plan to use it:

Answer this question only if the following conditions are met:

Answer was 'not at present, use is planned' for question '22 [F20]'. (7. Does your business have an Internet page or website?)

Please select only one of the following answers:

□ 2022
□ 2023
□ 2024
□ Later than 2024

Do you offer a web shop or booking facilities on the internet page/website?

Answer this question only if the following conditions are met:

Answer was 'Yes' to question '22 [F20]'. (7. Does your business have an internet page or website?)

Please select only one of the following answers:

□ Yes
□ No

Do you use other digital solutions in management/purchasing/sales that are not listed here?

Please specify the primary use of the applications listed above.

Answer this question only if the following conditions are met:

Scenario 1

Answer was 'Yes' or 'currently not, use is planned' for question '3 [F01]'. (1. Do you use eAMA (e.g., online registration of areas, RinderNET, etc.)?

or Scenario 2

Answer was 'Yes' or 'currently not, use is planned' for question '9 [F03]'. (3. Do you use a farm management solution and/or a digital field index (e.g., LBG Agrar, LBG Bodenwächter, LBG Feldplaner, etc.)?

or Scenario 3

Answer was 'Yes' or 'currently not, use is planned' for question '12 [F06]'. (4. Do you use smartphone apps for operations (e.g., for weather, prices, newsletters, alerts, etc.)?)

or Scenario 4

Answer was 'Yes' or 'not currently, use is planned' for question '6 [F09]'. (2. Do you purchase inputs and/or services online?)

or Scenario 5

Answer was 'Yes' or 'not at present, use is planned' for question '15 [F12]'. (5. Do you use weather services, price information, newsletters or similar on the tablet or PC?)

or Scenario 7

Answer was 'Yes' or 'not currently, use is planned' for question '18 [F18]'. (6. Does your business have a presence on social media (e.g., Facebook)?)

or Scenario 8

Answer was 'Yes' to question '21 [F181]' (Do you offer a web shop or booking facilities on social media?)

Please select all that apply:

□ Production increase
□ More stable production / fewer failures
□ Cost reduction
□ Facilitation of work / administration
□ Sales promotion, turnover promotion, better market positions
□ Other

Are you sure that none of the choices apply? *

Answer this question only if the following conditions are met:

Answer was for question '3 [F01]'. (1. Do you use eAMA (e.g., online area recording, RinderNET, etc.)?) and answer was for question '9 [F03]'. (3. Do you use a farm management solution and/or a digital field index (e.g., LBG Agrar, LBG Bodenwächter, LBG Feldplaner, etc.)? and answer was for question '12 [F06]'? (4. Do you use smartphone apps for the farm (e.g., for weather, prices, newsletters, warning services, etc.)?) and answer was for question '6 [F09]'. (2. Do you purchase inputs and/or services online?) and answer was for question '15 [F12]'. (5. Do you use weather services, price information, newsletters or similar on your tablet or PC?) and the answer was for question '18 [F18]'. (6. Does your business have a presence on social media (e.g., Facebook)?) and answer was for question '26 [F001]'. (Do you use other digital solutions in management/purchasing/sales that are not listed here?) and answer was for question '26 [F001]'. (Do you use other digital solutions in management/purchasing/sales that are not listed here?)

Please select only one of the following answers:

□ Yes

Soil cultivation, cultivation and care

Which digital solutions do you use or plan to use?

1. Do you use steering and tracking systems or digitally controlled weed control equipment?

Please select only one of the following answers:

□ Yes
□ Not at present, use is planned
□ No or not relevant

I have been using it since:

Answer this question only if the following conditions are met:
Answer was 'Yes' to question '29 [F24]' (1. Do you use steering and tracking systems or weed control equipment?)
Please select only one of the following answers:

□ Before 2017
□ 2017
□ 2018
□ 2019
□ 2020
□ 2021
□ 2022

I plan to use it:

Answer this question only if the following conditions are met:
Answer was 'currently not, use is planned' for question '29 [F24]'. (1. Do you use steering and tracking systems or weed control equipment?)
Please select only one of the following answers:

□ 2022
□ 2023
□ 2024
□ Later than 2024

2. Do you use part-width section control or individual nozzle control in crop protection?

Please select only one of the following answers:

□ Yes
□ Not at present, use is planned
□ No or not relevant

I have been using it since:

Answer this question only if the following conditions are met:
Answer was 'Yes' to question '32 [F28]'. (2. Do you use part-width section control or individual nozzle control in crop protection?)
Please select only one of the following answers:

□ Before 2017
□ 2017
□ 2018
□ 2019

□ 2020
□ 2021
□ 2022

I plan to use it:

Answer this question only if the following conditions are met:
Answer was 'currently not, use is planned' for question '32 [F28]'. (2. Do you part-width section control or individual nozzle control in crop protection?)
Please select only one of the following answers:

□ 2022
□ 2023
□ 2024
□ Later than 2024

3. Do you use site-specific sowing and/or fertilisation?

Please select only one of the following answers:

□ Yes
□ Not at present, use is planned
□ No or not relevant

I have been using it since:

Answer this question only if the following conditions are met:
Answer was 'Yes' to question '35 [F32]'. (3. Do you use site-specific seeding and/or fertilisation?)
Please select only one of the following answers:

□ Before 2017
□ 2017
□ 2018
□ 2019
□ 2020
□ 2021
□ 2022

I plan to use it:

Answer this question only if the following conditions are met:
Answer was 'currently not, use is planned' for question '35 [F32]'. (3. Do you use site-specific seeding and/or fertilisation?)
Please select only one of the following answers:

□ 2022
□ 2023
□ 2024
□ Later than 2024

4. Do you use autonomous weed and/or pest control (e.g., drones) or do you use them as a service?

Please select only one of the following answers:

□ Yes
□ Not at present, use is planned
□ No or not relevant

I have been using it since:

Answer this question only if the following conditions are met:

Answer was 'Yes' to question '38 [F36]'. (4. Do you use autonomous weed and/or pest control (e.g., drones) or take them on as a service. in claim?)

Please select only one of the following answers:

□ Before 2017
□ 2017
□ 2018
□ 2019
□ 2020
□ 2021
□ 2022

I plan to use it:

Answer this question only if the following conditions are met:

Answer was 'currently not, use is planned' at question '38 [F36]'. (4. Do you use autonomous weed and/or pest control (e.g., drones) or do you use them as a service?)

Please select only one of the following answers:

□ 2022
□ 2023
□ 2024
□ Later than 2024

5. Do you use sensor-controlled irrigation?

Please select only one of the following answers:

□ Yes
□ Not at present, use is planned
□ No or not relevant

I have been using it since:

Answer this question only if the following conditions are met:

Answer was 'Yes' to question '41 [F40]'. (5. Do you use sensor-controlled irrigation?)

Please select only one of the following answers:

□ Before 2017
□ 2017
□ 2018
□ 2019
□ 2020
□ 2021
□ 2022

I plan to use it:

Answer this question only if the following conditions are met:

Answer was 'currently not, use is planned' at question '41 [F40]'. (5. Do you use sensor-controlled irrigation?)

Please select only one of the following answers:

□ 2022
□ 2023

□ 2024
□ Later than 2024

6. Do you participate in plant protection warning services?

Please select only one of the following answers:

□ Yes
□ Not at present, use is planned
□ No or not relevant

I have been using it since:

Answer this question only if the following conditions are met:

Answer was 'Yes' to question '44 [F80]'. (6. Do you participate in plant protection warning services?)

Please select only one of the following answers:

□ Before 2017
□ 2017
□ 2018
□ 2019
□ 2020
□ 2021
□ 2022

I plan to use it:

Answer this question only if the following conditions are met:

Answer was 'currently not, use is planned' at question '44 [F80]'. (6. Do you participate in plant protection warning services?)

Please select only one of the following answers:

□ 2022
□ 2023
□ 2024
□ Later than 2024

Which digital technologies that are not mentioned here do you use in arable farming, crop production or vegetable/fruit and wine growing?

Please specify the primary use of the applications listed above.

Answer this question only if the following conditions are met:

Scenario 1

Answer was 'not at present, use is planned' or 'Yes' for question '41 [F40]'. (5. Do you use sensor-controlled irrigation?)

or Scenario 2

Answer was 'Yes' or 'not currently, use is planned' for question '29 [F24]'. (1. Do you use steering and tracking systems or chopping control?)

or Scenario 3

Answer was 'Yes' or 'currently not, use is planned' for question '32 [F28]'. (2. Do you use boom section and/or single nozzle control in crop protection?)

or Scenario 4

Answer was 'Yes' or 'currently not, use is planned' for question '35 [F32]'. (3. Do you use site-specific seeding and/or fertilisation?)

or Scenario 5

Answer was 'Yes' or 'currently not, use is planned' for question '38 [F36]'. (4. Do you use autonomous weed and/or pest control (e.g., drones) or do you use them as a service?)

or Scenario 6

Answer was 'Yes' or 'not currently, use is planned' for question '44 [F80]'. (6. Do you participate in plant protection warning services?)

Please select all that apply:

□ Production increase
□ More stable production / fewer failures
□ Cost reduction
□ Facilitation of work / administration
□ Other:

Are you sure that none of the choices apply? *

Answer this question only if the following conditions are met:

Answer was for question '29 [F24]'. (1. Do you use steering and tracking systems or weed control?) and answer was for question '32 [F28]'. (2. Do you use part-width section control or individual nozzle control in crop protection?) and the answer was for question '35 [F32]'. (3. Do you use precision seeding and/or fertilisation?) and the answer was for question '38 [F36]'. (4. Do you use autonomous weed and/or pest control (e.g., drones) or do you use them as a service?) and the answer was for question '41 [F40]'. (5. Do you use sensor-controlled irrigation?) and answer was at question '44 [F80]'. (6. Do you participate in crop protection warning services?) and answer was at question '47 [F44]'. (Which digital technologies not mentioned here do you use in arable farming, crop production or vegetable/fruit/vine growing?)

Please select only one of the following answers:

□ Yes

Animal husbandry

Which digital solutions do you use or plan to use?

1. Do you use a barn camera?

Please select only one of the following answers:

□ Yes
□ Not at present, use is planned
□ No or not relevant

I have been using it since:

Answer this question only if the following conditions are met:

Answer was 'Yes' to question '50 [F45]' (1. Do you use a barn camera?)

Please select only one of the following answers:

□ Before 2017
□ 2017
□ 2018
□ 2019
□ 2020
□ 2021
□ 2022

I plan to use it:

Answer this question only if the following conditions are met:

Answer was 'currently not, use is planned' for question '50 [F45]'. (1. Do you use a barn camera?)

Please select only one of the following answers:

□ 2022
□ 2023
□ 2024
□ Later than 2024

2. Does your barn have sensor-controlled ventilation and/or air conditioning (incl. spray cooling, floor heating)?

Please select only one of the following answers:

□ Yes
□ Not at present, use is planned
□ No or not relevant

I have been using it since:

Answer this question only if the following conditions are met:

Answer was 'Yes' to question '53 [F49]'. (2. Does your barn have sensor-controlled ventilation and/or air conditioning (incl. spray cooling, floor heating)?)

Please select only one of the following answers:

□ Before 2017
□ 2017
□ 2018
□ 2019
□ 2020
□ 2021
□ 2022

I plan to use it:

Answer this question only if the following conditions are met:

Answer was 'currently not, use is planned' at question '53 [F49]'. (2. Does your barn have sensor-controlled ventilation and/or air conditioning (incl. spray cooling, floor heating)?)

Please select only one of the following answers:

□ 2022
□ 2023
□ 2024
□ Later than 2024

3. Do you use a feeding robot or a digitally controlled feeding system?

Please select only one of the following answers:

□ Yes
□ Not at present, use is planned
□ No or not relevant

I have been using it since:

Answer this question only if the following conditions are met:

Answer was 'Yes' to question '56 [F53]'. (3. Do you use a feeding robot or a digitally controlled feeding system?)

Please select only one of the following answers:

□ Before 2017
□ 2017
□ 2018
□ 2019
□ 2020
□ 2021
□ 2022

I plan to use it:

Answer this question only if the following conditions are met:

Answer was 'currently not, use is planned' at question '56 [F53]'. (3. Do you use a feeding robot or a digitally controlled feeding system?)

Please select only one of the following answers:

□ 2022
□ 2023
□ 2024
□ Later than 2024

4. Do you use a milking robot?

Please select only one of the following answers:

□ Yes
□ Not at present, use is planned
□ No or not relevant

I have been using it since:

Answer this question only if the following conditions are met:

Answer was 'Yes' to question '59 [F57]'. (4. Do you use a milking robot?)

Please select only one of the following answers:

□ Before 2017
□ 2017
□ 2018
□ 2019
□ 2020
□ 2021
□ 2022

I plan to use it:

Answer this question only if the following conditions are met:

Answer was 'currently not, use is planned' at question '59 [F57]'. (4. Do you use a milking robot?)

Please select only one of the following answers:

□ 2022
□ 2023
□ 2024
□ Later than 2024

5. Do you use a robot for manure cleaning and/or cleaning machine?

Please select only one of the following answers:

□ Yes
□ Not at present, use is planned
□ No or not relevant

I have been using it since:

Answer this question only if the following conditions are met:

Answer was 'Yes' to question '62 [F61]'. (5. Do you use a robot for manure cleaning and/or cleaning crevices?)

Please select only one of the following answers:

□ Before 2017
□ 2017
□ 2018
□ 2019
□ 2020
□ 2021
□ 2022

I plan to use it:

Answer this question only if the following conditions are met:

Answer was 'currently not, use is planned' at question '62 [F61]'. (5. Do you use a robot for manure cleaning and/or cleaning crevices?)

Please select only one of the following answers:

□ 2022
□ 2023
□ 2024
□ Later than 2024

6. Do you monitor animal health with sensors?

Please select only one of the following answers:

□ Yes
□ Not at present, use is planned
□ No or not relevant

I have been using it since:

Answer this question only if the following conditions are met:

Answer was 'Yes' to question '65 [F65]'. (6. Do you monitor animal health with sensors?)

Please select only one of the following answers:

□ Before 2017
□ 2017
□ 2018
□ 2019
□ 2020
□ 2021
□ 2022

I plan to use it:

Answer this question only if the following conditions are met:

Answer was 'currently not, use is planned' for question '65 [F65]'. (6. Do you monitor animal health with sensors?)

Please select only one of the following answers:

□ 2022
□ 2023
□ 2024

□ Later than 2024

What other digital technologies, not mentioned here, do you use in animal husbandry?

Please specify the primary use of the applications listed above.

Answer this question only if the following conditions are met:

Scenario 1

Answer was 'currently not, use is planned' or 'Yes' for question '65 [F65]'. (6. Do you monitor animal health with sensors?)

or Scenario 2

Answer was 'Yes' or 'not at present, use is planned' for question '50 [F45]'. (1. Do you use a barn camera?)

or Scenario 3

Answer was 'Yes' or 'not currently, use is planned' for question '53 [F49]'. (2. Does your barn have sensor-controlled ventilation and/or air conditioning (incl. spray cooling, floor heating)?)

or Scenario 4

Answer was 'Yes' or 'currently not, use is planned' for question '56 [F53]'. (3. Do you use a feeding robot or a digitally controlled feeding system?)

or Scenario 5

Answer was 'Yes' or 'not at present, use is planned' for question '59 [F57]'. (4. Do you use a milking robot?)

or Scenario 6

Answer was 'Yes' or 'currently not, use is planned' for question '62 [F61]'. (5. Do you use a robot for manure cleaning and/or cleaning crevices?)

Please select all that apply:

□ Production increase
□ More stable production / fewer failures
□ Cost reduction
□ Facilitation of work / administration
□ Other:

Are you sure that none of the choices apply? *

Answer this question only if the following conditions are met:

Answer was for question '50 [F45]'. (1. Do you use a barn camera?) and answer was for question '53 [F49]'. (2. Does your barn have sensor-controlled ventilation and/or air conditioning (incl. spray cooling, floor heating)?) and answer was for question '56 [F53]'. (3. Do you use a feeding robot or a digitally controlled feeding system?) and answer was for question '59 [F57]'. (4. Do you use a milking robot?) and answer was for question '62 [F61]'. (5. Do you use a robot for manure cleaning and/or cleaning crevices?) and answer was for question '65 [F65]'. (6. Do you monitor animal health with sensors?) and answer was at question '68 [F69]'. (What other digital technologies, not mentioned here, do you use in animal husbandry?)

Please select only one of the following answers:

□ Yes

Costs of digital applications

You have indicated that you use the digital solutions listed below. Please indicate the acquisition costs and/or running costs. If you use digital applications via the machinery ring/service provider, please indicate the estimated annual additional costs under running costs

Acquisition and/or running costs of farm management solutions and/or digital farmland registers

Answer this question only if the following conditions are met:

Answer was 'Yes' to question '9 [F03]'. (3. Do you use a farm management solution and/or a digital field index (e.g., LBG Agrar, LBG Bodenwächter, LBG Feldplaner, etc.)?

Acquisition and/or running costs of smartphone or apps

Answer this question only if the following conditions are met:

Answer was 'Yes' for question '12 [F06]'. (4. Do you use smartphone apps for operations (e.g., for weather, prices, newsletters, alert services, etc.)?

Acquisition and/or running costs of weather services, price information, etc.

Answer this question only if the following conditions are met:

Answer was 'Yes' to question '15 [F12]'. (5. Do you use weather services, price information, newsletters or similar on the tablet or PC?)

Acquisition and/or running costs of presence on social media

Answer this question only if the following conditions are met:

Answer was 'Yes' to question '18 [F18]'. (6. Does your business have a presence on social media (e.g., Facebook)?)

Acquisition and/or running costs of the internet site, website, etc.

Answer this question only if the following conditions are met:

Answer was 'Yes' to question '22 [F20]'. (7. Does your business have an internet page or website?)

Acquisition and/or running costs of web shop and/or booking system

Answer this question only if the following conditions are met:

Answer was 'Yes' to question '21 [F181]' (Do you offer a web shop or booking facilities on social media?)

Acquisition and/or running costs of steering and tracking systems and/or weed control equipment

Answer this question only if the following conditions are met:

Answer was 'Yes' to question '29 [F24]' (1. Do you use steering and tracking systems or weed control equipment)

Acquisition and/or running costs of part-width section control or individual nozzle control in crop protection

Answer this question only if the following conditions are met:

Answer was 'Yes' to question '32 [F28]'. (2. Do you use boom section and/or single nozzle control in crop protection?)

Acquisition and/or running costs of site-specific seeding and/or fertilisation

Answer this question only if the following conditions are met:

Answer was 'Yes' to question '35 [F32]'. (3. Do you use site-specific seeding and/or fertilisation?)

Acquisition and/or running costs of autonomous weed and/or pest control equipment

Answer this question only if the following conditions are met:

Answer was 'Yes' to question '38 [F36]'. (4. Do you use autonomous weed- and/or pest control (e.g., drones) or take them on as a service. in claim?)

Acquisition and/or running costs of sensor-controlled irrigation

Answer this question only if the following conditions are met:

Answer was 'Yes' for question '41 [F40]'. (5. Do you use sensor-controlled irrigation?)

Acquisition and/or running costs of plant protection warning services

Answer this question only if the following conditions are met:

Answer was 'Yes' to question '44 [F80]'. (6. Do you participate in plant protection warning services?

Acquisition and/or running costs of the barn camera(s)

Answer this question only if the following conditions are met:

Answer was 'Yes' to question '50 [F45]' (1. Do you use a barn camera?)

Acquisition and/or running costs of sensor-controlled ventilation and/or air conditioning

Answer this question only if the following conditions are met:

Answer was 'Yes' to question '53 [F49]'. (2. Does your barn have sensor-controlled ventilation and/or air conditioning (incl. spray cooling, floor heating)?)

Acquisition and/or running costs of feeding robot and/or digitally controlled feeding system

Answer this question only if the following conditions are met:

Answer was 'Yes' to question '56 [F53]'. (3. Do you use a feeding robot or a digitally controlled feeding system?)

Acquisition and/or running costs of the milking robot

Answer this question only if the following conditions are met:

Answer was 'Yes' to question '59 [F57]'. (4. Do you use a milking robot?)

Acquisition and/or running costs of the robot for manure cleaning and/or cleaning crevices

Answer this question only if the following conditions are met:

Answer was 'Yes' to question '62 [F61]'. (5. Do you use a robot for manure cleaning and/or cleaning crevices?)

Acquisition and/or running costs of the system(s) for monitoring animal health with sensors

Answer this question only if the following conditions are met:

Answer was 'Yes' to question '65 [F65]'. (6. Do you monitor animal health with sensors?)

Final questions

What are the reasons that inhibit the use of digital technologies in your business?

Please select all that apply:

□ The prerequisites are missing, e.g., the internet connection is too slow.
□ I do not have the necessary knowledge to realise the potential.
□ The benefit is currently still too small.
□ The costs for this are currently too high.
□ Data exchange between applications does not work well enough.
□ I have data protection concerns.
□ Other:

To make the survey as simple as possible for you, we have reduced the survey to core elements of the study.

If you agree, the following key figures of your farm (federal state, type of operation or Production focus, standard output and reduced agricultural area) will be used by LBG Austria in an anonymous way as a supplement to the evaluation.

Please select only one of the following answers:

□ I therefore agree that data from my farm may be evaluated anonymously by LBG Austria.

□ I do not want to disclose my LBG number, but still want to submit my answers.

My LBG number is:

Answer this question only if the following conditions are met:

Answer was 'I therefore consent to data from my farm being analysed anonymously by LBG Austria' for question '90 [farm number]'. (In order to make the survey as simple as possible for you, we have reduced the survey to core elements of the study. If you agree, the following key data (province, type of farm or production focus, standard output and reduced agricultural area) of your farm will be used by LBG Austria in an anonymous way for the evaluation.)

Please enter your answer here:

Please specify the type of business or the production focus of your business.

Answer this question only if the following conditions are met:

Answer was 'I do not want to disclose my LBG number, but still want to submit my answers' for question '90 [company number]'. (In order to make the survey as simple as possible for you, we have reduced the survey to core elements of the study. If you agree, the following key data (province, type of farm or production focus, standard output and reduced agricultural area) of your farm will be used by LBG Austria in an anonymous way for the evaluation.)

Please select all that apply:

□ fattening (e.g., pig or poultry farming)
□ Permanent crops (e.g., vineyards or orchards)
□ Cash crops (e.g., cereals, oilseeds, protein crops, sugar beet, potato, etc.)
□ Forage production (e.g., dairy cattle farming, cattle fattening, suckler cow farming, sheep and goat farming husbandry etc.)
□ Forest (predominantly forestry)
□ Mixed agricultural holding (several production focuses)

Standard output in € and/or area RLN in ha:

Answer this question only if the following conditions are met:

Answer was 'I do not want to disclose my LBG number but still want to submit my answers' for question '90 [company number]'. (In order to make the survey as simple as possible for you, we have reduced the survey to core elements of the study.

If you agree, the following key data (federal state, type of farm or production focus, standard output and reduced agricultural area) of your farm will be used by LBG Austria in an anonymous way for the evaluation.

State:

Answer this question only if the following conditions are met:

Answer was 'I do not want to disclose my LBG number, but still want to submit my answers' for question '90 [company number]'. (In order to make the survey as simple as possible for you, we have reduced the survey to core elements of the study.

If you agree, the following key data (province, type of farm or production focus, standard output and reduced agricultural area) of your farm will be used by LBG Austria in an anonymous way for the evaluation.

Please select only one of the following answers:

□ Burgenland
□ Carinthia
□ Lower Austria
□ Upper Austria
□ Salzburg
□ Styria
□ Tyrol
□ Vorarlberg
□ Vienna

Thank you very much for your efforts!

If you would like to tell the research team something, please use the following input field: Please enter your answer here:

Would you like to be informed about the research results?

Please select only one of the following answers:

□ Yes

□ No

If Yes, please enter your email address here:

Answer this question only if the following conditions are met:

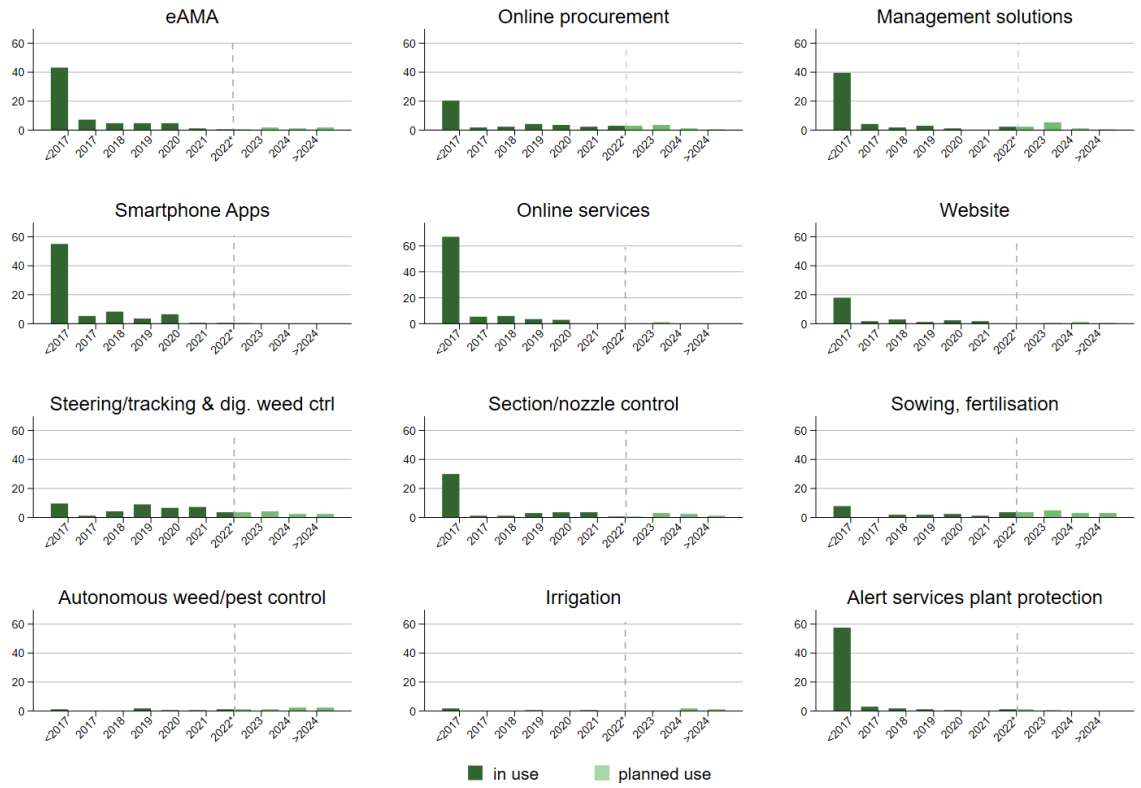
Answer was 'Yes' to question '96 [F000]' (Would you like to be informed about the research results?)

Please enter your answer here:

Thank you very much for answering the questionnaire.

Annex III. Implementation of Digital Farming Technologies

Figure 12: Implementation timing of digital technologies in crop farms



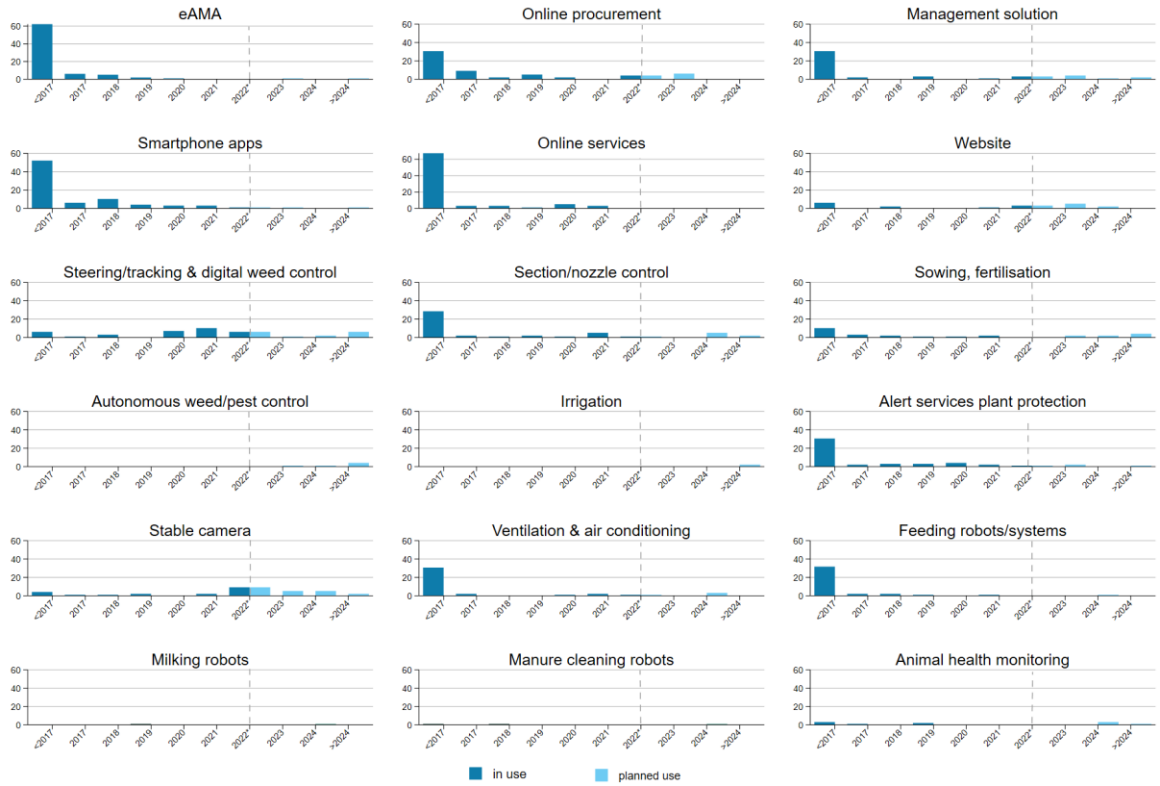
Source: own illustration. – *The height of the two-part column in 2022 (when the survey was conducted) corresponds to the aggregated shares of implemented and planned technologies in this year, it therefore provides no information on the division between those two categories.

Figure 13: Implementation timing of digital technologies in livestock farms



Source: own illustration. – *The height of the two-part column in 2022 (when the survey was conducted) corresponds to the aggregated shares of implemented and planned technologies in this year, it therefore provides no information on the division between those two categories.

Figure 14: Implementation timing of digital technologies in mixed farms



Source: own illustration. – *The height of the two-part column in 2022 (when the survey was conducted) corresponds to the aggregated shares of implemented and planned technologies in this year, it therefore provides no information on the division between those two categories.

Annex IV. Detailed Costs of Digital Farming Technology

Table 3: Detailed costs of general digital farming technology

	Investment costs						Annual operating costs					
	lqt	med	uqt	min	mean	max	lqt	med	uqt	min	mean	max
Crop farms	**11.0**	**25.0**	**54.6**	**0.0**	**106.5**	**1,758.7**	**0.9**	**6.7**	**18.9**	**0.0**	**36.3**	**384.0**
Management solution/ field book	20.4	28.8	47.6	0.0	180.4	3,000.0	0.0	10.4	20.5	0.0	15.3	106.6
Online services	0.0	0.0	0.0	0.0	10.4	305.3	0.0	0.0	0.2	0.0	5.9	104.9
Smartphone apps	14.9	34.6	75.9	0.0	128.0	3,000.0	0.0	10.9	34.3	0.0	20.2	79.5
Social media	0.0	0.0	0.0	0.0	34.3	375.0	0.0	0.0	18.3	0.0	239.5	3,000.0
Web shop and booking	0.0	86.0	113.6	0.0	66.5	113.6	0.0	5.7	10.3	0.0	5.4	10.3
Website	26.8	64.1	169.9	0.0	254.6	2,000.0	6.8	12.8	26.8	0.0	24.8	200.0
Mixed farms	**6.2**	**13.0**	**58.9**	**5.3**	**40.8**	**205.7**	**2.0**	**5.4**	**11.5**	**0.3**	**12.5**	**94.0**
Management solution/ field book	6.4	9.1	89.4	0.0	70.5	330.7	3.9	7.9	13.2	0.0	10.7	44.7
Online services	0.0	0.0	0.0	0.0	2.6	83.3	0.0	0.0	0.0	0.0	0.2	3.6
Smartphone apps	0.0	12.0	59.1	0.0	35.5	199.2	0.0	3.4	15.1	0.0	15.1	181.7
Social media	0.0	0.0	0.0	0.0	59.5	416.7	0.0	0.0	0.0	0.0	2.4	16.7
Web shop and booking	0.0	22.2	44.4	0.0	22.2	44.4	14.	20.8	26.9	14.8	20.8	26.9
Website	176.3	221.8	747.8	176.3	381.9	747.8	22.	51.0	67.3	0.0	95.8	338.5
Livestock farms	**6.1**	**20.0**	**59.6**	**0.0**	**48.5**	**558.6**	**0.9**	**7.1**	**24.1**	**0.0**	**20.6**	**222.6**
Management solution/ field book	0.0	7.9	13.5	0.0	27.9	265.6	0.0	0.0	10.3	0.0	5.7	26.9
Online services	0.0	0.0	0.0	0.0	7.6	266.2	0.0	0.0	0.0	0.0	5.4	202.8
Smartphone apps	14.2	35.4	101.1	0.0	76.0	948.1	1.7	11.6	42.0	0.0	31.4	288.2
Social media	0.0	0.0	0.0	0.0	6.1	115.0	0.0	0.0	0.0	0.0	0.1	2.3
Web shop and booking	1.9	27.9	113.9	0.0	57.9	175.8	1.6	47.3	79.6	0.8	47.1	106.2
Website	4.2	53.9	181.1	0.0	134.3	645.4	1.8	15.8	50.6	0.0	50.2	381.2
Total	**7.5**	**20.0**	**58.0**	**1.1**	**63.6**	**830.7**	**1.1**	**6.6**	**19.8**	**0.1**	**23.3**	**240.0**
Management solution/ field book	9.7	16.5	47.7	0.0	99.4	1,355.8	1.2	6.4	15.2	0.0	10.9	63.5
Online services	0.0	0.0	0.0	0.0	7.2	234.8	0.0	0.0	0.1	0.0	4.3	131.6
Smartphone apps	11.2	30.0	85.8	0.0	79.7	1,281.7	0.9	9.5	34.1	0.0	25.1	217.3
Social media	0.0	0.0	0.0	0.0	25.0	255.8	0.0	0.0	6.3	0.0	82.4	1,030.5
Web shop and booking	0.9	46.0	98.3	0.0	52.8	125.8	3.7	29.5	48.3	3.3	29.3	61.6
Website	26.2	70.4	217.9	12.9	202.3	1,214.5	6.0	18.3	42.7	0.0	44.8	303.4

Source: own calculation.

Table 4: Detailed costs of digital technology specific to crop farming

	Investment costs						Annual operating costs					
	lqt	med	uqt	min	mean	max	lqt	med	uqt	min	mean	max
Crop farms	**291.6**	**622.9**	**1,341.0**	**0.9**	**890.7**	**4,219.5**	**1.7**	**5.1**	**30.4**	**0.2**	**28.5**	**177.2**
Autonomous weed and/or pest control	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.0	20.0	0.0	10.0	20.0
Sensor-controlled irrigation	26.7	46.6	134.0	26.7	69.1	134.0	5.3	7.8	134.0	5.3	49.0	134.0
Alert services for plant protection	0.0	0.0	0.0	0.0	14.9	375.0	0.0	0.0	7.4	0.0	13.9	112.5
Section/nozzle control	42.3	300.7	709.2	0.0	1,051.5	9,731.6	0.0	0.0	0.8	0.0	13.7	134.0
Site-specific sowing and/ fertilisation	134.0	333.3	1,033.5	0.0	477.8	1,243.6	0.0	15.5	134.0	0.0	116.9	536.6
Digital steering and tracking systems or digital weed control	1,032.7	2,001.3	4,151.1	0.0	2,272.7	6,341.0	6.3	14.1	51.4	0.0	39.2	238.5
Mixed farms	**99.8**	**377.3**	**886.8**	**47.0**	**678.5**	**2,572.0**	**0.0**	**4.3**	**8.1**	**0.0**	**6.2**	**28.7**
Sensor-controlled irrigation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.1	0.0	1.6	12.5
Section/nozzle control	46.6	207.2	1,773.3	0.0	1,127.0	5,416.7	0.0	0.0	0.0	0.0	1.6	14.0
Site-specific sowing and/or fertilisation	0.0	124.7	249.5	0.0	124.7	249.5	0.0	0.0	0.0	0.0	0.0	0.0
Digital steering and tracking systems or digital weed control	262.2	949.4	1,208.4	141.0	1,117.3	3,349.4	0.0	16.2	26.8	0.0	19.1	73.9
Total	**226.7**	**539.8**	**1,187.3**	**16.5**	**818.9**	**3,662.1**	**0.0**	**10.0**	**20.0**	**0.0**	**10.0**	**20.0**
Autonomous weed and/or pest control	0.0	0.0	0.0	0.0	0.0	0.0	5.3	7.8	134.0	5.3	49.0	134.0
Sensor-controlled irrigation	26.7	46.6	134.0	26.7	69.1	134.0	0.0	0.0	5.4	0.0	9.2	74.8
Alert services for plant protection	0.0	0.0	0.0	0.0	9.9	250.0	0.0	0.0	0.5	0.0	9.4	91.4
Section/nozzle control	43.9	266.7	1,096.1	0,0	1,079.0	8,162.5	0.0	11.7	100.5	0.0	87.7	402.5
Site-specific sowing and/or fertilisation	104.2	287.0	859.3	0.0	399.3	1,022.7	4.0	14.9	42.5	0.0	31.9	178.6
Digital steering and tracking systems or digital weed control	728.5	1,586.1	2,989.5	55.6	1,816.6	5,160.1	1.1	4.8	22.7	0.1	20.8	125.8

Source: own calculation.

Table 5: Detailed costs of digital technology specific to livestock farming

	Investment costs						Annual operating costs					
	lqt	med	uqt	min	mean	max	lqt	med	uqt	min	mean	max
Livestock farms	**409.7**	**753.3**	**1,806.5**	**16.7**	**1152.5**	**3,152.3**	**6.6**	**18.9**	**38.2**	**1.1**	**28.7**	**109.7**
Sensor-based animal health monitoring	155.3	816.8	1478.3	155.3	816.8	1,478.3	14.8	46.2	77.7	14.8	46.2	77.7
Feeding robots or digital feeding systems	671.4	1,170.6	2,672.1	0.0	1,769.2	4,939.5	9.7	26.9	53.4	0.0	40.4	160.7
Manure cleaning robots	65.2	82.9	182.5	52.1	123.8	277.6	0.6	2.2	11.0	0.0	5.8	18.8
Milking robots	224.5	416.7	1,276.3	1.4	746.8	2,065.0	2.5	7.5	17.1	0.0	16.8	80.4
Stable camera	490.7	823.7	1,265.2	217.4	1,129.8	6,259.2	14.0	23.2	53.3	5.6	52.6	286.8
Sensor-based ventilation and/or air-conditioning	202.5	429.8	732.1	0.0	517.1	1,751.5	0.0	12.3	55.8	0.0	57.9	333.3
Mixed farms	**563.1**	**1,159.3**	**1,837.6**	**7.6**	**1,795.6**	**14,285.7**	**11.1**	**20.1**	**55.7**	**0.0**	**75.2**	**586.3**
Sensor-based animal health monitoring	889.3	1,114.4	3,069.4	563.3	1,894.5	4,615.9	20.9	22.2	23.6	2.5	22.0	40.7
Feeding robots or digital feeding systems	6,340.0	8,427.3	9,344.3	5,069.6	7,842.1	9,444.4	215.2	304.3	445.6	135.2	330.4	577.8
Manure cleaning robots	21.0	37.1	94.3	4.0	123.3	2,034.6	0.0	0.0	3.7	0.0	3.8	28.4
Milking robots	124.8	364.1	666.7	16.7	757.4	4,285.7	6.2	12.0	50.3	0.0	35.8	171.4
Stable camera	472.7	808.1	1,385.5	172.8	1,134.9	5,568.8	12.4	22.3	50.0	4.7	47.4	248.5
Sensor-based ventilation and/or air-conditioning	409.7	753.3	1,806.5	16.7	1,152.5	3,152.3	6.6	18.9	38.2	1.1	28.7	109.7
Total	**155.3**	**816.8**	**1478.3**	**155.3**	**816.8**	**1,478.3**	**14.8**	**46.2**	**77.7**	**14.8**	**46.2**	**77.7**
Sensor-based animal health monitoring	197.3	472.8	815.0	17.3	550.4	1,721.1	1.6	16.1	58.2	1.6	56.6	304.9
Feeding robots or digital feeding systems	597.6	1,162.9	2,103.9	5.2	1,787.2	11,302.9	10.7	22.2	55.0	0.0	64.4	454.6
Manure cleaning robots	889.3	1,114.4	3,069.4	563.3	1,894.5	4,615.9	20.9	22.2	23.6	2.5	22.0	40.7
Milking robots	6,340.0	8,427.3	9,344.3	5,069.6	7,842.1	9,444.4	215.2	304.3	445.6	135.2	330.4	577.8
Stable camera	25.5	41.7	103.1	8.8	123.3	1,858.9	0.1	0.3	4.6	0.0	4.1	27.3
Sensor-based ventilation and/or air-conditioning	162.6	384.0	897.9	10.9	753.4	3,443.4	4.9	10.4	38.2	0.0	28.9	138.3

Source: own calculation.

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