Catalytic vs electrocatalytic CO2 reduction to added-value products

sustainability

MDPI

Article

Skill Needs for Sustainable Agri-Food and Forestry Sectors (II): Insights of a European Survey

Ana Ramalho Ribeiro [1,2,*], Billy Goodburn [3], Luis Mayor [1], Line F. Lindner [1], Christoph F. Knöbl [1], Jacques Trienekens [4], Daniel Rossi [5], Francesca Sanna [6], Remigio Berruto [6] and Patrizia Busato [6]

1 ISEKI-Food Association, Impacthub Vienna, Lindengasse 56, 1070 Vienna, Austria
2 Research Centre for Natural Resources, Environment and Society (CERNAS), Coimbra Agriculture School, Bencanta, 3045-601 Coimbra, Portugal
3 Irish Co-Operative Organisation Society, The Plunkett House, 84 Merrion Square, DO2 T882 Dublin, Ireland
4 Business Management & Organisation Group, Social Sciences Department, Wageningen University, Hollandseweg 1, 6706KN Wageningen, The Netherlands
5 Confagricoltura, Corso Vittorio Emanuele II, 101, 00186 Roma, Italy
6 Department of Agriculture, Forestry and Food Science (DISAFA), Università di Torino, Largo Paolo Braccini, 2, Grugliasco, 10095 Torino, Italy
* Correspondence: ana.ramalho@iseki-food.net

Abstract: The agri-food and forestry sectors are in transition towards more sustainable, green, and innovative systems tackling several challenges posed by globalization, governance, and consumers' demands. This transition to novel processes, markets, and businesses requires skills and competences to prepare the new generations and upskill the actual workforce. The purpose of this paper was to assess the skills and knowledge needs of future professionals in the agri-food and forestry sectors, from European stakeholders' perspectives, by using a European questionnaire. Overall, respondents highlighted the importance of improving sustainability and soft and digital skills. In particular, food safety management and control; quality management and assurance of processes and product; efficient use of resources and organization; and planning, visioning, and strategic thinking skills ranked higher. In almost all countries, respondents had the perception that neither formal nor non-formal training covered training needs, though formal training was more suited to address education requirements. Both for organizations and individuals, it is far more relevant to have skills to perform than to have training recognition. The outcomes also provide findings that can be used to help develop updated curricula that meet the sector's needs.

Keywords: skills survey; skills training; sustainability; bioeconomy; agri-food sector; forestry sector

Citation: Ramalho Ribeiro, A.; Goodburn, B.; Mayor, L.; Lindner, L.F.; Knöbl, C.F.; Trienekens, J.; Rossi, D.; Sanna, F.; Berruto, R.; Busato, P. Skill Needs for Sustainable Agri-Food and Forestry Sectors (II): Insights of a European Survey. *Sustainability* **2023**, *15*, 4115. https://doi.org/10.3390/su15054115

Academic Editors: Mariarosaria Lombardi, Vera Amicarelli and Erica Varese

Received: 24 November 2022
Revised: 17 February 2023
Accepted: 18 February 2023
Published: 24 February 2023

1. Introduction

The European agri-food and forestry sectors are facing diverse challenges due to the impacts of climate change, war, rising energy prices, and economic uncertainty along with low incremental crop productivity [1–3]. Such vulnerabilities are stressed by an increasing demand for food and feed, rising environmental concerns, and climatic changes that generate more uncertainties [4]. The Farm-to-Fork strategy [5], a key element of the European Green Deal [6], aims to achieve an innovative and sustainable food system, targeting improvements in the whole food chain from production and processing to consumption and food waste management. In the sectors of agriculture, forestry, and bioeconomy, focus is on mitigating the effects of climate change to reduce the loss of biodiversity and shifting to a neutral or even positive environmental impact [7]. Furthermore, the bioeconomy, boosted by the European Green Deal, is now becoming a substantial element for development and growth in Europe. The bioeconomy concept harnesses both the valorization of natural resources and human manpower in a sustainable way [8]. The transition to long-term sustainable farming and food systems entails complex processes that require a structured

approach, including reshaping education methods [9]. Dedicated bioeconomy training must be driven by these emerging needs to prepare the workforce with new skills. Besides being widespread in everyday life, digital tools and smart technology have been rapidly evolving in all processes across agri-food and forestry sectors, clearly shifting production with automation processes, communication, and new business management to a new level of complexity, innovation, and efficiency [10]. New products, greener processes, and complex food chains and business models demand new skills and knowledge to successfully thrive in a competitive sector [11]. Market globalization requires linking the various actors of the value chain by making use of the new circular economy model and successfully tackling many of the current challenges [12].

The evolution in different economic sectors and markets leads the search and discussion to define adequate and matching skills [13]. In 2015–2016, the European Commission launched a survey entitled "European Digital Skills Survey" to identify, among other topics, the digital skills required by employers in the workplace [14]. Several studies and reports have addressed the main skills and competences required to drive the agri-food and forestry sectors towards a more sustainable path. In the farming sector, research identified skills to engage professionals in more sustainable agriculture [11,15]. In the food sector, the transition to the highly digital and technological processes of Food Industry 4.0 is happening, and insights about the skills and new professions needed were assessed by academics and industry [10,16]. Surveys conducted in the forestry sector assessed if knowledge and skills needed for contemporary forestry careers are being provided by degree programs [17,18]. Paralleled in the labor market is the digitalization of the economy as a major transformation of how people work, representing challenges and opportunities in all production sectors. Complementary to the identification of skills gaps is the need for further engagement between education institutions and industry to design and deliver adequate training programs and to foster the development of these sectors [19,20].

The ERASMUS + "FIELDS" project (acronym for: addressing the current and future skill needs for sustainability, digitalization, and the bioeconomy in agriculture: European skills agenda and strategy) has been designed to identify the gaps and define the needs of knowledge and skills for the agri-food and forestry sectors addressing these above-mentioned emerging challenges. The FIELDS project aims to develop an integrated view of a sectoral strategy at the European level by considering four main areas of skill trends: sustainability, digitalization, bioeconomy, and soft skills and entrepreneurship. Within the scope of the FIELDS project, it was critical to have a broader understanding focused on stakeholders' views on knowledge and competences needed in the future. The survey is part of more comprehensive empirical research on skills needs including other activities such as focus groups [21] and trends and scenario analyses [22].

As a first step, nine focus groups were undertaken in different European countries to identify skills and training needs in the agri-food and forestry sectors. The outcomes of the focus groups [21] were used to design an online survey as follow-up research.

This study describes the results of the online survey, implemented as a broader exploratory tool to collect information about skills and training needs, as well as business and entrepreneurship trends, for the future of the agri-food and forestry sectors. The survey aimed to engage stakeholders from different areas of operation and to gain information on their understanding regarding skills needs and gaps in each sector. It also aimed to provide insight into the range of perceived future skills and training needs. The information provided by the survey may be used to help develop fit-for-purpose training courses for the areas of sustainability, digitalization, and bioeconomy. A coordinated strategy is needed to empower the workforce with new professional skills necessary to cope with emerging challenges and technologies of the agri-food and forestry sectors.

Due to the exploratory nature of this survey, the results are described and discussed in tandem and are herein organized by the following sections: the respondents' demographic characterization and their working context; skills needed by addressed areas

(sustainability, bioeconomy—sector-specific skills, digitalization, soft skills, and business–entrepreneurship); perception of training availability by country; and business insights.

2. Materials and Methods

2.1. Description of Survey

Both current and future skills needs were first identified in previously performed FIELDS focus group sessions [21]. In these focus groups, participants were asked to select the 10 most important overall skills from skill lists that covered the topics of sustainability, digitalization, bioeconomy, soft skills, and business-entrepreneurship skills [21]. The five most-selected skills per category in this ranking exercise were included in the survey questionnaire. The web-based survey was developed and designed in English using the online SurveyMonkey® tool, which allowed the survey to be translated into nine different languages: Dutch, English, Finnish, French, German, Greek, Italian, Portuguese, Slovenian, and Spanish. It gave an overall introduction to the participants and allowed for both full and partial completion of the questions with an opt-out break built into the survey before the business trends section. In the introduction, participants were informed about the total confidentiality of the information provided to only be used in an aggregate manner for the purpose of identifying underlying trends and demands across European member states, in full compliance with the General Data Protection Regulation (EU) 2016/679. The survey comprised 10 sections with 31 questions (Appendix A) and was estimated to take no more than 15 min to complete. The questions with more relevant insights were selected to be analyzed and presented for discussion. Therefore, the survey sections were grouped as follows:

(1) Demographic profiles of participants, with particular focus on the country of work, gender, age, and organizational insights, including the working sectors and the size of their organizations.
(2) Current skill needs in the categories of sustainability, digitalization, bioeconomy—sector-specific (agriculture, forestry, and food industry), and soft and business–entrepreneurship skills. Questions about future skills needs in a 5–10 year range were also asked.
(3) Countries' particular training needs and the importance of training recognition.
(4) Business insights, including questions about business trends and challenges, current business models, and business strategy skills and tools. This final section was optional to complete.

2.2. Dissemination Campaign

The aim was to have input from stakeholders working in the agri-food sector, including the views of industry (workers, managers, cooperatives), academics, and policy entities. The core platform for dissemination was via direct email contacts with industry stakeholders through project partners' email contacts, as well as through the project website and social media (Facebook®, Twitter®, and LinkedIn®) and other accounts owned by project partners, using the snowball sampling technique [23]. The survey was shared among all 31 FIELDS partner organizations across 12 participating countries and was also disseminated in partner organizations' newsletters (ISEKI newsletter Dec 2020) and through other Erasmus+ and EU project contacts. The slogan "have your say in the future skills needs of the agri-food and forestry Sectors" was used to engage stakeholders. Dissemination was also done via direct (partner) newsletters as well as through their webpages. Other Erasmus+ and EU projects also disseminated the survey via their own platforms and social media channels. Several direct contact email reminders were sent out via the project partners and particular attention was given to countries where it was determined there were insufficient responses captured. The survey was available online between 1 December 2020 and 22 January 2021.

2.3. Data Analysis

The survey collected 517 answers; however, 123 were excluded because they only provided data on demographic questions. As a result, the considered sample size had 394 participants. Answers were exported from the SurveyMonkey® website to an Excel file for further analysis. The survey was set up with general and sector-specific questions and participants could select which questions to answer. This option led to a varying number of answers by question, which is specified in each presented figure or table. Before data analysis, the survey sections were reorganized for better clarity in the results presentation, and some less relevant sections are not discussed in this work. Graphical representation in the results section clustered respondents who answered categories "Very important" and "Absolutely essential" as "Very important," and categories "Not important at all" and "Of little importance" as "Of little importance," combining high- and low-scale scores. This data treatment was made for the sake of simplicity in the outcomes' presentation. The categories "Multiple sectors" and "Multiarea" grouped all respondents working in more than one sector or area of activity. The category "Other" within sectors comprised policy operators, educators, researchers, and service providers. In the area of operation, the category "Other" included researchers, associations, public representatives, and service providers. In the demographic profile analysis, the age categories were reduced from eight to six (<20 years; 20–29; 30–39; 40–49; 50–59; over 60). The results of the open question about skills needed in the future in 5 to 10 years were counted and we considered the number of answers by category. Regarding training needs by country, data for analysis included only countries with more than 15 answers. The section regarding business insights was optional, with 91 participants who selected to continue the survey and complete this section. The results from the open question "What do you see as the top three challenges facing your business over the next 2–3 years?" were grouped under seven topics according to the researchers' assessment, namely: "sustainability & climate," "bioeconomy & technical issues," "economic & investment & markets," "digitalization," "human resources," "soft skills," and "training & specialization." For this question, respondents (67) had the option to identify three different challenges.

Descriptive analysis regarding skills' importance was performed using cross-tabulations to analyze frequencies and associations between skills and sectors of activity. For the questions related to sustainability, digitalization, soft skills, and business and entrepreneurship skills, mean scores were calculated for the five-point Likert scale. The Kruskal–Wallis test, a nonparametric approach, was used to compare groups, followed by Dunn's post-hoc test when statistical differences were found (Appendix B Table A1) [24]. Statistical significance was tested at 0.05 probability level. Statistical tests were performed using IBM SPSS®25 software.

3. Results and Discussion

The survey collected opinions and views of professionals and other stakeholders about future skills needs in different sectors. A main goal was to reach a large audience among sectors and countries, conveying a broader view of the path to follow in upcoming years. The five surveyed and discussed skills in each category are the five most important skills obtained from the focus groups study [21].

3.1. Demographics and Organizational Insights

The demographic profile of respondents participating in the survey is presented in Table 1, totaling 394 responses. The survey gathered participants from 23 countries within the European Union, and some from the European Economic Area (EEA) (Figure 1). However, there were four countries (Spain, Italy, Ireland, and Austria) with higher inputs, corresponding to 53% of total participants. The majority of respondents were between 40 and 60 years old and 59% were male; this gender difference was reflected in all sectors except for the food industry, where more women contributed to the survey. The distribution by sector of activity was quite uneven: half of respondents worked in the Agricultural sector,

14% in the Food Industry, 10% worked in Multiple sectors (more than one considered sector of activity), and 16% in Other sectors (such as operators, educators, researchers, or service providers). The Bio-Based industries and the Forestry sectors were the least represented; the small sample size counted only 3% and 5% of the total responses. By area of operation, education providers and advisors were half of the respondents while the other half was distributed as farmers (10%), cooperatives (8.4%), agri-food companies (7.4%), and foresters-forest industries (1.5%). "Other" for area of operation included several professional areas, such as social partners, regulators, policy makers, trade associations, other industry sectors, researchers, and technicians. An overview of the size of organizations shows a fair balance between all categories included in the questionnaire, although most of the answers can be included in the range of small and medium enterprises. A large share of the respondents did not include information on organization size. The majority of respondents who answered represented micro-enterprises and SMEs while only 10% of participants were from large companies. The differences observed regarding sector of activity in the demographic profile will be further discussed in the results section.

Table 1. Description of socio-demographic characteristics of respondents in total and distributed by sector of activity.

	Total Respondents	**Agriculture**	**Bio-Based Industries**	**Food Industry**	**Forestry**	**Multiple Sectors [1]**	**Other [2]**
Number of participants	394 (100%)	201 (51%)	11 (3%)	55 (14%)	21 (5%)	41 (10%)	65 (16%)
Age (years)							
Less than 20	3 (1%)	2	0	2	0	2	0
20–29	39 (10%)	11	0	9	5	15	6
30–39	48 (12%)	12	18.2	22	14	5	8
40–49	122 (31%)	26	63.6	31	24	39	37
50–59	113 (29%)	27	18.2	27	43	27	34
over 60	66 (17%)	21	0	9	14	12	15
Gender							
Female	154 (39%)	35	36	56	24	32	46
Male	231 (59%)	64	64	36	76	63	51
Prefer not to say	9 (2%)	0.5	0	7.3	0	5	3
Area of Operation							
Advisor	45 (11.4%)	12	9	7	10	17	9
Education Provider	151 (38.3%)	32	55	36	57	22	60
Agri-Food Companies	29 (7.4%)	4	9	31	0	7	0
Co-operatives	33 (8.4%)	11	9	5	10	10	2
Farmer	40 (10.2%)	17	0	0	0	15	0
Forest Industries and Foresters	6 (1.5%)	0	0	0	24	2	0
Multiarea [3]	30 (7.6%)	6	9	15	0	22	2
Other [4]	60 (15.2%)	18	9	5	0	5	28
Organization size (persons)							
0–9	61 (15.5%)	21.9	9.1	7.3	9.5	19.5	3.1
10–49	50 (12.7%)	12.4	18.2	14.5	9.5	26.8	3.1
50–250	34 (8.6%)	10	0	12.7	4.8	9.8	3.1
250+	39 (9.9%)	7.5	0	18.2	19	14.6	6.2
No answer	210 (53.3%)	48.3	72.7	47.3	57.1	29.3	84.6

Data represented in %, except for data in column "total respondents" and line "number of participants" where data are presented as frequency and percentage. [1] Multiple sectors: grouped all respondents working in more than one sector; [2] Other sectors: comprised policy operators, educators, researchers, and service providers; [3] Multiarea: grouped all respondents working in more than one area of operation; [4] Other areas of operation included researchers, associations, public representatives, and service providers.

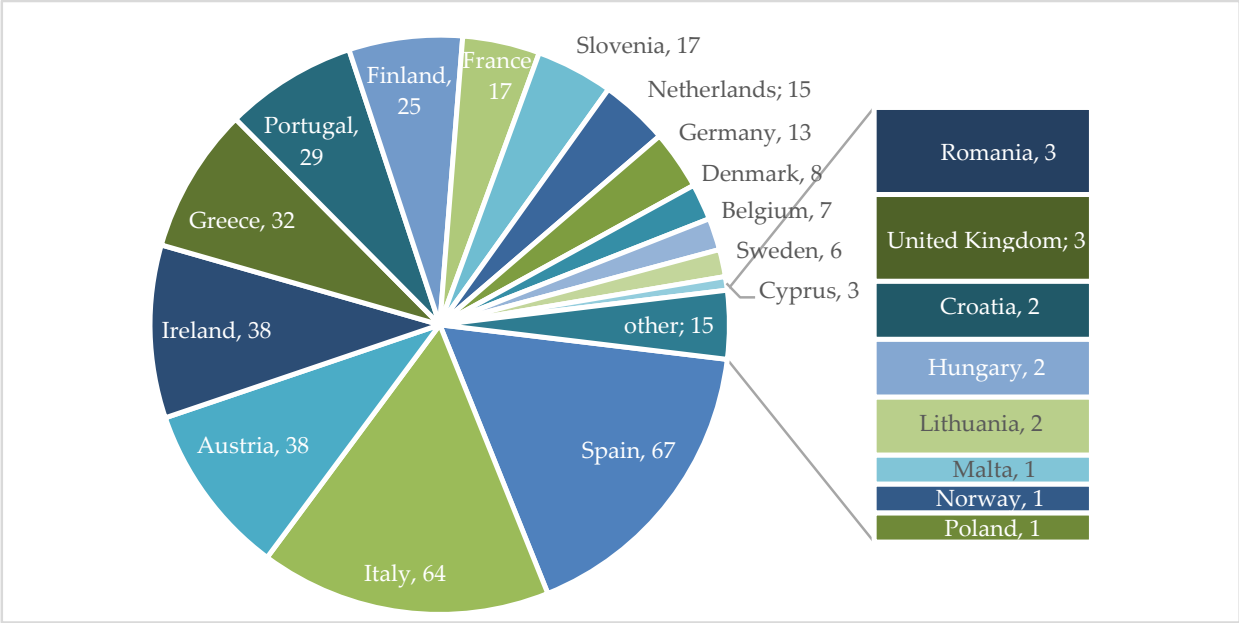

Figure 1. Number of respondents by country.

3.2. Identified Current and Future Skills Needs

3.2.1. Sustainability Skills

A sustainable food system encompasses environmental, health, and social benefits, as well as fairer economic gains [6]. Some studies address sustainability skills as the competences to thrive in an evolving agri-food sector, such as coping with unexpected events and adapting to new developments [25] or learning (critical thinking or communication) and life skills (flexibility and leadership) [26]. Within this study, these were considered soft skills and discussed in another section. In this study, sustainability skills were addressed as "green skills" important in the awareness of sustainable production, the mitigation of climate change, the reuse and recycling of resources and materials, and the use of renewable energy sources [15]. In this survey, the importance of five sustainability skills identified as relevant for the agri-food and forestry sectors previously in FIELDS focus groups [21] were evaluated by respondents. The results of this question are shown in Figure 2. Though all skills were important, "efficient use of resources and logistics," "mitigation and adaptation to climate change," and "good agricultural practices" were found the most important for respondents. "Efficient use of resources and logistics" was found to be important for all sectors. Skills related to "mitigation and adaptation to climate change" were identified as statistically more important by Agricultural, Food, Multiple, Forestry, and Other (Table A1) respondents' sectors. "Good agricultural practices" were found significantly more important for most of the respondents from the Agriculture, Other, and Multiple sectors (Table A1). "Soil nutrient and health management" were significantly less important to Food and Bio-Based industries (Table A1), and skills related to "by-products and co-products valorization" were those with lower shares of respondents finding the skills very important.

The agri-food industry clearly recognizes the importance of protecting and making good use of natural resources and the impact of climate change in disrupting supplies and processes as the main challenges to tackle towards a more sustainable future [27]. Agri-food and forestry activities contribute to climate change, but at the same time are dependent on natural resources and more vulnerable to its effects [12]. Previous studies suggest that technological developments to mitigate climate change effects require trained skilled workers [9]. Similar skills were previously identified in a sustainability transition context, referring to the importance of agri-food workers having global awareness of climate change impact, carbon emission reduction, water resources, and ecosystems management, but

they should also have the skills to put in practice strategies related to renewable energies, by-products valorization, and more efficient production [11,15]. As indicated, to achieve the transition to sustainable production systems, it is required to train workers presently displaying poor or moderate skills levels with new competences that enable them to effectively promote sustainable agriculture through formal or life-long learning [28]. This upskilling will pave the way to apply better and more efficient processes with reduced impact on the environment and biodiversity.

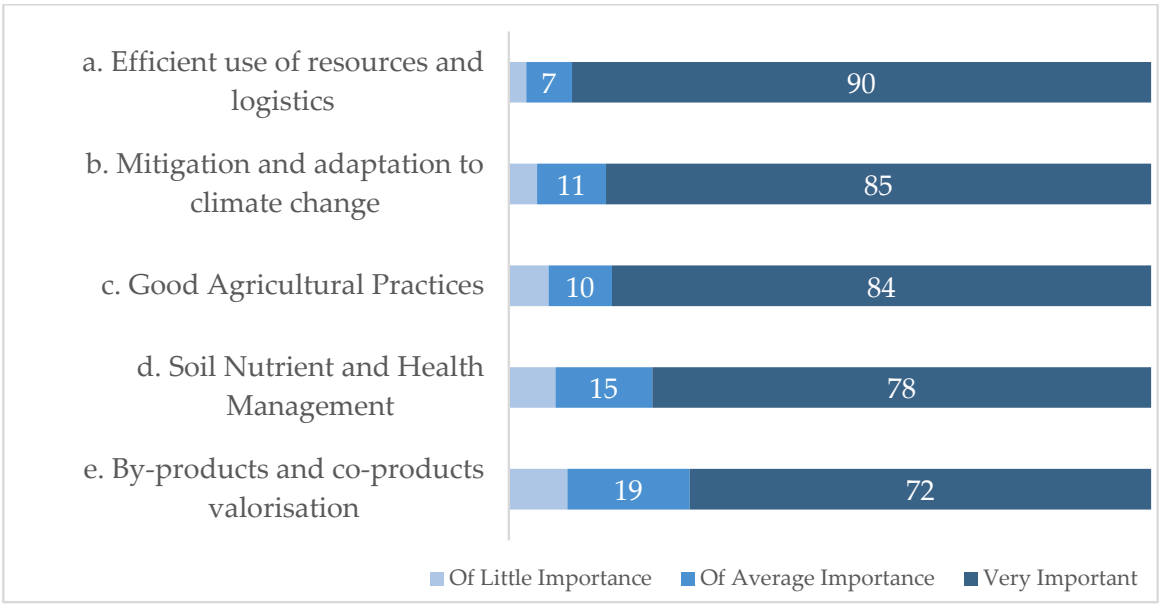

Figure 2. Categorization of the five selected sustainability skills by importance. Values in the graph represent the percentage of answers for each skill.

3.2.2. Digitalization Skills

Digital transformation occurs in everyday life and skills needed are applicable to all sectors. Information and communication technologies applied to agriculture have improved productivity, supply chains, strategic decisions, and control [29]. Digitalization is the main driver of Industry 4.0 development, comprising advanced technologies including automation of processes, use of robotics, and Internet of Things. These advances are now gaining *momentum* in the agri-food sector [30,31]. Big data is considered to be a key opportunity for the future development of agriculture since it increases the variety and velocity of data collection, enabling various tools and services to be implemented [32]. How to use and interpret the collected raw data is still a challenge. This concern is reflected in the high demand for skills related to "data handling and analysis" (Figure 3). The five selected skills from the FG outcomes were assessed in the survey questionnaire and results are presented in Figure 3. A high number of respondents also considered skills related to "everyday use of digital technology to communicate" particularly important. Likewise, a recent study on future skills required in the food industry for the transition to Industry 4.0 identified basic digital skills, data analysis, and use of complex digital communication skills as some of the essential skills in seven professional profiles of the food industry [10,33]. "Field operations management systems" and "farm management information systems (FMIS)" were also considered more important by the Agriculture and Multiple Sector respondents, as these are specific skills for agricultural practices (Table A1). These are digital operational practices developed to reduce operational and production costs with less environmental impact [34] and several obstacles related to their implementation have been identified, including insufficient farmers with adequate skills [35]. The importance of "e-commerce and e-marketing" scored lower for all sectors but still was found relevant for the respondents. E-commerce in the agri-food sector is promising and may help direct

sales, shortening supply chains; however, it is still a challenging process and dependent on several factors, such as agricultural prices, logistics time, product quality, credibility, spending habits, and profitability [36,37]. Furthermore, in the agri-food sector, non-digital channels are preferably used, with this difference being even higher in rural areas [38]. It was highlighted that simple digital platforms are gaining position in communication, marketing, and business relationships in the agriculture market, particularly after the COVID-19 crisis [33], with digital technologies presenting several opportunities including the potential to reduce trade and transaction costs [39]. The inclusion of e-commerce and marketing skills in farmers' training has been proposed [40] and may help to develop food business, mainly in rural areas [36].

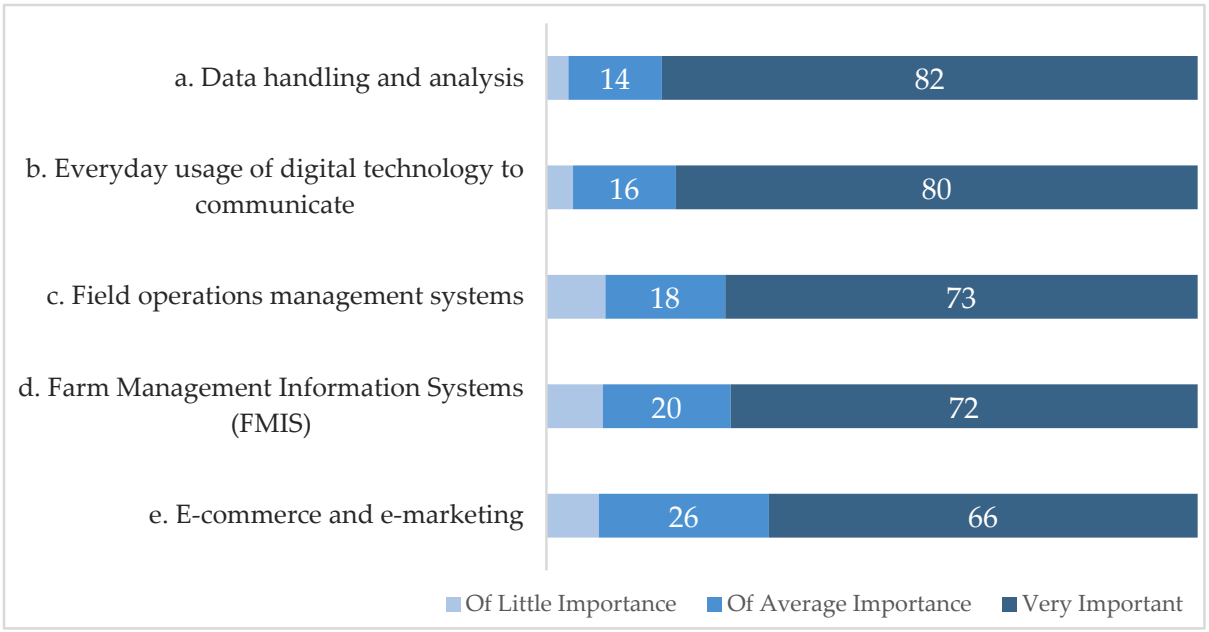

Figure 3. Categorization of five selected digitalization skills by importance. Values represent the percentage of answers for each skill.

The literature referring to the transition to Industry 4.0 for food companies describes diverse adoption patterns and technological demands [30,31], highlighting also that a skilled workforce is needed to fully exploit this technological potential [16]. Despite the numerous advantages of adopting innovative technologies in the agri-food and forestry sectors, there are challenges and risks, such as associated costs and the existence of appropriate training to support digital transition [41]. A guide for the food industry to meet the future skill requirements emerging from Industry 4.0 has recently been published [10]. The five selected digital skills in this work were also identified by Akyazi and colleagues [10] as very relevant to implementing the transition to a more digitalized food industry.

3.2.3. Bioeconomy—Sector-Specific Skills

In this survey, bioeconomy skills have been considered as those that are sector-specific for agriculture (Figure 4), food industry (Figure 5), and forestry (Figure 6) activities [8].

Regarding agriculture skills (Figure 4), the results of the survey clearly showed the importance of having a strategic and management vision to perform the activity. Skills related to "planning and coordinating production" and "calculating, handling and managing risks" were considered very important for the Agriculture sector respondents. The implementation of organizational tools in small farms, as a case study, was observed to improve productivity, product quality, and work environment [42]. "Performing farming operations" is becoming increasingly related to automated systems that reduce time and production costs and increase profitability [34]. Results showed that respondents found it more im-

portant to develop skills related to planning and coordinating production together with managing risks compared with those related to innovations in products and production, such as shifting to organic or growing new crops and developing new bioproducts more interesting from a bioeconomy point of view. In fact, using a management approach and organizational tools with a focus on planning and monitoring were suggested to increase profitability and contribute to a more agroecological and sustainable environment [27,42].

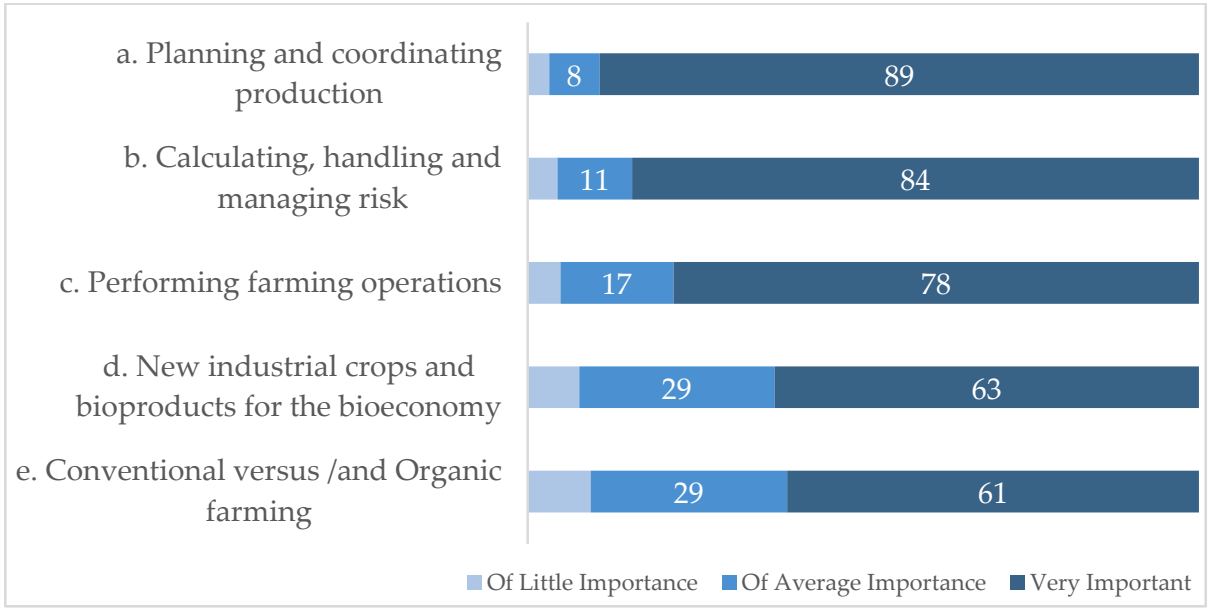

Figure 4. Categorization of five selected Bioeconomy—Agriculture skills by importance. Values represent the percentage of answers for each skill.

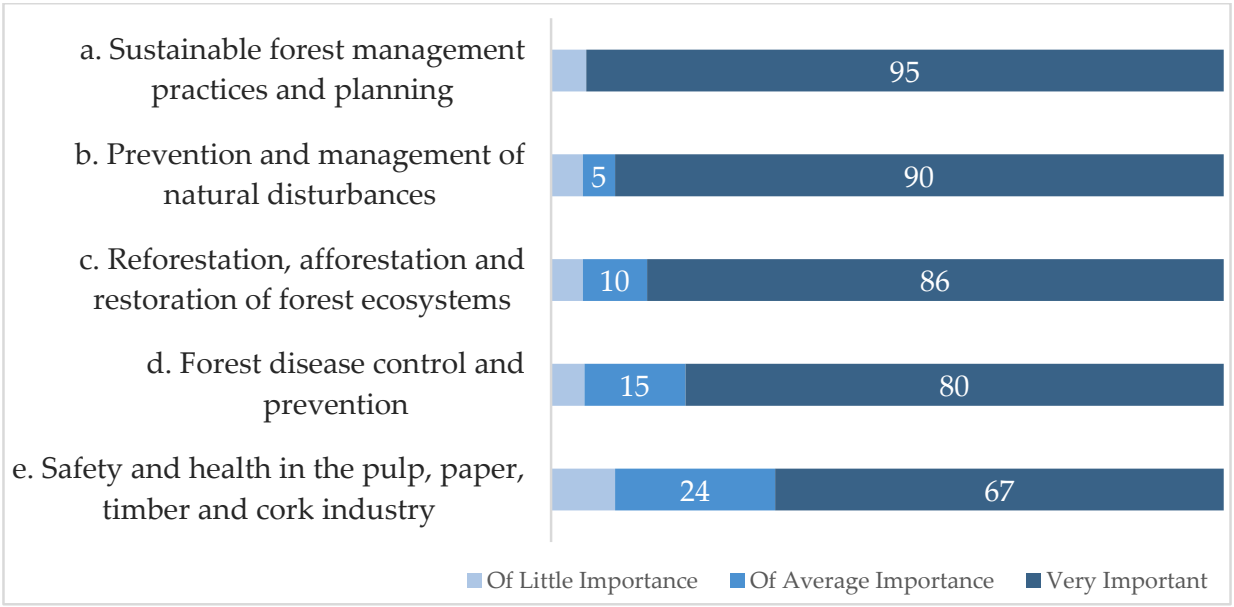

Figure 5. Categorization of five selected Bioeconomy—Forestry skills by importance. Values represent the percentage of answers for each skill.

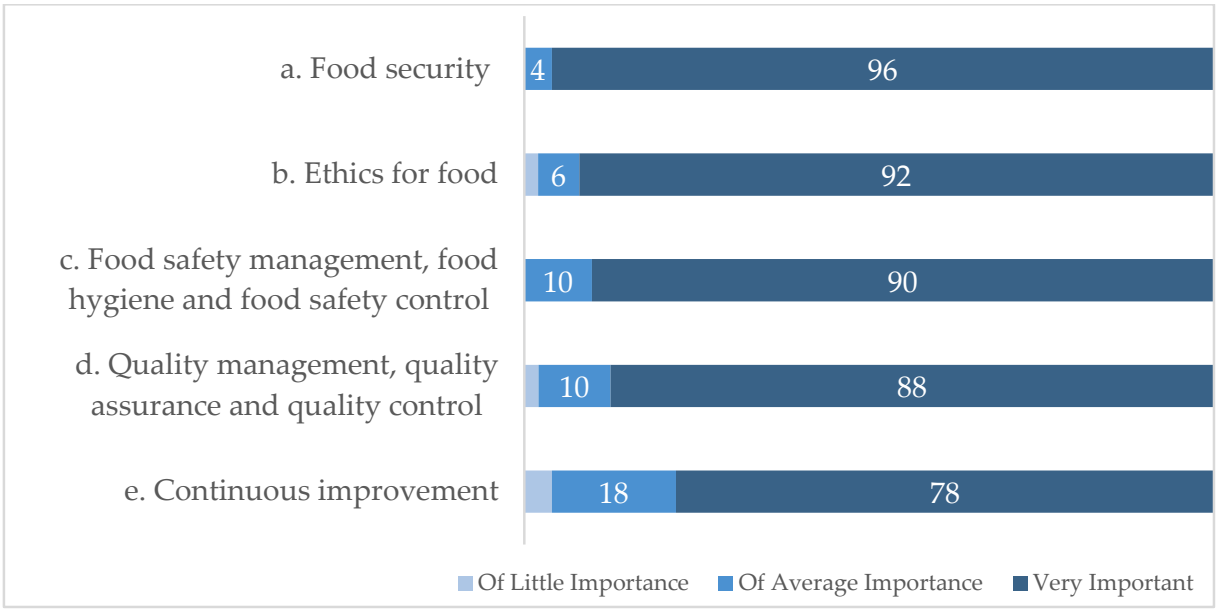

Figure 6. Categorization of five selected Bioeconomy—Food Industry skills by importance. Values represent the percentage of answers for each skill.

Regarding forestry skills (Figure 5), "sustainable forest management practices and planning," together with "prevention and management of natural disturbances," were considered the most important bioeconomy skills for the forestry sector and forest industries respondents. "Reforestation, afforestation and the restoration of forest ecosystems" were also indicated as very important. A recent online survey in the England and Wales forestry sector identified a long list of future skills needs, headed by practical skills and agroforestry and silvicultural knowledge. Other skills, such as "forest management and design" and "carbon and climate resilience," were also demanded, as well as more trained officers on plant health and diseases [18]. Another survey administered to forestry employers and students also highlighted the need for curricula improvement of land-management skills and suggested the continuous improvement of training programs to face unprecedented environmental challenges from forest disease, wildfire, drought, and population growth [17]. Different studies refer to the same skills needs as the ones here identified, which demands an effort to improve workforce abilities in this sector considering the current climate change scenario.

Regarding the food industry sector, skills related to "food security" and "ethics for food" were those found most important. These topics and their relation were referred to as one of the greatest dilemmas of our time [43]. How will nutritious food be available and provided for all, in a sustainable and safe manner, considering also complex public health problems, such as undernutrition, obesity, and micronutrient deficiencies [43]? The influence of climate change in food production is also immediately related to food systems and access to affordable, healthy food [44]. The challenges faced by food industry stakeholders are vast and include animal welfare, transparency, social justice, healthy food, and environmental issues, creating dilemmas when solutions are opposed [45]. Food industry workers need to be empowered with knowledge and decision-making tools to assist them in the ethical decision-making process [46].

"Quality management, quality assurance and quality control" and "food safety management, food hygiene and food safety controls" were also considered core skills in the food sector. The food industry is highly regulated and very compliance-driven to assure food quality for consumers. Food safety is a major concern in the sector, comprising significant challenges such as longer food chains, novel ingredient sources, new processing technologies, and higher consumer demands for fresh, low additive, and natural foods [46]. Scientific and technological advances that significantly impact food products and improve

processes demand technical skills and knowledge to guarantee ingredients' safe application, processes control, and management along the food chain [47]. A European study to assess skills development of food professionals described similar important training activities more focused on current critical skills for the industry: product development, food legislation and control, food safety management, food hygiene and food safety control, quality management, quality assurance and quality control, and consumer and nutritional sciences [48].

3.2.4. Soft Skills

Soft skills are a set of positive attributes and competencies that can improve productivity and enhance relationships and are critical for performance in the workplace [49]. Like digital skills, soft skills are transversal and necessary in all sectors of activity. In general, respondents (between 89% and 91% depending on the skill) rated soft skills as very important for their work (Figure 7). Interestingly, there were only minor differences among sectors. The skills "being resilient, adaptable, and proactive" and "organization, planning, visioning and strategic thinking" were significantly more important for the Multiple, Food, Agriculture, and Other sectors. Creative and critical thinking, strategic planning, communication, networking, adaptability, and continuous learning are some of the skills identified to promote a transition to sustainable agriculture production [11,28], food industry and forestry sector development [10,16,50], and leadership in agriculture and natural resources activities [51]. A survey administered to students and employers identified communicating effectively and behaving professionally and ethically as the most important skills in forestry education [17]. In the food industry, a skill needs survey administered to food science and technology professionals and employers found that seven out of ten of the most required skills were soft skills; both groups agreed that communication was the strongest non-food skill [48]. In another survey for employers, the most significant skill gaps found were in the areas of personal attributes and attitudes [52]. In the agriculture sector, communication skills were among the required skills for young farmers [53], whereas communication, facilitating, and networking skill needs were found in agronomists' workers [28]. A shift from the traditional curricula centered on technical skills towards a curriculum equally balanced between technical, personal, and soft skills has been suggested for the forestry [18,54,55], food [10,48], and agriculture sectors [10,45]. The importance of soft skills in the workplace has long been recognized, and although these competences are generally considered to be acquired throughout life, several authors suggest that higher education institutions should be more active in promoting soft skills training in agri-food and forestry students [28,56,57].

3.2.5. Business and Entrepreneurship Skills

The business and entrepreneurship skills selected for this survey were found very important in general for the majority of respondents (Figure 8). The best qualifications were obtained by skills related to having business and management skills to consolidate a business and to find new business models or new value chains. The highest qualification was the need for "collaboration and cooperation across all sectors of the food chain." Comparing between activity sectors, higher importance scores were observed for all analyzed sectors but were significantly less important for the Forestry sector (Table A1). Furthermore, "interdisciplinary knowledge to assess the whole value chain" was highly evaluated by participants mainly working in Multiple sectors, probably because these stakeholders have a wider understanding across areas of activity for business growth, and significantly less relevant for the Bio-Based industry respondents. Collaboration along the supply chain and maintaining sustainable relations by fostering bonds were revealed to be key sources of value creation [58]. Enterprises are perceiving the importance of collaborations in their core activity and the advantages for their business competitiveness [59,60]. Skills that followed were "business planning/model and strategic management," scoring higher for all sectors, and again significantly less important for the Bio-Based industry participants (Table A1). Planning and management are found to be essential skills for business development. A

study performed with small family farm businesses found that managers who focused on extensive planning and controlling perceived their business as successful [61]. However, developing and creating strategic plans was pointed out by others to be time-consuming but also difficult due to market uncertainty [62]. Skills related to "new value chains/business models" were generally regarded as important by all sectors. A well-defined business development strategy, shaped by unique features of each firm, was considered very significant to gain competitive advantage in both existing and new markets in the agri-food sector in a Northern Ireland survey [19]. However, lack of management skills, mainly in small firms, limits their innovative capability for growth [63]. These results are in line with McElwee [64], who described networking, innovation, teamwork, leadership, and business monitoring as very important skills in rural and farm entrepreneurship. Agri-food and forestry entrepreneurs are often demanded to have the technical skills to create a valuable product but also the competences to run a business. Therefore, a set of different skills involved in entrepreneurship requires a combination of theory and practice [65]. In small business, each farmer's characteristics and motivations are important drivers in the influence of their entrepreneurial activity, creating diversity in farm management, heterogeneity in value-creating strategies, and resiliency of farm systems [66]. As a general remark, new agri-entrepreneurs were shown to have fewer resources and capabilities, and in particular lower entrepreneurial skills and social capabilities, than entrepreneurs from other activities [67].

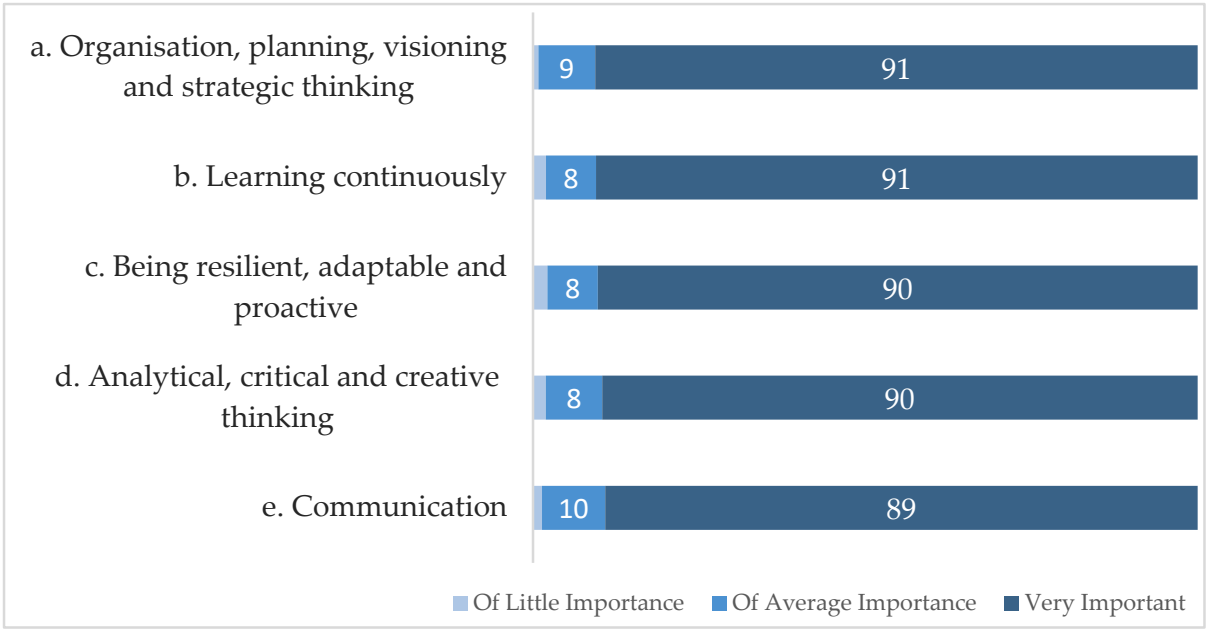

Figure 7. Categorization of five selected soft skills by importance. Values represent the percentage of answers for each skill.

3.2.6. Skills Needs in the Near Future

The participants' understandings of skills needs in the near future (5–10 years) are represented in Figure 9. Sector-specific skills were less significant in the future from respondents' point of view because they were considered more sector-specific. Digitalization skills were those found more important in the future, followed by sustainability skills, business–entrepreneurship, and soft skills. In the literature, these skills are found very relevant in the surveyed agriculture [11], food [16], and forestry [17] sectors. Lack of social competences as soft skills may limit workers to technical positions rather than filling managerial and leadership vacancies [55]. Advances in digitalization technologies are constant, meaning a continuous demand for upskilling. Digital transformation is shaping all aspects of the agri-food and forestry sectors, such as trade logistics, and distribution [39], smart farming

and robotics production [31], marketing and communication, and contributing to achieving the Sustainable Development Goal [41,68].

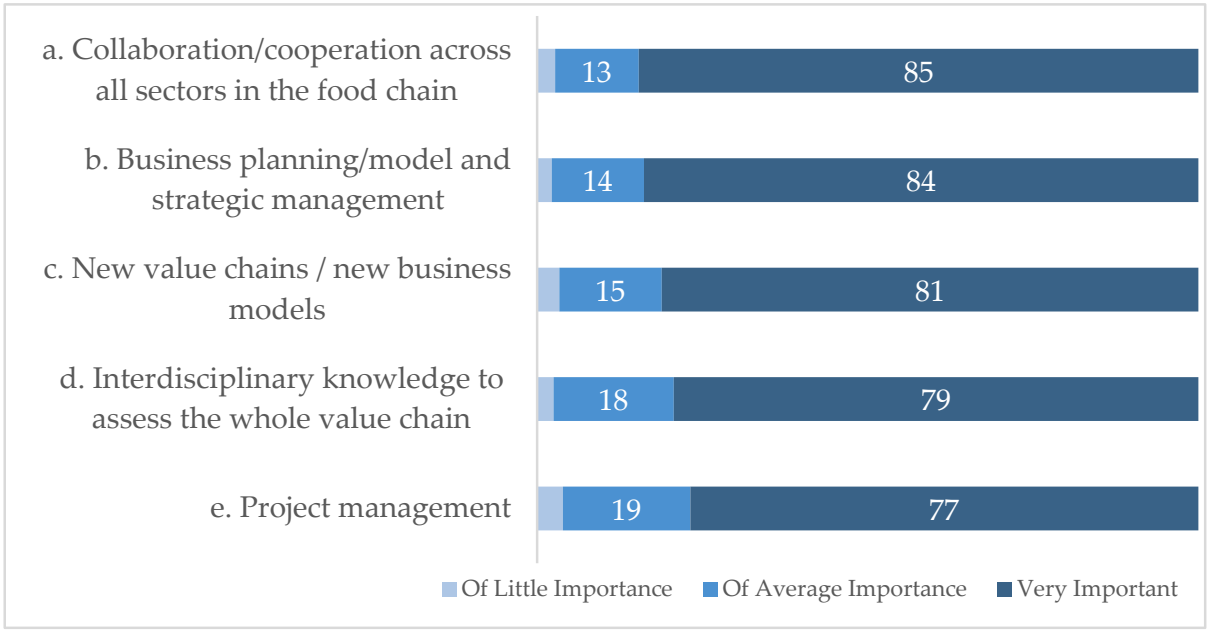

Figure 8. Categorization of five selected business and entrepreneurship skills by importance. Values represent the percentage of answers for each skill.

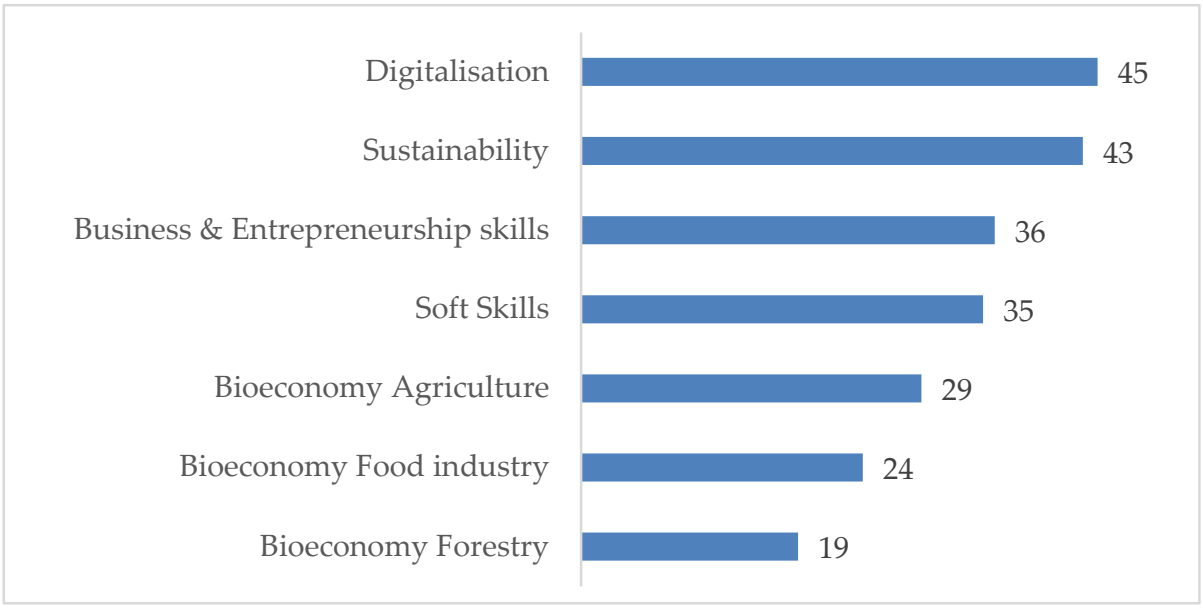

Figure 9. Skill categories required in the future for agri-food and forestry professionals (next 5 to 10 years). Values represent the percentage of answers for each skill category related to total answers.

The challenge for present and future workers in the agri-food and forestry industries is to acquire an assorted set of competences including digital and technical skills, communication and soft skills, and to efficiently manage decisions.

3.3. Countries' Training Needs and the Importance of Training Recognition

This study also intended to assess participants' views regarding the suitability of training systems, formal and non-formal, to cover existing training needs in each country (Figure 10). A considerable number of respondents were unaware of currently available training (including mostly non-formal but also about formal training) in their countries. Still, respondents were more aware of the formal education provided. Generally, formal training was considered more adequate to meet needs than non-formal, except for French respondents. For Austria, Finland, France, Ireland, the Netherlands, and Portugal, respondents clearly did not believe that the existing training systems, formal or non-formal, covered the country's needs. In contrast, in Spain, Slovenia, Greece, and Italy (only non-formal), systems were considered to cover training needs, formal and non-formal, by more than half of respondents. Respondents from Austria and Finland were more skeptical, and more than 80% of respondents considered training needs not covered by formal or non-formal training systems. Performing the analysis by sector of activity (Figure 11), participants consistently considered formal training more suitable to covering training needs compared with non-formal training. Furthermore, there is more uncertainty about existing training for non-formal systems, except for Bio-Based industry respondents. Though agricultural training varies largely throughout Europe, on average, only 8.5% of farmers have received formal agricultural training, and 70% have only practical experience [69]. Therefore, farmers' training seems to be an unresolved matter and is essential for the acquisition of skills in an ever-evolving sector [69]. Universities are viewed as essential to fostering the development of agriculture by having the ability to develop efficient training based on the latest research, to continuously evolve, and to provide education in different formats to support lifelong learning [9]. Despite these efforts, universities and training centers seem to face difficulties with providing needed education due to a lack of competent instructors and effective curricula [70]. Education institutions need to overcome conventional knowledge systems [71] and develop a new educational perspective by integrating formal and informal knowledge, scientific with technical subjects [72], and a broader understanding of challenges and opportunities in order to promote more sustainable agriculture [11].

When assessing the importance of training recognition and/or having the skills to perform the task after training (Figure 12), consideration was given at both organization and at trainee levels. Interestingly, organizations seemed to have more interest in both assessed aspects (formal qualification and having the skills to perform the task) when compared with the importance for the individual. This fact was observed across all studied sectors. It is also clearly observed that it is more important for both organizations and trainees to have the skill to perform the task than the recognition of training through formal qualifications. In the agri-food sector, the skill to perform is linked to innovation, and higher-skilled workers improve productivity by using innovative technologies at a faster rate [19], which is important. Organizations invest in upskilling employees' skills; however, around 50% of this training is "on-the-job" and provided by the firms, and only 24% are trained by a nationally recognized qualification [19].

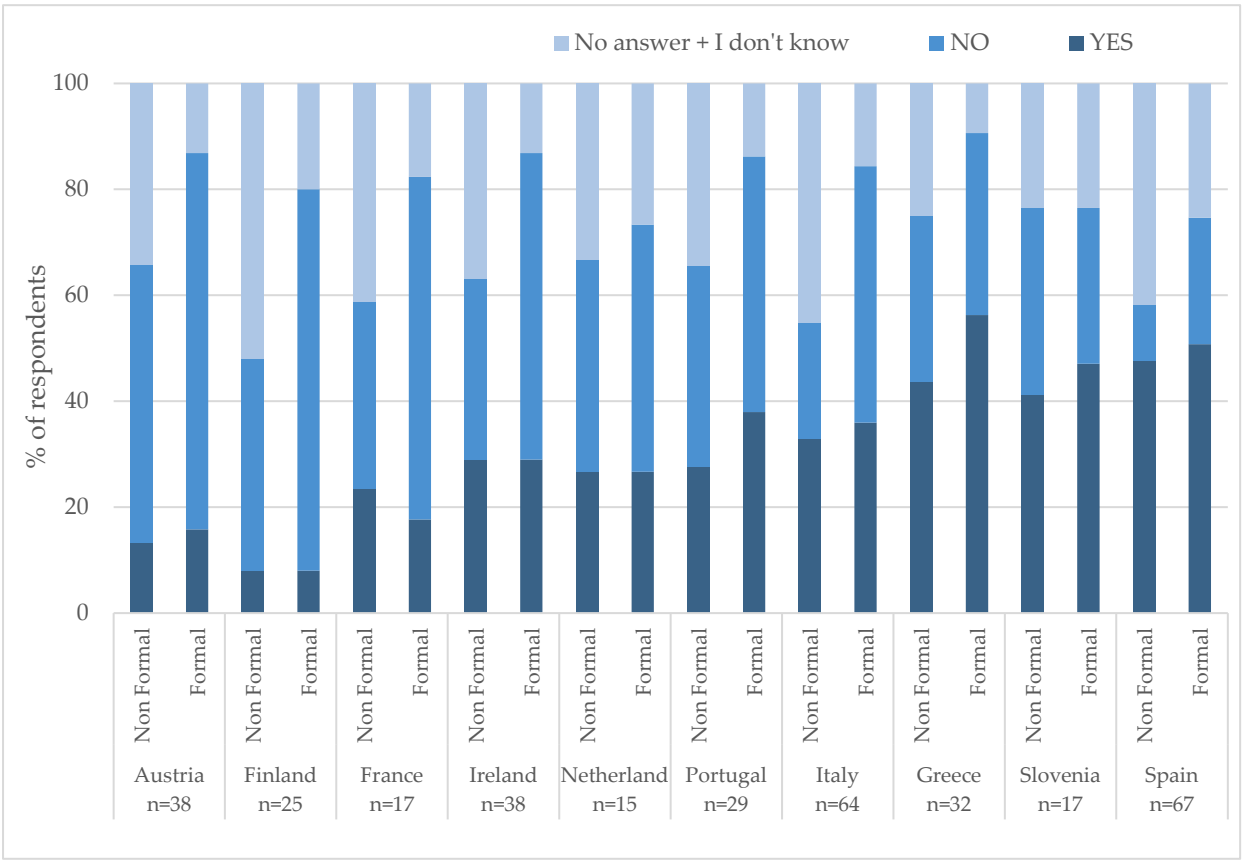

Figure 10. Perception of the suitability of training systems (formal and non-formal) to cover existing training needs by country. Bars represent the percentage of answers for each country and training system. N is the sample size.

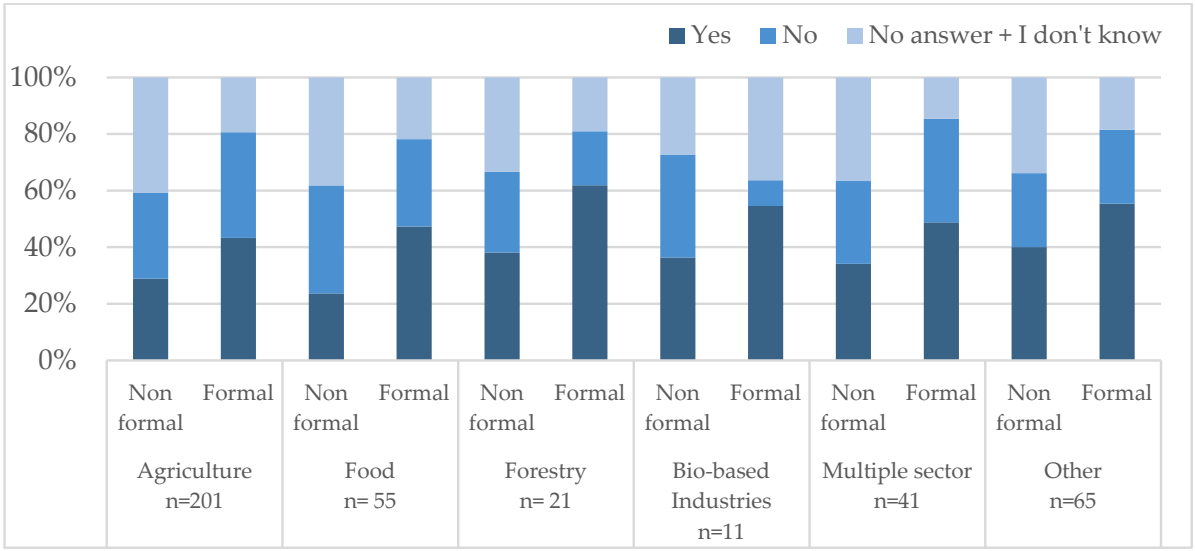

Figure 11. Perception of the suitability of training systems (formal and non-formal) to cover existing training needs by sector. Values represent the percentage of answers for each sector and training system. N is the sample size by sector.

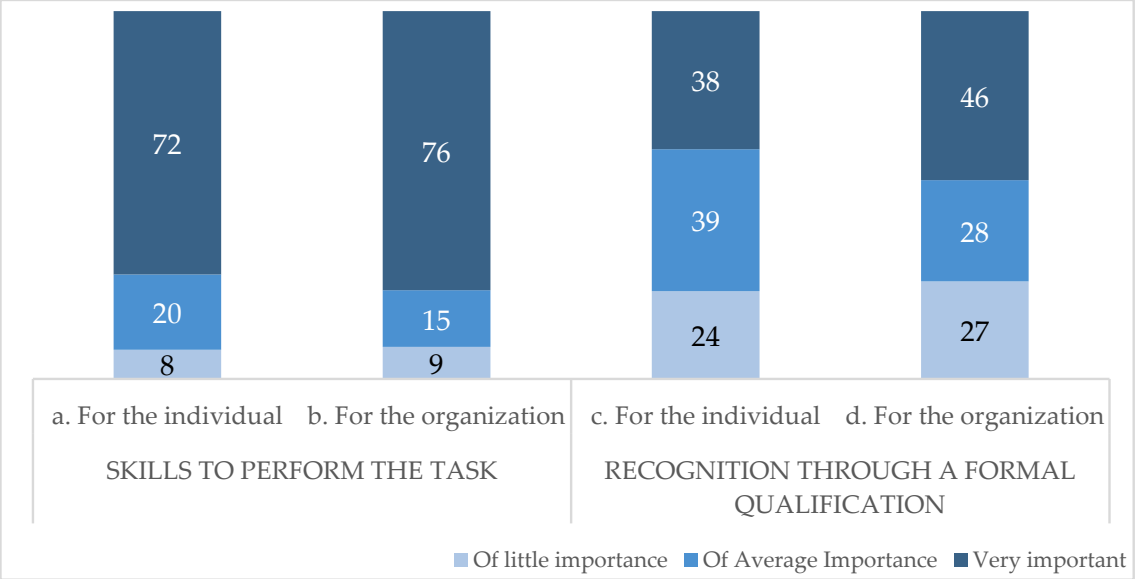

Figure 12. Results of the question on the importance of "having the skills to perform a task" after a training activity and the "recognition for a qualification" answered by trainees and organizations. Number of respondents by question: a. 176, b. 253, c. 197, d. 309. Values represent the percentage of answers for each question.

3.4. Business Trends

The questionnaire section related to business trends was optional and 91 participants agreed to proceed. More than half of the respondents were from the Agriculture sector (49), followed by Food, Other (both 13), and Multiple (12) sectors, and only some few were from Forestry (3) and Bio-Based industries (1). Within the business strategy context, consideration was given to the business operating models, the strategic business focus, and the required business strategy skills. This section first addressed the type of business models participants are operating in. The majority of respondents operated their core business model as business-to-business (B2B—56%), some were operating business-to-consumer (B2C—27%), and less (Other—7%) had a combination of the two models, or were cooperatives or research or consultancy institutions. Regarding sectors, and comparing both business models questioned, the business-to-business model was more adopted in all sectors compared with business-to-consumer: Agriculture (23 vs. 8 answers), Food (5 vs. 2 answers), Multiple (5 equal 5 answers), Forestry (3 vs. 0 answers), and Bio-Based industries (1 vs. 0 answers).

In Figure 13, the core strategic focus of the participants' business model is presented. Findings showed sustainability, innovation, business growth, and increased competitiveness as the main selected drivers for business development. Focuses on digital transformation and work to secure business also featured high on the strategic business focus. The transition to sustainable agri-food and forestry systems is closely linked with technical innovation [41] and digital transformation [73], as discussed in previous sections. Moreover, innovative business models supported by digital tools may foster the agri-food sector, value supply chains, and boost sustainability and employability [74].

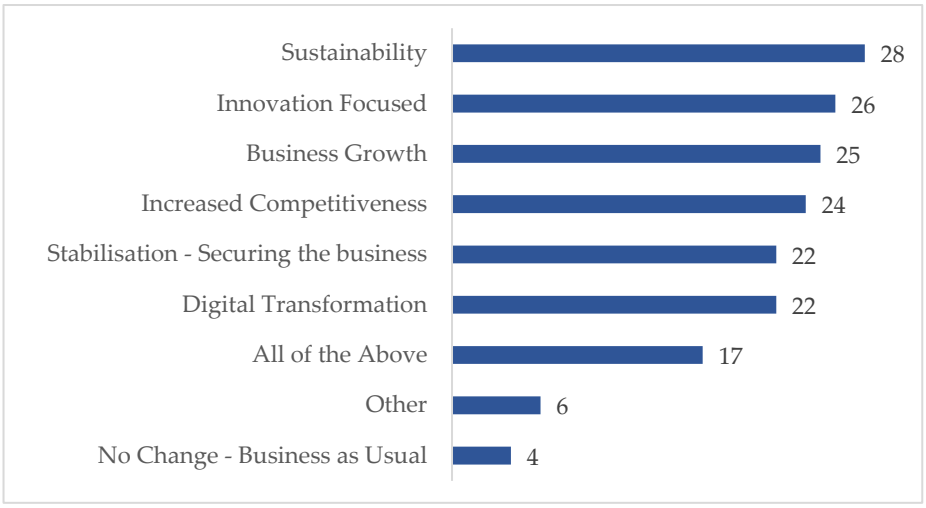

Figure 13. The strategic focus of business. Values represent the number of answers by question.

The three most relevant strategic business skills to support business models (Figure 14) were related to "business strategy, development, implementation, and analysis," "business continuity planning," "business planning/modelling and strategic management," and "recognition and realizing business opportunities." These were followed by "change management," "providing leadership," and "data analytics." "Growth mindset" and "collaboration and co-operation across sectors of the food chain" were also valued. Agriculture and Food Industry were the two sectors with more answers to this question. The agriculture sector highlighted "business strategy, development, implementation and analysis," and the Food Industry sector highlighted "new value chains and business models" as main business strategy skills. These findings showed an increased interest in new business models and management-related skills.

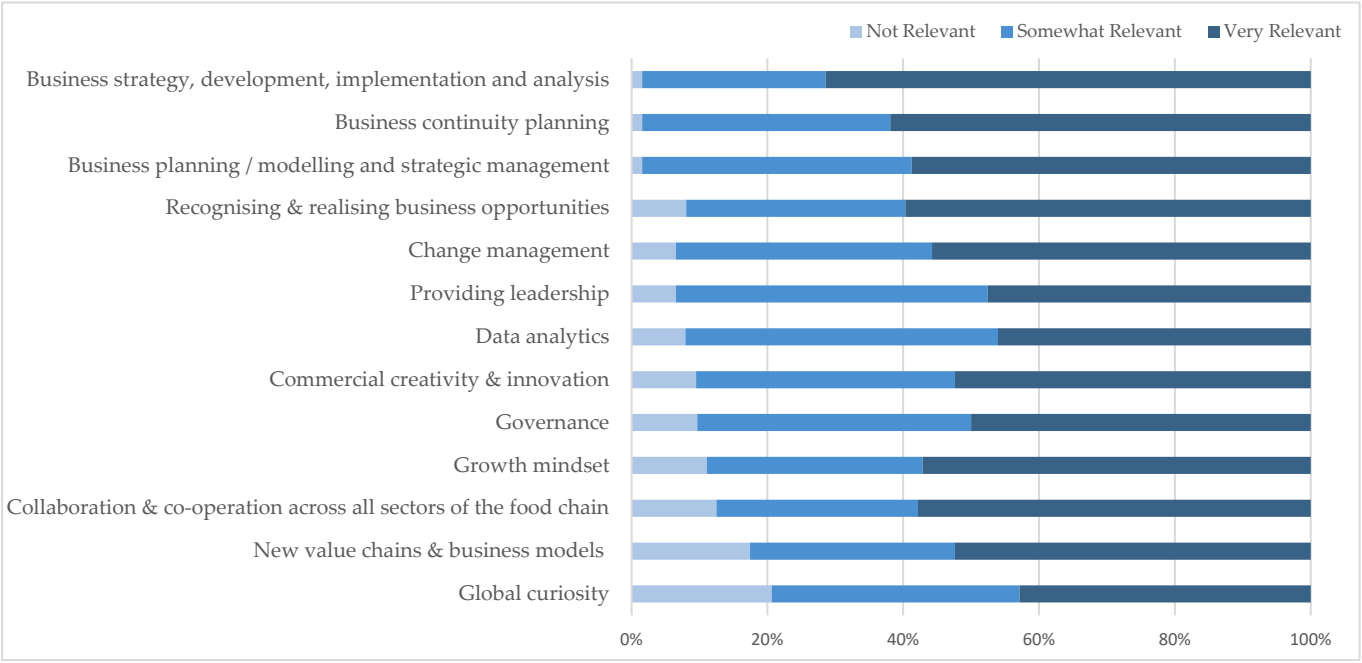

Figure 14. Answers to the question: How relevant are the following business strategy skills to your Core Business Model? Number of respondents varied between 61 and 64. Values represent the percentage of answers.

4. Conclusions

The identification of existing and emerging skills needs in bioeconomy, sustainability, and digitalization is of paramount importance to the development of a strategic approach that will bolster the European agri-food and forestry sectors in the transition to sustainable production in the long term. Survey outcomes on skills needs are in concordance with those found in the FIELDS focus groups. The skills considered most important in focus groups were found in general very important also by survey respondents, with some differences depending on the working sector and skill. Though some differences between each sector and specific skills were observed, on the main, the evaluated set of skills were considered relevant and may feature the agri-food and forestry workforce upskilling and reskilling training. A highlight should be given to the relevance of soft skills for all sectors, with all skills ranking very important for more than 90% of respondents, including skills related to "data handling analysis" and "everyday usage of digital technology to communicate" among those better evaluated by respondents. Among business and entrepreneurial skills, those considered most important were "collaboration across all sectors of the value chain" and "business planning and strategic management." For sector-specific skills, the skill with higher ranking for Agriculture was "planning and coordinating production," for Forestry it was "sustainable forest management practices and planning," and "food security" for the Food sector. According to participants' prospects of required skills in 5 to 10 years, these were mainly digital and sustainability skills. Using a trainer perspective over all the skills analyzed in this study, it is possible to remark that regardless of the category or sector assessed, "planning," "management," and "control" are key activities associated with the most-demanded skills in the survey, setting a focus to train students and workers in these competences.

There is a general perception among respondents that formal training better responds to training needs compared with non-formal training, but also that existing training systems do not cover actual skill needs. The results showed that a cross-sectoral approach developed to train a set of skills, including sustainability, digital skills, soft skills, and business skills, was identified by stakeholders as a way to tackle the agri-food and forestry sectors' challenges. Increasing technical skill levels will promote innovation and digital advances, which, harnessed with soft skills training, will create experts with sound human and technical competences who will be able to improve productivity, face business challenges, and create new markets to support and develop sustainable and solider agri-food and forestry sectors.

This study presented some limitations, mainly related to the fact that samples are not representative of studied sectors (small sample size) and not equally represented, being also quite unbalanced. This study is an exploratory study complemented by other activities on skill needs conducted in the FIELDS project, such as focus groups and scenario analysis. In the future, work skills needs will be analyzed from the perspective of the three activities.

Author Contributions: Conceptualization: R.B., P.B. and D.R.; methodology and validation: L.M., B.G. and L.F.L.; formal analysis: L.M., B.G., L.F.L., C.F.K. and A.R.R.; data curation: L.M., B.G., L.F.L. and A.R.R.; writing—original draft preparation, A.R.R., L.M. and L.F.L.; writing—review and editing: F.S., R.B., P.B., D.R., J.T. and B.G.; supervision: L.M. and L.F.L.; project administration: R.B., F.S. and P.B.; funding acquisition: R.B. and D.R. All authors have read and agreed to the published version of the manuscript.

Funding: This research was co-funded by the ERASMUS+ programme of the European Union, grant agreement number 612664-EPP-1-2019-1-IT-EPPKA2-SSA-B. This publication reflects only the authors' views, and the European Union is not responsible for any use that may be made of the information it contains.

Informed Consent Statement: Informed consent was obtained from all subjects involved in this study. This study was conducted in accordance with the Declaration of Helsinki, and the protocol was approved by the High Steering Committee of the FIELDS ERASMUS+ project (612664-EPP-1-2019-1-IT-EPPKA2-SSA-B).

Data Availability Statement: The data presented in this study are available on request from the corresponding author. The data are not publicly available due to privacy.

Acknowledgments: The authors would like to express their gratitude to the FIELDS project partners who contributed to the conducting and reporting of the survey.

Conflicts of Interest: The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

Appendix A. Questionnaire

https://zenodo.org/record/7245370#.Y1eyR3bMJD8 (accessed on 17 February 2023).

Appendix B

Table A1. Categorization of selected skills by sector of activity.

	Sample (n)	Agriculture	Bio-Based Industries	Food	Forestry	Multiple Sectors	Other	*p* Value
Sustainability Skills								
Mitigation and adaptation to climate change	363	4.28 ^{ab}	3.90 ^{a}	3.92 ^{ab}	4.35 ^{b}	4.51^{b}	4.41 ^{ab}	0.004
Efficient use of resources and logistics	366	4.31	3.80	4.35	4.43	4.46	4.38	0.391
By-products and co-products valorisation	362	3.81	3.92	3.70	3.67	4.22	3.97	0.111
Good agricultural practices	355	4.46 ^{c}	3.76 ^{a}	3.48 ^{ab}	3.30 ^{ab}	4.59 ^{c}	4.07 ^{bc}	<0.001
Soil nutrient and health management	358	4.27 ^{b}	3.47 ^{a}	3.75 ^{a}	3.45 ^{ab}	4.26^{b}	3.98 ^{ab}	<0.001
Digitalization Skills								
Everyday usage of digital technology to communicate	367	4.20	3.55	4.19	4.00	4.24	4.28	0.320
Data handling and analysis	355	4.23 ^{ab}	3.60 ^{a}	4.18 ^{ab}	4.05 ^{ab}	4.49 ^{b}	4.00 ^{ab}	0.026
E-commerce and e-marketing	360	3.69	3.10	3.90	3.95	3.91	3.90	0.141
Farm Management Information Systems (FMIS)	357	4.08 ^{b}	3.30 ^{a}	3.39 ^{ab}	3.29 ^{a}	4.14 ^{b}	3.76 ^{ab}	<0.001
Field operations management systems	364	4.01 ^{b}	3.18 ^{a}	3.48 ^{ab}	3.62 ^{ab}	4.14 ^{b}	3.90 ^{ab}	0.010
Soft Skills								
Communication	368	4.31	3.80	4.44	4.24	4.57	4.35	0.072
Analytical, critical, and creative thinking	365	4.28	4.00	4.21	4.33	4.53	4.52	0.133
Being resilient, adaptable, and proactive	369	4.34 ^{bc}	3.60 ^{a}	4.34 ^{bc}	3.89 ^{ab}	4.56 ^{c}	4.45 ^{bc}	0.001
Organisation, planning, visioning, and strategic thinking	363	4.42 ^{bc}	3.78 ^{a}	4.37 ^{bc}	4.10 ^{ab}	4.66 ^{c}	4.33 ^{bc}	0.005
Learning continuously	358	4.37	4.00	4.31	4.43	4.53	4.39	0.706
Business and Entrepreneurship Skills								
Business planning/model and strategic management	359	4.26 ^{ab}	3.67 ^{a}	4.02 ^{ab}	3.90 ^{ab}	4.49 ^{b}	4.08 ^{ab}	0.006
New value chains/new business models	355	4.06	3.67	4.10	4.05	4.31	4.10	0.589
Collaboration/cooperation across all sectors in the food chain	364	4.31 ^{b}	3.91 ^{ab}	4.26 ^{ab}	3.68 ^{a}	4.52 ^{b}	4.29 ^{ab}	0.024
Interdisciplinary knowledge to assess the whole value chain	363	4.04 ^{ab}	3.60 ^{a}	4.06 ^{ab}	4.06 ^{ab}	4.46 ^{b}	4.17 ^{ab}	0.031
Project management	358	4.03	3.44	3.96	3.80	4.29	3.97	0.085

Data represent mean values of answers rated by importance. Superscript letters within rows represent statistical differences between median values ($p < 0.05$).

References

1. European Commission; Directorate-General for Research and Innovation; Froidmont-Görtz, I.; Faure, U.; Gajdzinska, M.; Haentjens, W.; Krommer, J.; Lizaso, M.; Lutzeyer, H.; Mangan, C.; et al. *Food 2030 Pathways for Action: Research and Innovation Policy as a Driver for Sustainable, Healthy and Inclusive Food Systems*; Ndongosi, I., Fabbri, K., Eds.; Publications Office: Brussels, Belgium, 2020.
2. Grassini, P.; Eskridge, K.M.; Cassman, K.G. Distinguishing between Yield Advances and Yield Plateaus in Historical Crop Production Trends. *Nat. Commun.* **2013**, *4*, 2918. [CrossRef] [PubMed]
3. The World Bank Food and Energy Price Shocks from Ukraine War Could Last for Years. Available online: https://www.worldbank.org/en/news/press-release/2022/04/26/food-and-energy-price-shocks-from-ukraine-war (accessed on 3 February 2023).
4. FAO. *Climate Change and Food Security: Risks and Responses*; FAO: Rome, Italy, 2015.
5. European Commission. Farm to Fork Strategy for a Fair, Healthy and Environmentally-Friendly Food System. In *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions*; European Commission: Brussels, Belgium, 2020.
6. European Commission. *The European Green Deal*; Communication No. COM/2019/640; European Commission: Brussels, Belgium, 2019.
7. European Commission. *EU Biodiversity Strategy for 2030: Bringing Nature Back into Our Lives*; Publications Office of the European Union: Brussels, Belgium, 2021.
8. Sakellaris, G. Bioeconomy Education. In *Bio#Futures*; Koukios, E., Sacio-Szymańska, A., Eds.; Springer International Publishing: Cham, Switzerland, 2021; pp. 489–506. ISBN 978-3-030-64969-2.

9. Kőmíves, P.M.; Pilishegyi, P.; Novák, N.; Nagy, A.S.; Körösparti, P. The Role of the Higher Education in the Development of the Agriculture. *Int. J. Inf. Educ. Technol.* **2019**, *9*, 607–612. [CrossRef]
10. Akyazi, T.; Goti, A.; Oyarbide, A.; Alberdi, E.; Bayon, F. A Guide for the Food Industry to Meet the Future Skills Requirements Emerging with Industry 4.0. *Foods* **2020**, *9*, 492. [CrossRef] [PubMed]
11. Sorensen, L.B.; Germundsson, L.B.; Hansen, S.R.; Rojas, C.; Kristensen, N.H. What Skills Do Agricultural Professionals Need in the Transition towards a Sustainable Agriculture? A Qualitative Literature Review. *Sustainability* **2021**, *13*, 13556. [CrossRef]
12. Fróna, D.; Szenderák, J.; Harangi-Rákos, M. Economic Effects of Climate Change on Global Agricultural Production. *Nat. Conserv.* **2021**, *44*, 117. [CrossRef]
13. International Labour Organisation; European Centre for the Development of Vocational Training; European Training Foundation; Organisation for Economic Co-Operation and Development. *Skill Needs Anticipation: Systems and Approaches: Analysis of Stakeholder Survey on Skill Needs Assessment and Anticipation*; International Labour Organisation: Geneva, Switzerland, 2017.
14. Gualtieri, V.; Curtarelli, M.; Donlevy, V.; Shater Jannati, M. *ICT for Work: Digital Skills in the Workplace: Final Report*; Publications Office: Brussels, Belgium, 2017.
15. Silva, L.L.; Baptista, F.; Cruz, V.F. Analysis of Skills Needs for Agricultural Workers for a "Sustainable Agriculture". 2017. Available online: http://www.sagriproject.eu/wp-content/uploads/2018/11/D2.1_Analysis-of-skills-needs-for-agricultural-workers_EN_VFinal.pdf (accessed on 3 January 2023).
16. Hamann, K.; Gentile, M.; Loi, A.; Hegyi, A.; Zelenák, L. *New Professions and Career Paths in the Food and Drink Industry: Delivering High-Level Food Industry Skills in the Digital Economy*; European Federation of Food, Agriculture and Tourism Trade Unions, and Food Drink Europe: Brussels, Belgium, 2019.
17. Kelly, E.C.; Brown, G. Who Are We Educating and What Should They Know? An Assessment of Forestry Education in California. *J. For.* **2019**, *117*, 95–103. [CrossRef]
18. Forestry Skills Forum. *Forestry Workforce Research*; RDI Associates Ltd.: Edinburgh, UK, 2021.
19. Jack, C.; Anderson, D.; Connolly, N. Innovation and Skills: Implications for the Agri-Food Sector. *Educ. Train.* **2014**, *56*, 271–286. [CrossRef]
20. Phillips, C. The Role of the Universities in Agriculture Teaching and Research in the Twenty-First Century. *Outlook Agric.* **1999**, *28*, 253–256. [CrossRef]
21. Mayor, L.; Lindner, L.F.; Knöbl, C.F.; Ramalho, A.; Berruto, R.; Sanna, F.; Rossi, D.; Tomao, C.; Goodburn, B.; Avila, C.; et al. Skill Needs for Sustainable Agri-Food and Forestry Sectors (I): Assessment through European and National Focus Groups. *Sustainability* **2022**, *14*, 9607. [CrossRef]
22. Trienekens, J.; Morrenhof, W.; Nanda, A.; Bozou, E.; Lazaro Mojica, J.; Kretschmann, L. D1.8—Trend and Scenario Analysis. 2021. Available online: http://www.erasmus-fields.eu/management/sites/default/files/documents/final/D1.8_T1.5_FIELDS_Trend%20and%20scenario%20analysis_final.pdf (accessed on 5 January 2023).
23. Grbich, C. *Qualitative Research in Health: An Introduction*; Sage: London, UK, 1998; ISBN 1446235017.
24. Elliott, A.C.; Hynan, L.S. A SAS® Macro Implementation of a Multiple Comparison Post Hoc Test for a Kruskal–Wallis Analysis. *Comput. Methods Programs Biomed.* **2011**, *102*, 75–80. [CrossRef]
25. Darnhofer, I.; Bellon, S.; Dedieu, B.; Milestad, R. Adaptiveness to Enhance the Sustainability of Farming Systems. A Review. *Agron. Sustain. Dev.* **2010**, *30*, 545–555. [CrossRef]
26. Aver, B.; Fošner, A.; Alfirević, N. Higher Education Challenges: Developing Skills to Address Contemporary Economic and Sustainability Issues. *Sustainability* **2021**, *13*, 12567. [CrossRef]
27. Duru, M.; Therond, O.; Martin, G.; Martin-Clouaire, R.; Magne, M.-A.; Justes, E.; Journet, E.-P.; Aubertot, J.-N.; Savary, S.; Bergez, J.-E.; et al. How to Implement Biodiversity-Based Agriculture to Enhance Ecosystem Services: A Review. *Agron. Sustain. Dev.* **2015**, *35*, 1259–1281. [CrossRef]
28. Charatsari, C.; Lioutas, E.D. Is Current Agronomy Ready to Promote Sustainable Agriculture? Identifying Key Skills and Competencies Needed. *Int. J. Sustain. Dev. World Ecol.* **2019**, *26*, 232–241. [CrossRef]
29. Bollini, L.; Caccamo, A.; Martino, C. Interfaces of the Agriculture 4.0. In Proceedings of the WEBIST, Vienna, Austria, 18–20 September 2019; pp. 273–280.
30. Romanello, R.; Veglio, V. Industry 4.0 in Food Processing: Drivers, Challenges and Outcomes. *Br. Food J.* **2022**, *124*, 375–390. [CrossRef]
31. Ojo, O.O.; Shah, S.; Coutroubis, A.; Jiménez, M.T.; Ocana, Y.M. Potential Impact of Industry 4.0 in Sustainable Food Supply Chain Environment. In Proceedings of the 2018 IEEE International Conference on Technology Management, Operations and Decisions (ICTMOD), Marrakech, Morocco, 21–23 November 2018; pp. 172–177.
32. Lytos, A.; Lagkas, T.; Sarigiannidis, P.; Zervakis, M.; Livanos, G. Towards Smart Farming: Systems, Frameworks and Exploitation of Multiple Sources. *Comput. Netw.* **2020**, *172*, 107147. [CrossRef]
33. Payne, J.; Willis, M. *Digital Solutions Used by Agriculture Market System Actors in Response to COVID-19*; United States Agency for International Development: Washington, DC, USA, 2021.
34. Fountas, S.; Mylonas, N.; Malounas, I.; Rodias, E.; Hellmann Santos, C.; Pekkeriet, E. Agricultural Robotics for Field Operations. *Sensors* **2020**, *20*, 2672. [CrossRef] [PubMed]
35. Tummers, J.; Kassahun, A.; Tekinerdogan, B. Obstacles and Features of Farm Management Information Systems: A Systematic Literature Review. *Comput. Electron. Agric.* **2019**, *157*, 189–204. [CrossRef]

36. Zeng, Y.; Jia, F.; Wan, L.; Guo, H. E-Commerce in Agri-Food Sector: A Systematic Literature Review. *Int. Food Agribus. Manag. Rev.* **2017**, *20*, 439–460. [CrossRef]
37. Cai, Y.; Lang, Y.; Zheng, S.; Zhang, Y. Research on the Influence of E-Commerce Platform to Agricultural Logistics: An Empirical Analysis Based on Agricultural Product Marketing. *Int. J. Secur. Its Appl.* **2015**, *9*, 287–296. [CrossRef]
38. Bojkić, V.; Vrbančić, M.; Žibrin, D.; Čut, M. Digital Marketing in Agricultural Sector. *Entren. Enterp. Res. Innov.* **2016**, *2*, 419–424.
39. Jouanjean, M.-A. *Digital Opportunities for Trade in the Agriculture and Food Sectors*; Organisation for Economic Co-operation and Development: Paris, France, 2019.
40. Fecke, W.; Danne, M.; Musshoff, O. E-Commerce in Agriculture—The Case of Crop Protection Product Purchases in a Discrete Choice Experiment. *Comput. Electron. Agric.* **2018**, *151*, 126–135. [CrossRef]
41. Khan, N.; Ray, R.L.; Kassem, H.S.; Hussain, S.; Zhang, S.; Khayyam, M.; Ihtisham, M.; Asongu, S.A. Potential Role of Technology Innovation in Transformation of Sustainable Food Systems: A Review. *Agriculture* **2021**, *11*, 984. [CrossRef]
42. Barth, H.; Melin, M. A Green Lean Approach to Global Competition and Climate Change in the Agricultural Sector—A Swedish Case Study. *J. Clean. Prod.* **2018**, *204*, 183–192. [CrossRef]
43. Fanzo, J. Ethical Issues for Human Nutrition in the Context of Global Food Security and Sustainable Development. *Glob. Food Secur.* **2015**, *7*, 15–23. [CrossRef]
44. Mbow, C.; Rosenzweig, C.; Barioni, L.G.; Benton, T.G.; Herrero, M.; Krishnapillai, M.; Liwenga, E.; Pradhan, P.; Rivera-Ferre, M.-G.; Sapkota, T.; et al. Food Security. In *Climate Change and Land: An IPCC Special Report on Climate Change, Desertification, Land Degradation, Sustainable Land Management, Food Security, and Greenhouse Gas Fluxes in Terrestrial Ecosystems*; Shukla, P., Skea, J., Buendia, E.C., Mas-son-Delmotte, V., Pörtner, H.-O., Roberts, D., Zhai, P., Slade, R., Connors, S., van Diemen, R., Eds.; Intergovernmental Panel on Climate Change: Geneva, Switzerland, 2019.
45. Wernaart, B.F.W. *Applied Food Science*; Wernaart, B., van der Meulen, B., Eds.; Wageningen Academic Publishers: Wageningen, The Netherlands, 2022; ISBN 978-90-8686-381-5.
46. McClements, D.J.; Barrangou, R.; Hill, C.; Kokini, J.L.; Lila, M.A.; Meyer, A.S.; Yu, L. Building a Resilient, Sustainable, and Healthier Food Supply Through Innovation and Technology. *Annu. Rev. Food Sci. Technol.* **2021**, *12*, 1–28. [CrossRef] [PubMed]
47. WEF (World Economic Forum). *Innovation with a Purpose: The Role of Technology Innovation in Accelerating Food Systems Transformation*; WEF: Geneva, Switzerland, 2019.
48. Mayor, L.; Flynn, K.; Dermesonluoglu, E.; Pittia, P.; Baderstedt, E.; Ruiz-Bejarano, B.; Geicu, M.; Quintas, M.A.C.; Lakner, Z.; Costa, R. Skill Development in Food Professionals: A European Study. *Eur. Food Res. Technol.* **2015**, *240*, 871–884. [CrossRef]
49. Robles, M.M. Executive Perceptions of the Top 10 Soft Skills Needed in Today's Workplace. *Bus. Commun. Q.* **2012**, *75*, 453–465. [CrossRef]
50. Sample, V.A.; Ringgold, P.C.; Block, N.E.; Giltmier, J.W. Forestry Education: Adapting to the Changing Demands on Professionals. *J. For.* **1999**, *97*, 4–10. [CrossRef]
51. Easterly III, R.G.; Warner, A.J.; Myers, B.E.; Lamm, A.J.; Telg, R.W. Skills Students Need in the Real World: Competencies Desired by Agricultural and Natural Resources Industry Leaders. *J. Agric. Educ.* **2017**, *58*, 225–239. [CrossRef]
52. Dench, S.; Hillage, J.; Reilly, P.; Kodz, J. *Employers Skill Survey: Case Study Food Manufacturing Sector*; DFEE: Sheffield, UK, 2000.
53. Bailey, N.E.; Arnold, S.K.; Igo, C.G. Educating the Future of Agriculture: A Focus Group Analysis of the Programming Needs and Preferences of Montana Young and Beginning Farmers and Ranchers. *J. Agric. Educ.* **2014**, *55*, 167–183. [CrossRef]
54. Bullard, S.H. Forestry Curricula for the 21st Century—Maintaining Rigor, Communicating Relevance, Building Relationships. *J. For.* **2015**, *113*, 552–556. [CrossRef]
55. Sample, V.A.; Bixler, R.P.; McDonough, M.H.; Bullard, S.H.; Snieckus, M.M. The Promise and Performance of Forestry Education in the United States: Results of a Survey of Forestry Employers, Graduates, and Educators. *J. For.* **2015**, *113*, 528–537. [CrossRef]
56. Juhász, T.; Horváth-Csikós, G. The Emergence of Soft Skills in Agricultural Education. *Probl. Perspect. Manag.* **2021**, *19*, 453–466. [CrossRef]
57. Flynn, K.; Wahnström, E.; Popa, M.; Ruiz-Bejarano, B.; Quintas, M.A.C. Ideal Skills for European Food Scientists and Technologists: Identifying the Most Desired Knowledge, Skills and Competencies. *Innov. Food Sci. Emerg. Technol.* **2013**, *18*, 246–255. [CrossRef]
58. Howieson, J.; Lawley, M.; Hastings, K. Value Chain Analysis: An Iterative and Relational Approach for Agri-Food Chains. *Supply Chain. Manag. Int. J.* **2016**, *21*, 352–362. [CrossRef]
59. Reynolds, N.; Fischer, C.; Hartmann, M. Determinants of Sustainable Business Relationships in Selected German Agri-food Chains. *Br. Food J.* **2009**, *111*, 776–793. [CrossRef]
60. Schmiemann, M. Inter-Enterprise Relations in Selected Economic Activities. *Eurostat Stat. Focus* **2007**, *57*, 1–8.
61. Miller, N.J.; Mcleod, H.; Young Ob, K. Managing Family Businesses in Small Communities. *J. Small Bus. Manag.* **2001**, *39*, 73–87. [CrossRef]
62. Stanford-Billington, C.; Cannon, A. Do Farmers Adopt a Strategic Planning Approach to the Management of Their Businesses. *J. Farm Manag.* **2010**, *14*, 3–40.
63. Tell, J.; Hoveskog, M.; Ulvenblad, P.; Ulvenblad, P.-O.; Barth, H.; Ståhl, J. Business Model Innovation in the Agri-Food Sector: A Literature Review. *Br. Food J.* **2016**, *118*, 1462–1476. [CrossRef]
64. McElwee, G. A Taxonomy of Entrepreneurial Farmers. *Int. J. Entrep. Small Bus.* **2008**, *6*, 465–478. [CrossRef]
65. Anderson, A.R.; Jack, S.L. Role Typologies for Enterprising Education: The Professional Artisan? *J. Small Bus. Enterp. Dev.* **2008**, *15*, 259–273. [CrossRef]

66. Alvarez, A.; García-Cornejo, B.; Pérez-Méndez, J.A.; Roibás, D. Value-Creating Strategies in Dairy Farm Entrepreneurship: A Case Study in Northern Spain. *Animals* **2021**, *11*, 1396. [CrossRef]
67. Pindado, E.; Sánchez, M. Researching the Entrepreneurial Behaviour of New and Existing Ventures in European Agriculture. *Small Bus. Econ.* **2017**, *49*, 421–444. [CrossRef]
68. Cf, O. *Transforming Our World: The 2030 Agenda for Sustainable Development*; United Nations: New York, NY, USA, 2015.
69. Augère-Granier, M.-L. Agricultural Education and Lifelong Training in the EU. European Parliamentary Research Service. 2017. Available online: https://www.europarl.europa.eu/RegData/etudes/BRIE/2017/608788/EPRS_BRI(2017)608788_EN.pdf (accessed on 9 January 2023).
70. Erickson, B.; Fausti, S.; Clay, D.; Clay, S. Knowledge, Skills, and Abilities in the Precision Agriculture Workforce: An Industry Survey. *Nat. Sci. Educ.* **2018**, *47*, 1–11. [CrossRef]
71. Laforge, J.M.L.; McLachlan, S.M. Learning Communities and New Farmer Knowledge in Canada. *Geoforum* **2018**, *96*, 256–267. [CrossRef]
72. Lankester, A.J. Conceptual and Operational Understanding of Learning for Sustainability: A Case Study of the Beef Industry in North-Eastern Australia. *J. Environ. Manag.* **2013**, *119*, 182–193. [CrossRef]
73. Shepherd, M.; Turner, J.A.; Small, B.; Wheeler, D. Priorities for Science to Overcome Hurdles Thwarting the Full Promise of the 'Digital Agriculture' Revolution. *J. Sci. Food Agric.* **2020**, *100*, 5083–5092. [CrossRef]
74. Vlachopoulou, M.; Ziakis, C.; Vergidis, K.; Madas, M. Analyzing AgriFood-Tech e-Business Models. *Sustainability* **2021**, *13*, 5516. [CrossRef]