

Skill Needs for Sustainable Agri-Food and Forestry Sectors (I): Assessment through European and National Focus Groups

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## Article

# Skill Needs for Sustainable Agri-Food and Forestry Sectors (I): Assessment through European and National Focus Groups

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**Abstract:** The agri-food and forestry sectors are under increasing pressure to adapt to climate change, consumer concern, technological and economic change, and complex global value chains. In turn, such challenges require that the necessary skills and competences are identified at various levels and within specific areas of the sectors. For that purpose, eleven focus groups in nine different EU-countries and two at EU-level were organized within the ERASMUS+ project “FIELDS” with the participation of farmers, cooperatives, agri-food companies, foresters, forest industries, advisors, and education providers to identify the skills needed in the agri-food and forestry sectors. The focus group participants identified business and strategic management skills, communication skills, and other skills related to sustainability, entrepreneurship, digital and soft skills to be most important for the agri-food and forestry sectors as a whole.

**Keywords:** education; training; skill needs; farmers; food industry; forestry; focus groups

## 1. Introduction

Climate change, the greening of products and processes, the reuse of side-stream products, the raised complexity of value chains, and the increased availability of information-driven novel challenges and opportunities in the agri-food and forestry sectors. Agri-food systems are highly dependent on climatic changes and integrally considered major world players in the fight for long term natural resource sustainability and a critical subsystem for the climate change challenge [1,2]. Furthermore, the agri-food and forestry sectors are more and more affected by enabling ICT technologies in practically all parts of the value chain. Such developments draw both sectors into a stream of global level innovation and lead to a readjustment of skills and job profiles.

To successfully address and react to these drivers, the agri-food and forestry workforce needs new skills and competences, which, in turn, require the identification of needed existing and emerging skills in the categories of bioeconomy, sustainability, and digital technology. This is necessary to develop a strategic approach keeping the European agri-food and forestry sectors competitive and sustainable in the long term [3,4].

Significant efforts have been invested in the assessment of skill needs in various working sectors in the last years [5], and in particular, research has been invested into the current and future agri-food and forestry workforce.

For the farming sector, literature reviews and bibliometric analyses have been performed on key trends and challenges for higher education regarding the development of a sustainable and resilient European economy [6]; specifically, farmers' entrepreneurship skills [7] and skill needs for professionals to engage in the transition towards sustainable agriculture [8]. Moreover, empirical research, such as surveys and focus groups, have been conducted examining skill needs in the precision agriculture workforce [9]; personal, communication, and leadership skills desired for agricultural and natural resources industry leaders [10]; and skill needs and competences for agronomists to promote sustainable agriculture [11].

Flynn et al. [12] organized workshops with food industry employers to identify the most desired knowledge, skills, and competences in the food industry workforce. Mayor et al. [13] compared the results by Flynn et al. [12] and carried out a survey to food industry professionals assessing training needs. Furthermore, Handayani et al. [14] performed surveys to identify green skill needs for food industry vocational graduates assessing the current skills in small and medium enterprises in the Thai food industry, and Akyazi et al. [15] developed a database on current and future skills emerging within Industry 4.0 for different food industry professional profiles.

The forestry skills forum, in its forestry workforce 2021 research report (forestry skills forum [16], highlighted the increased importance and lack of non-forestry skills, such as business and commercial skills, digital skills, and marketing/promotional skills. Forestry programs' performance in terms of provision of knowledge and skills for contemporary forestry professionals was assessed [17], while Blanc et al. [18] identified the forestry training sector stakeholders in the Western Italian Alps and described their characteristics and priorities in relation to training activities on entrepreneurial topics for forestry loggers.

The ERASMUS+ "FIELDS" project started in 2020 and aims at addressing the current and future skill needs for sustainability, digitalization, and bioeconomy in the agri-food and forestry sectors. When the project began in 2020, project partners encroached upon the assessment of skill needs through a set of activities that begun with the organization of focus groups (FGs), followed by a European survey and with the implementation of a future scenario analysis. All these activities were complementary and used later in the project to design training activities in different European countries.

FGs are small group discussions in which participants respond to a series of questions focused on a single topic. A skilled facilitator meets with five to twelve people to collect in-depth qualitative information about the group's ideas, perceptions, attitudes, or experiences on the defined topic [19]. FGs originate in marketing research as a method of collecting information about consumer perceptions and attitudes. Today, FGs are a common data collection technique in behavioral and social sciences, business, and in many other areas of knowledge production [20–22]. More specifically in education and training, FGs have been used in different activities, such as training needs assessment, the development of new training methodologies, curricula improvement, and marketing strategies for educational programs [23–25].

FG discussions typically involve face-to-face facilitation, although there is growing interest in utilizing digital technologies to conduct online FGs because of the many advantages: they are easier to attend, it is possible to recruit participants from different locations and the time and resources organizations spend are significantly reduced [26]. Another

advantage is that by using online web-conferencing tools, FGs can be easily recorded, making the collection and processing of data easier and less time consuming.

In the FIELDS project, eleven FGs were carried out in nine countries during the period of May to July 2020 to assess the skills and training needs of current and future professionals of the agri-food and forestry sectors in the areas of sustainability, bioeconomy, digitalization, soft skills, and business entrepreneurship skills. The FGs, organized at national (all sectors) and at European Level (Forestry sector and Policy issues), tackled several aspects related to skill needs and best methodologies to carry out the required training. The results were later used to develop a European survey on skill needs [27] and to support a future scenario analysis on the same topic. Due to the COVID pandemic, FGs were held in online synchronous mode.

This work shows the findings of the first part of the FIELDS FGs related to skill needs, and also on the FG on policy aspects linked to those needs.

## 2. Materials and Methods

### 2.1. Focus Group Guidelines

FG guidelines were prepared by FIELDS project partners to plan, conduct, and report the findings of the FGs, making sure that a common methodology was followed in all of them. Due to the COVID-19 situation in spring of 2020, it was decided to conduct all FGs online using online web-conferencing tools and following guidelines providing specific online set-up recommendations. While the FGs were structured into two main sections on skill needs and training methods, this paper deals only with the results from the first section on skill needs.

### 2.2. Focus Group Organization

In the recruitment phase, FG organizers recruited between five and ten participants per FG from at least five of the following stakeholder profiles: farmers, cooperatives, agri-food companies, foresters, forest industries, advisors, education providers, and others (policy makers, market actors, consumers, etc.) and participants with proven experience and/or representing sectors at national level. For the European Forestry and Policy FGs, European associations representing the education, food, and forest industries, farmers and farm cooperatives, and trade unions were recruited. FG organizers sent invitations to participants including an information sheet about the project and an informed consent form to be filled in by participants beforehand.

### 2.3. Data Collection Previous to the Focus Groups

Skill categories on (A1) sustainability, (A2) digitalization, (A3) bioeconomy, (A4) soft skills, and (A5) business entrepreneurship were prepared by project partners allowing for input from different perspectives and backgrounds: companies, education providers (vocational education and training organizations, high schools and universities), chambers of commerce, national associations of cooperatives and agri-food companies, European representatives of the agri-food and forestry sectors, and others. Within the skill category of bioeconomy, it was decided to distinguish between agriculture (Table A3a), forestry (Table A3b), and food industry (Table A3c) skills. The resulting five FIELDS skills lists are outlined in Appendix A.

For the sake of simplicity, skill lists were shortened, skill concepts kept short, and the term “skills” was identified as a set of knowledge, skills, and competences related to a certain topic (as an example, the skill “communication” included the knowledge, skills, and competences related to communication, and the same applied to all the skills appearing in the lists).

The five skill lists were sent to all FG participants beforehand. Participants were asked to rank in order of importance (where one was most important and five least important), on each of the five skills lists, the five most important skills for the sector they represent (e.g., farmer, forester, food industry, etc.). Furthermore, participants were asked to look at

their rankings on each of the five skills lists and select the 10 overall most important skills among all 25 skills and rank them in order of importance (where 1 was the most important and 10 the least important). Data was collected by email through excel sheets.

#### 2.4. Running of the Focus Groups

In the period from May to July 2020, eleven online FGs were held, nine at national level (in Italy, Ireland, Spain/Portugal, Netherlands, Austria, Germany, Greece, France, and Slovenia) and two at a pan-European level (forestry sector training needs and EU policy issues). Table 1 shows the composition of the FGs.

**Table 1.** Composition of the FGs.

Country	Farmers	Cooperatives	Food Industry	Foresters	Forest Industry	Educators	Advisors	Other	TOT	Main Organizer
Italy	1	1	2	1		5		3	13	Confagricoltura <sup>4</sup>
Ireland	2	2	2	1		3	2	1	13	ICOS <sup>5</sup>
Spain/Portugal	1	2				2	3	2	10	FIAB <sup>6</sup>
Netherlands	1		1	1		3	2		8	AERES <sup>7</sup>
Austria	1	2	1	1	1	5	1		12	LVA <sup>8</sup>
Germany		1	1			1	1	3	7	UHOH <sup>9</sup>
Greece	1	1	1			2	1		6	EFB <sup>10</sup>
France	2		1			3		3	9	AC3A <sup>11</sup>
Slovenia	2	1	1			3	1		8	GZS <sup>12</sup>
EU-Forest		1		2	2	4	5		14	CEPI <sup>13</sup>
EU-Policy	3	1	2	1		4		2	13	FoodDrinkEurope <sup>14</sup>
TOT	14	12	12	7	3	35	16	14	113	

Superscripts correspond to affiliation information.

Each of the FGs followed the same procedure of conduction and the same questions (except for the FG Policy) were posed in all of them. All FGs included a facilitator and a rapporteur, both from the FG organizing institution, who both acted as observers and from whom no data was collected. In the first section of the FG, participants were asked to present the three most important skills on their top 10 list and explain why these skills were important for them, following a Round Robin format [19], where the facilitator asked each person to respond to the same question in turn. The FGs followed a list of questions related to skill needs and training methodologies, although this article focuses on the first *Round Robin* part.

On average, each FG lasted two hours. They were conducted in the national languages with different online web-conferencing tools (GoToMeeting, Zoom, etc.) and digitally recorded for the further processing of information.

#### 2.5. Reporting

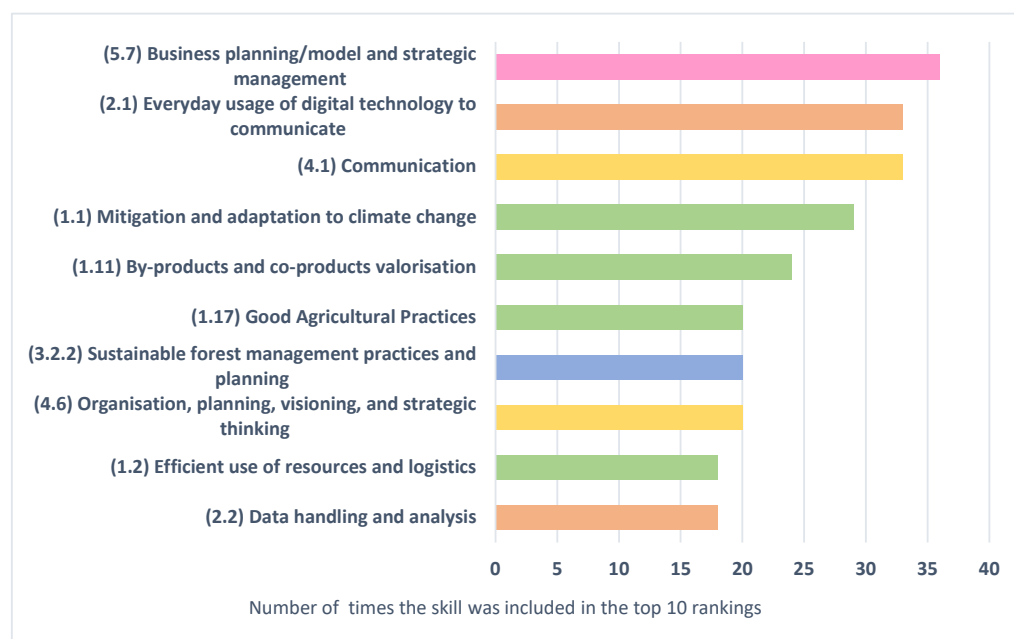
Each FG organizer was asked to prepare:

1. An executive summary of the FG.
2. A transcription of the audio file in English. The free YouTube transcription tool was used when available (depending on the language), and when not, transcription was carried out manually from the video recording. When quoting FG participants, data were anonymized by assigning 5-digit ID strings indicating FG country, stakeholder profile, participant number, gender, and role in the FG (participant or moderator/rapporteur).

### 3. Results and Discussion

#### 3.1. Most Important Skills, All Countries, All Sectors

Ninety-five participants carried out the 10-ranking exercise. Figure 1 shows the most selected skills in the 10-rankings, considering working sectors and countries as a whole.



**Figure 1.** Most selected skills from the skills lists, 10-ranking exercise. In brackets skill numbers from Appendix A tables.

Viewed independently of the sector or country participants represent, skills related to *business planning/model and strategic management* were deemed very important, followed by communication skills. Skills related to doing business, including business management and planning and financial and economic understanding were relevant to all types of stakeholders represented in the FGs. As a cooperative advisor said in the Spanish/Portuguese FG: “All our farmers, forest producers, industries, are in a field of economic development and it must be very clear what their role is, how value is generated, how profit is generated. I have seen how farmers have been successful, even as entrepreneurs, many times in businesses that they did not know [ . . . ] But I think they started from a base of understanding the business”. Additionally, the need for understanding business and where it is going so as to adapt to current and future challenges was mentioned: “we need to sort of reassess what we do on a day-to-day basis, we can’t push additional costs onto the customer, and understand where business is going and be prepared for what’s happening in the future” (agri-food industry, Irish FG). In this sense, Bröring and Vanaker [28] stressed the need for designing new business models from a bioeconomy perspective to enable the translation of new emerging technologies into value propositions and, thus, product–market applications.

Following skills related to *business planning/model and strategic management*, FG participants identified *digital skills* to be very important. While digitalization is here to stay, participants also recognized that digital skills entail communication skills and that the acquisition of more demanding digital skills is equally important. As an education provider said in the French FG: “[ . . . ] is something that is of fundamental importance today and we realize that codes and instructions for use are not necessarily mastered by everyone”. In the same vein, the European Commission stated: “Information and communication technologies profoundly and irreversibly affect the ways of working, accessing knowledge, socializing, communicating, collaborating—and succeeding—in all areas of the professional, social, and personal life of European young people and citizens” [29].

FG participants addressed the importance of *communication skills* at different levels: among day-to-day collaborators, among different actors of the agri-food and forestry sectors, and with consumers and society in general; emphasizing not only one-way communication but as a tool for engagement and interaction with networks and for collaboration concerning higher-level topics, such as sustainability. As a cooperative participant in the Irish FG said: “there’s a vast amount of stakeholders that we need to engage with whether



that's our own shareholders, board employees, customers, so I think communication skills are critical in terms of creating a rationale for change and making sustainability or some of the complex concepts much more accessible and putting them into more layperson's terms". Additionally, the ability to inform and create awareness about processes and decisions to various stakeholders was highlighted as an important aspect of communication skills: "I think that everywhere we have attacks on agriculture [ . . . ] and that agriculture does not know how to communicate what it does, the food it produces daily for everyone and in the times we are living, is important the skill to communicate and learn to publish what we do" (farm advisor, Spanish/Portuguese FG). Communication and social cooperation were identified as skills strongly related to employability for the 21st century [30].

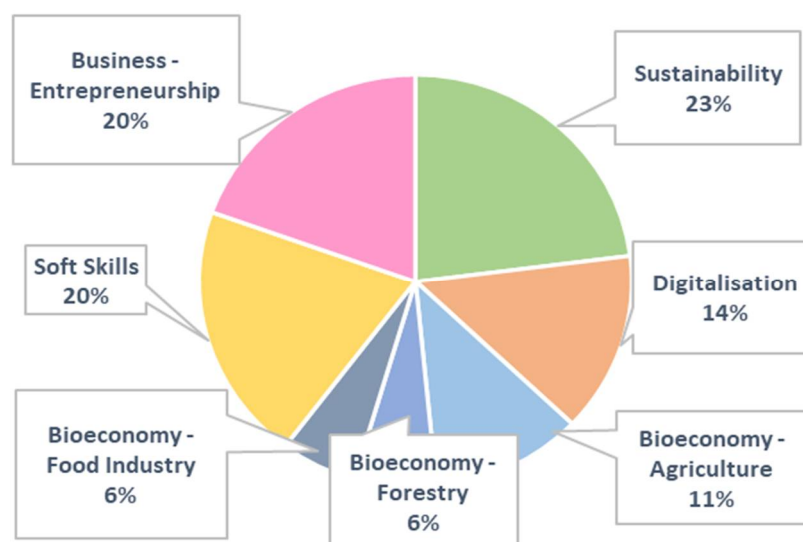
Skills related to sustainability were selected by participants and within this category skills for *mitigation and adaptation to climate change, by-products and coproducts valorization, and good agricultural practices* particularly. Skills for *mitigation and adaptation to climate change* were regarded as important to find solutions to exacerbate climate conditions and important for contributing to more sustainable and adaptable agri-food and forestry sectors. As a farmer of the Austrian FG commented: "[ . . . ] weather and the climate are constantly changing and extreme weather events must be taken into account, and we must find solutions to this and make adjustments, especially in the producing sector of agriculture". Skills for mitigating and adapting to climate change were also connected to communication skills and the ability to inform and create awareness in society about actions taken by key actors for environmental sustainability. As a cooperative participant from the Irish FG emphasized: "It's absolutely critical that we will be employing people that know this, that are able to talk about this and who can basically go one-to-one with de NGOs and others that are attacking our sector". Skills for valorizing *by products and co-products* were found important in the context of circular economy, resource efficiency, and conservation; their use as an energy source; for innovative product development; or as an opportunity for creating or relocating jobs. As a representative from an agri-food company in France said: "I think that a fundamental element for the bioeconomy is also the knowledge of potential resources, and more specifically the biomass field, there is training to be done in this area"; an Austrian farmer commented: "By-product use and economic usability, is again connected with the bioeconomy, that new value added chains can open up, and if you have something innovative that you can bring to market"; and a French education provider indicated: "When you need jobs that cannot be relocated, the bioeconomy is one of the major activities that allows that, the valorization of co-products is one of them". Skills for *good agricultural practices* from a sustainability perspective were also selected as important for solving day-to-day problems in farming operations, while the normative aspect of these practices was also noted as a market requirement. As a cooperative participant in the Greek FG said: "It is not enough just to harvest and transport to the premises of the cooperative, the product must also meet all these characteristics required by the market. The standards that our customers ask (GLOBAL GAP, ISO . . . ) are essentially the standards that we give priority to our producers". In this regard, viewing practitioners as change-agents in the move towards more sustainable agri-food chains was also maintained. As an advisor in the Iris FG commented: "[ . . . ] to have and to get really simple practices out there into practice on farms to try and give people the confidence, and I suppose an attitude change to how they can do an awful lot to contribute towards those challenges in terms of climate".

Skills for *sustainable forest management practices and planning* were also regarded as important, including forest regulations on sustainability. As a farmer participant in the Austrian FG put it: "[ . . . ] forestry already has many regulations on sustainability, and yet there is still more pressure coming from the NGOs in the direction of more and stricter sustainability requirements in the forestry sector". Additionally, innovative forestry practices and products were highlighted: "there are some sustainable products, what you can or cannot make out of wood, so there is also the term non-timber forest products. I believe that a great deal of knowledge can and should still be created here" (forest industry, Austrian FG).

Soft skills related to *organization, planning, visioning, and strategic thinking* were mentioned as important for looking ahead and making sound and long-term choices and decisions. As a cooperative participant of the Spanish/Portuguese FG said: “To do a strategic planning, your digitization needs, your logistics needs, your training of personnel. Not in all agri-food companies has the culture of strategic planning been acquired and it is fundamental”. Along the same lines, an education provider in the Slovenian FG pointed out: “We focus too much on the present or on some short-term survival decision-making. Too little emphasis is given to strategic thinking”. Bikse et al. [30] identified *perspective taking* as a core skill for employability in the 21st century and also as organizational skills [15].

*Skills for the efficient use of resources and logistics* were regarded as important for sustainability and for business reasons. Skills for *handling and analyzing data* were seen not only as technical skills but also related to issues such as GDPR and ethics. As an education provider in the Spanish/Portuguese FG said: “This is not only the matter of analyzing the information at a technical level, but it also has many things associated with it: using our personal data and privacy issues, ethical issues . . . that is, using the information well”. Furthermore, creating awareness about the strong potential that data handling and analysis may have in agriculture and forestry was emphasized by a farmer in the French FG: “Data processing and analysis aspect is only in its infancy. Farmers are big producers of data, but these are not fully exploited because of a lack of effective and competent treatment, certainly on the part of farmers. There is also a lack of visualization of the interest that this can have, particularly in pooling and massifying data”. As reported by the European Commission [31], the transition towards Industry 4.0 will require workers to interact with digital interfaces and analyze larger amounts of data in their day-to-day decisions. The awareness of data security and protection will acquire importance as will trust in new technologies.

FG participants’ ranking of the most important skills, considering working sectors and countries as a whole (Figure 2), show that the non-technical skills of business and entrepreneurship and soft skills (together accounting for 40% of all skills), followed by sustainability and digital skills, predominate the ranking, while technical bioeconomy skills in the agri-food and forestry sectors are less pre-eminent.



**Figure 2.** Distribution of skills in categories, 10-ranking exercise.

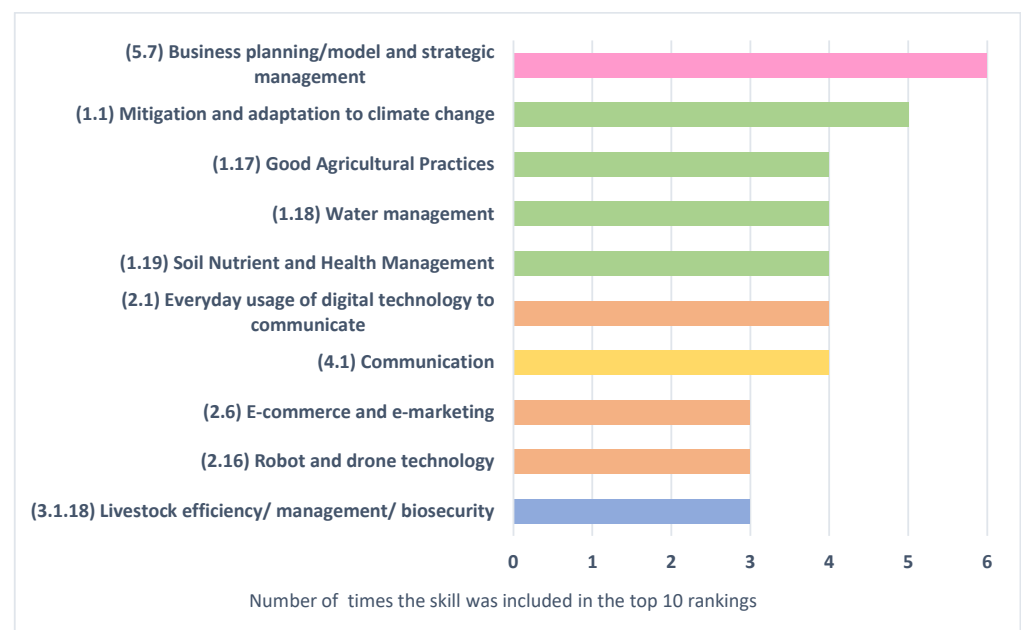
### 3.2. Most Important Skills by Producing Sector

#### 3.2.1. Farmers

When seen independently, farmers also selected *business planning/model and strategic management* as the most important skill (Figure 3). This is in line with McElwee [32] asserting that farmers are businesspeople running businesses, but in practice they do not necessarily have well-defined business skills. Previous studies suggested that a minority of farmers



have a vision or mission statements in written form, and many have no strategic mission at all [33]. Bailey et al. [34], after conducting focus groups with young farmers, found a need for more education relating to agriculture business management skills. Dias et al. [7] stated that farmers can be considered as entrepreneurs and decision-makers aiming to maximize profits to develop various typologies of agricultural diversification. In this sense the authors, based on previous literature, emphasized the importance of differentiating between entrepreneurial skills and management skills. Entrepreneurship is more than management as it is increasingly centered on innovation, risk-taking, and the discovery and exploitation of opportunities [35]. Although successful business creation also requires management skills, it is the entrepreneurial attitude which allows for perceiving opportunities [36]. In the FGs, recognizing business opportunities was included as part of *business planning/model and strategic management* (see Table A5, skill 5.7), inducing that FG participants may have perceived this skill as including both management and entrepreneurial skills.



**Figure 3.** Most selected skills by farmers. In brackets are the skill numbers from Appendix A tables.

Following from *business planning/model and strategic management*, farmers deemed sustainability skills to include *mitigation and adaptation to climate change*, *good agricultural practices*, *water management*, and *soil nutrient and health management* very important. Previous studies suggest that agricultural professionals are not prepared to promote sustainable agriculture [8,11,37]. On water management, FG participants stressed the importance of water (quantity and quality) in agriculture: “It all starts with the water. If there is water, everything can be accomplished” (farmer, Greek FG). Planning and managing technologies and legislation were considered important aspects for training: “There are many advances in technology to do good water management, but we also have to go deep into planning and management, at the level of the European policies. Either we learn to manage properly in this climate change situation that increases conflicts, or we will do a disservice to the next generations” (farmer, Spanish/Portuguese FG). For soil nutrient and health management, the proper soil management and its relation to circularity and sustainability were seen as important topics for participants: “Since resources are becoming scarce, it is actually becoming much more important to operate more circularly and to look at the end how one can produce more sustainably” (farmer, French FG). Similar studies have identified areas where skill needs for a more sustainable agriculture are needed: precision technology; remote sensing to assess land capability; integrated pest management in plant protection;

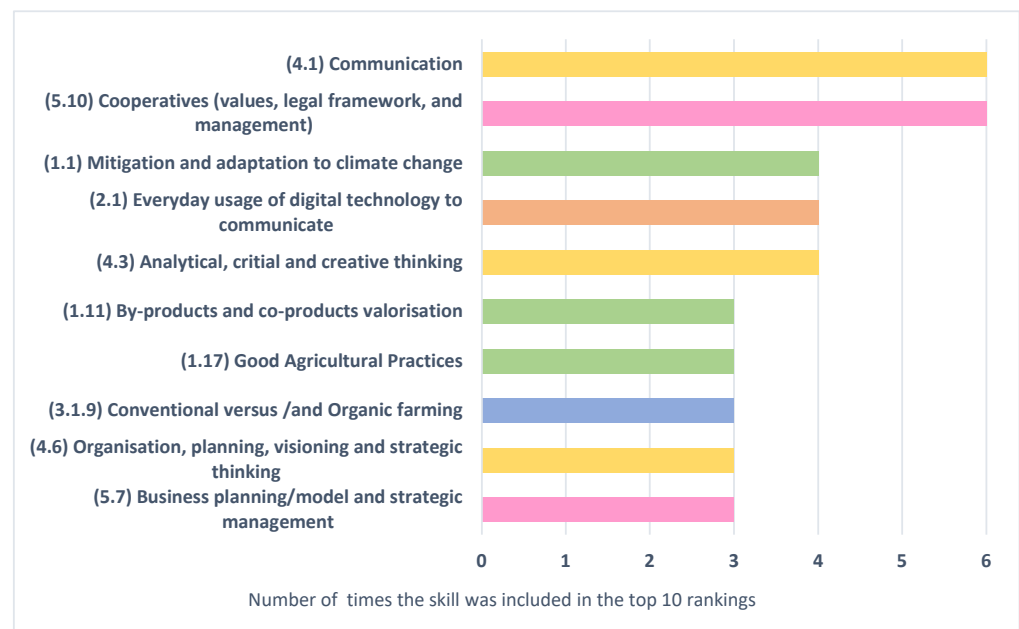
agricultural reuse of organic residuals; drip irrigation and water-conserving technologies; renewable energy; and bioenergy and energy crops [38].

Two skills related to communication follow in the list: *everyday use of digital technology to communicate* (digital skill) and *communication* (soft skill). Communication skills were also highlighted by Bailey et al. [34], who found that young farmers' desire to enhance their ability to communicate with family members, other people within their farm or ranch, and to develop the skills to communicate to a broader audience, such as loan officers and even the general public. Other works have also found communication skills very important for farmers and other agricultural workers [9–11].

Two digital skills follow in the ranking: *e-commerce and e-marketing* and *robot and drone technology*, and with the same number of citations the list finishes with *livestock efficiency/management/biosecurity* (bioeconomy–technical skill). Regarding *E-commerce and e-marketing*, the need for training was stressed on this set of skills. As a farmer from the Italian FG said: “[ . . . ] it's not like you make a site and two minutes later you sell your products. With this, there's still some work to be done because logistics costs are not easy for farms. In Italy we always run into problems of logistics not so much with large-scale distribution but with private individual.”; and from another farmer from the French FG: “The whole digitalization part is very important, we need it both for our crops, for farm management, and if we want to sell our products for direct sales. If the farmers who are selling directly are not professional enough in managing their site, then there's certainly something to work on that side of it”.

### 3.2.2. Cooperatives

*Cooperatives (values, legal framework and management)* and *communication* are the most selected skills (Figure 4) among cooperative representatives.



**Figure 4.** Most selected skills by cooperatives. In brackets skill numbers from Appendix A tables.

A cooperative participant in the Spanish FG remarked the importance of putting cooperatives in their current context: “[...] the objective of the farmer is to obtain a sustainable production and translate it into an appropriate income for his work and risk. This must be contextualized in terms of the problems of the sectoral organization, the positioning of farmers in the value chain and in relation to the context of climate change, use of natural resources, food security and globalization”.

Regarding *communication*, as a participant in the Slovenian FG said: “Communication is essential. You need to know how to communicate with the members, to coordinate with them, also in the transaction itself, the purchase, such as for example why is it so, why not otherwise, why such price? If this works well, the cooperative has much less problems than if issues are handled without any discussions”.

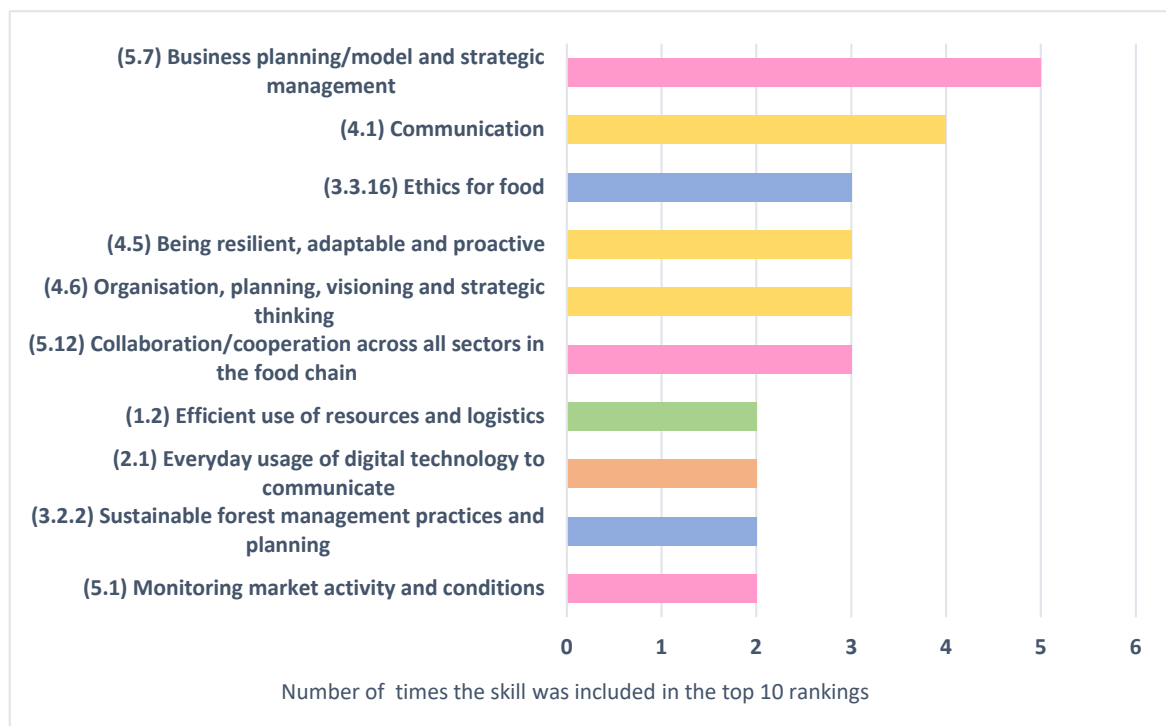
These findings are in concordance with the “Support for farmers’ cooperatives” report [39], which indicated that general technical and entrepreneurial education and training of (future) employees, managers, and board members is necessary, as well as education and training on how cooperative identity translates into business activities. The report also suggested that all parties involved need to be aware of the specific characteristics of this form of collective entrepreneurship and to develop the capacity and the willingness to communicate with each other and jointly develop their businesses.

Skills for *mitigation and adaptation to climate change*; *the everyday use of digital technology to communicate*; and *analytical, critical and creative thinking* follow in the list. For the last, a cooperative participant from the Irish FG remarked on the lack of these skills in young alumni: “[ . . . ] I see the lack of these skills in people who have just graduated, at the moment that there is an inability to kind of decipher between facts and fiction”.

Five skills follow in the list with the same number of mentions: *by-products and co-products valorization*; *good agricultural practices*; *organization, planning, visioning and strategic thinking*; *conventional vs./and organic farming*; and *business planning/model and strategic management*.

### 3.2.3. Agri-Food Companies

As observed for farmers as well as for agri-food company participants, *business planning/model and strategic management* (from the category business entrepreneurship skills) was the most selected skill followed by *communication* (soft skill); *ethics for food* (bioeconomy skill); *being resilient, adaptable and proactive* (soft skill); *organization, planning, visioning and strategic thinking* (soft skill); and *collaboration/cooperation across all sectors in the food chain* (business entrepreneurship skill) (Figure 5).



**Figure 5.** Most selected skills by agri-food companies. In brackets are the skill numbers from Appendix A tables.

Regarding the ability of *being resilient, adaptable, and proactive*, an agri-food company of the Slovenian FG said: “[...] specially in the sense that you are able to adapt to change rapidly and that you are proactive when tackling challenges”. It was also viewed as a requirement for group leaders: “being resilient and adaptable and proactive are for sort of management of people, management of the teams etc. Having the ability to deal with day-to-day life and to keep themselves going strong, being adaptable and being able to see changes and make the right decisions on a day-to-day basis” (agri-food industry, Irish FG).

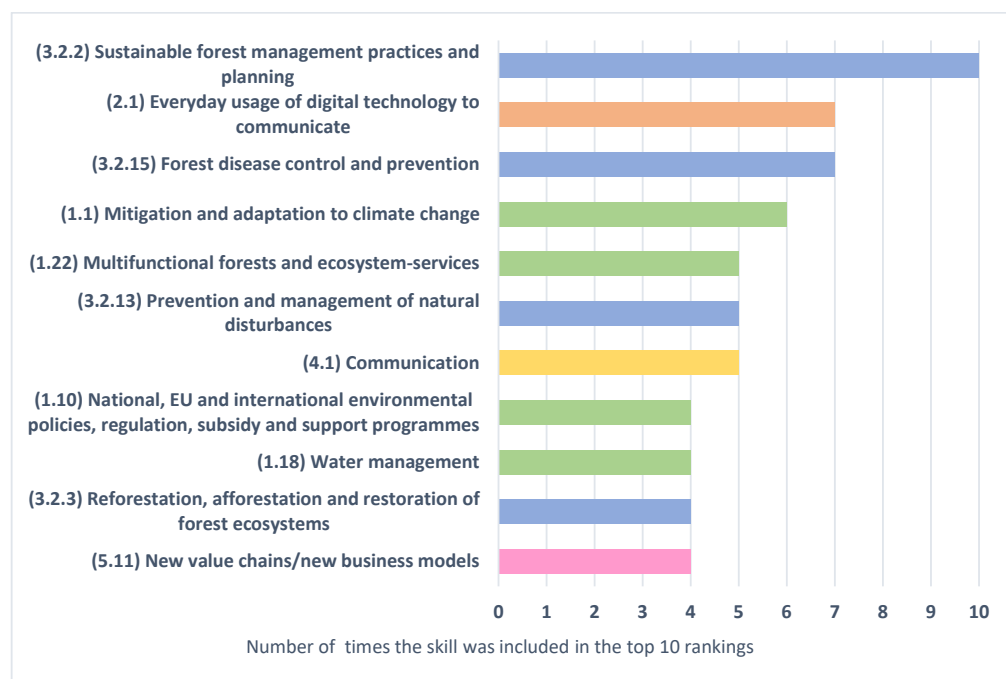
For *collaboration and cooperation across all sectors in the food chain*, an advisor from the German FG commented: “I find this cooperation very important because I often see that there are problems in communication and cooperation, simply because there is no interest or no time or no know-how”. It was also viewed as an opportunity to grow businesses: “Open communication in the value chain and pursue win-win situations (advisor, Dutch FG).

Nazzaro et al. [22], found that companies have turned towards business models based on social and environmental protections. Indeed, consumers’ purchasing behavior lead stakeholders to adopt sustainable, socially-oriented production models in which natural and environmental resources become a lever for competitive advantage. Consequently, competitiveness changes to address sustainability and citizen-consumer issues.

Akyazi et al. [15] identified current and near-future key skills and competencies emerging with Industry 4.0, demanded by different professional profiles, and generated a database of current and future professions, competencies, and skills. They used the ESCO database of knowledge, skills and competences [40] for current skills and competencies, and data from the European ICT Professional Role Profiles framework and from several sectorial and inter-sectorial European projects for future skill needs and competences. The database focuses future industry needs on digital and soft skills, and some similarities with skills from Figure 5 can be found: *advanced communication skills, use of digital communication tools, and adaptability and continuous learning*. The need for soft skills, and communication skills in particular, for food industry workers has often been reported in the literature. Jack et al. [41] found shortages in planning and organizing skills in Northern Ireland Food industry workers, especially among managers and supervisors. Flynn et al. [12], in a survey found that the most desired skills for food industry employers were soft skills and more specifically those related to communication. Mayor et al. [13], comparing Flynn results with a survey to food industry employees, confirmed the importance of soft skills also for food industry workers, and also found that marketing, consumer science, and financial skills were evaluated as low by both employers and employees, a situation that may be hindering entrepreneurship. Topliceanu et al. [42] also identified new skills requested by the food industry labor market, such as “people of character, able to work in teams, communicative and capable to cope with stressful situations”. Lertpiromsuk et al. [43], assessing current levels of skills in small and medium enterprises in the Thai food industry, found that social skills (including communication, team working, negotiation, etc.) and personal skills (including leadership, flexibility, continuous learning, working under pressure, etc.) are deemed very important for Industry 4.0.

#### 3.2.4. Forestry Sector

For the forestry sector (Forestry FG, Figure 6), overall bioeconomy–forestry and sustainability skills predominated with *sustainable forest management practices and planning* (the bioeconomy–forestry skill related to sustainability being the most selected skill followed by *everyday usage of digital technology to communicate* (digital skill) and *forest disease control and prevention* (bioeconomy–forestry skill); *mitigation and adaptation to climate change* (sustainability skill); *multifunctional forests and ecosystem services* (sustainability skill but related to forestry); *the prevention and management of natural disturbances* (bioeconomy–forestry skill); *communication* (soft skill); *national, EU, and international environmental policies; regulation, subsidy, and support programs* (sustainability skill); *water management* (sustainability skills); *the reforestation, afforestation, and restoration of forest ecosystems* (bioeconomy–forestry skill); and *new value chains/new business models* (business entrepreneurship skill).



**Figure 6.** Most selected skills for the forestry FG. In brackets are the skill numbers from Appendix A tables.

As an education provider in the Forestry FG said, *forest disease control and prevention* will need training in the coming years: “Forest Disease Control and Prevention is going to be rising at least here in Finland. As for climate change, there’s not that much pests or diseases yet, so we’re going to need new skills on that”. Additionally, the importance of skills for *prevention and management of natural disturbances* in the future were brought up: “Here in the open range regions of Austria we will have to deal much more with prevention and management of natural disturbances. First, climate change also damages forests and so people have to be more assertive in these strategies and in the interaction between the forest owners and the wood processing industry” (Advisor, Forestry FG). For *national, EU, and international environmental policies and regulation, subsidy, and support programs*, some quotations can be shown but not from the Forestry FG, although they are representative of all the FG sectors. Quotations stress the importance of these knowledge/skills because regulations affect the business strategy, they are helpful in risk prevention and important to obtain national and European funding. As a farmer of the Spanish/Portuguese FG said: “We are in a situation where administrative regulation has been put in place above science, so if we want to focus on making farms profitable, we have to combine the two aspects [...] regulation, subsidies and support programs. In the end this is what marks the path that we are going to follow as farmers, it absolutely conditions the agricultural approach of a farm”.

Communication skills have been considered an important need in the forestry sector at least since mid of the past century [44]. Written and oral communication are the basics demanded by forestry employers [45–47] but also communication skills in general [48]. In a broader sense, Bullard [49] reported that forestry employers, recent graduates, and educators agree that entry-level foresters must be better prepared than they are now in terms of communicating relevance and building strong relationships with key forestry stakeholders throughout society.

Bullard et al. [48], in focus groups and surveys to forestry employers and alumni, found that areas of knowledge on emerging issues for society-ready forestry graduates included climate change; water availability and quality; and dealing with invasive plants, pathogens, and insects. However, the skill sets and abilities that involve dealing effectively with people (communication, conflict management, problem solving, etc.) were those that

should be prioritized to strengthen the bachelor curricula. Moreover, assessing curricula content in forestry degree programs, Kelly and Brown [17] found that land-management skills should be the focus of curriculum improvement, while additionally, employers and students alike identified professional skills to be very important, especially behaving professionally and ethically and communicating effectively.

More recently, The Forestry Skills Forum [16], emphasized the need for enforcing the core silvicultural knowledge taught across all levels of forestry education, the importance of non-forestry skills, and the general lack of business and commercial acumen, digital skills, marketing/promotional skills, and those of communication and engagement.

### 3.2.5. Similarities and Differences among Sectors

Skills related to business planning, business management, and business modelling were very important for all FG participants, independent of the producing sector they pertained to. This is supported by the fact that *business planning/model and strategic management* was the most selected skill for farmers and agri-food companies and *cooperative skills* for the cooperatives sector and *sustainable forest management practices and planning* for the forestry sector. Essentially, strategic planning is about setting visions for an organization and realizing that visioning through goals, strategies, and actions; entailing on the one hand the ability to see the big picture and draw road maps, thereby planning, organizing, and executing tasks; and on the other hand, entailing the ability to communicate the vision, goals, tasks, and necessary steps to employees. Participants associated the basis of understanding business, the role of the company, its viability, and how value and profit are generated with this skill. Indeed, business planning and strategic management is very much related to the ability to adapt and respond to current and future technological, environmental, social, and economic challenges.

Communication skills appear to be also very important for all the sectors with *communication* and *everyday usage of digital technology to communicate* being the two skills among the most selected for all of them. The ability to use digital technologies to communicate and the ability to communicate overall were seen as fundamental skills in transferring information to others and in engaging with immediate stakeholders as a means of transferring information about complex concepts, such as sustainability, in an easily understandable way. Several FGs also discussed the broader concept of communication and the importance of engaging with civil society (particularly important for the forestry sector), connecting with consumers and other stakeholders not only for marketing and management purposes but also for sustainability purposes.

A shift towards business and soft skills is observed when advancing in the agri-food value chain from farmers to cooperatives and in the food industry where sustainability and digital skills predominate for farmers but are replaced by business and soft skills for cooperatives and the food industry. It seems that, from the FG participants' perspective, skills related to sustainability are critical for producing raw materials and less important when the raw produce is available in the food chain.

## 3.3. Main Outcomes from the Policy Focus Group

### 3.3.1. Focus Group Design and Implementation

With representatives from agriculture, food industry and forestry sectors, and education at European level, the FG on EU policy issues produced a set of recommendations on how to improve the current policy framework on skills and training in the agri-food and forestry sectors:

To set up the particular goals of this FG, the guiding topics were the following:

- from an EU perspective on skills needs, participants were given the opportunity to share their opinion on the skills lists developed by the FIELDS project partners linking with the work of the national FGs;
- reviewing participants' opinions on the current legislative framework: how EU policies are set in training and education and how they adapt to the sectoral needs,



particularly to the sectors specified. This matter had the intended outcome to have some recommendations on the next steps regarding EU policy.

### 3.3.2. Skill Lists Used in the National and Forestry Focus Groups

Policy FG participants found the skill lists exhaustive and appropriate for managing the expectations of the labor market. Nevertheless, since the “skills” are defined in a wide sense, it was recommended to expand the lists when used in the design of training and to be more specific in terms of knowledge, skills, and competences for each of the skills of the lists.

For the same purpose of training development and adaptation to the ESCO classification [40], participants recommended the organization of skills into a hierarchy in two ways: considering the level of education (basic, intermediate, higher education) and the level of application (general skills and specific skills that are not essential for all employees but needed in certain sectors or ESCO job profiles).

In accordance with national FGs, policy FG participants agreed on the importance of developing new skills and competences to better communicate with society and increase consumers’ trust in the agri-food and forestry sectors, particularly in aspects, such as environmental and social sustainability and risk management.

### 3.3.3. Improvement of the EU Policy Landscape

The first aspect tackled by policy FG participants was the harmonization of national educational systems for job profiles and related skills. When it comes to training activities, there is often no equal recognition in different EU countries and there is a clear discrepancy between the national and international level training. Referring to the ESCO framework, which includes all skills [40], participants highlighted the challenge of harmonizing skill concepts between countries or regions, as it is often difficult to understand the names of job positions and the skills needed because of the language barrier and as the definition of a job position and related skills are different among EU countries. Further dialogue is needed to overcome these differences since skills and training might differ among national and international policies but needs do not.

Furthermore, policy FG participants stressed the lack of understanding of the current skill challenges faced by employers and employees in the agri-food and forestry sectors. Participants agreed that the “Social Dialogue” should be strengthened, fostering communication between employers and employees at both EU and member state level, and on relevant topics such as how to train the current workforce. A cross-sectorial stakeholder dialogue (policy, academic, corporate, etc., actors) was also identified as particularly important to develop skills addressing contemporary economic and sustainability issues [6].

Social partners must provide evidence-based practices for policy makers. Good examples in this field are the recognition of universities as capacity-building entities or projects that bring together a community of different organizations and experts around a specific topic. Another best practice, as suggested by participants, could be to ensure access to lifelong learning for the entire workforce, which is, in general, poorly trained in the farming sector [33]. In the end, the exchange of best practices is a powerful tool to improve EU policy.

Finally, the need to increase the attractiveness of the agri-food and forestry sectors was stressed as one of the main causes of the continuous decline of the labor force in the last decades [50].

### 3.3.4. Recommendations/Key Messages

The final recommendations/key messages of the policy FG are presented below:

- The skills gap should be explored and even forecasted to design the training of the future.
- Curricula at universities and training centers must be adapted to the sector needs, adjusting the homologation and recognition of skills and experience.

- European strategies on education and training for workers should take a holistic approach, addressing the complexity of food and forestry systems and ensuring the coherence of the skills and training provided at the EU level in the agri-food and forestry sectors [8,51].
- The agri-food sector is the largest in Europe; there is a need to establish bigger alliances to reshape the scenario in order to support farmers and the food industry.
- There must be an evidence-based approach to provide guidelines to policy makers in the field of education in the agri-food sector. These recommendations should be given by sectorial and educational representatives in collaboration with policy makers.
- The Social Dialogue should be reinforced to promote the interaction between employers and employees in order to set the basis for the needed training and skills.
- There is a need to increase the attractiveness of the agri-food and forestry sectors for the younger generation.

#### 4. Conclusions

Skills related to business planning, business management, and business modelling were very important for all the FG participants, independently of the producing sector they pertained to. As such, *business planning/model and strategic management* was the most selected skill for farmers and agri-food companies, *cooperatives* for the cooperatives sector, and *sustainable forest management practices and planning* for the forestry sector.

Communication skills appear to be also very important for all sectors, *communication* and the *everyday usage of digital technology to communicate* being the two skills that were among the most selected.

A shift towards business and soft skills was observed when advancing in the agri-food value chain (farmers–cooperatives–food industry). Sustainability and digital skills predominate in the lists for farmers, but these skills are replaced by business and soft skills for cooperatives and the food industry.

Differences among educational systems at a national level were discussed in the EU-policy FG and the need for further harmonization between EU and national policies regarding education was agreed. Education and training curricula must be adapted to sectorial needs, addressing the complexity of the food and forestry systems, establishing bigger sector alliances, and reinforcing the social dialogue. The need to increase the attractiveness of the agri-food and forestry sectors for the younger generation was also remarked.

Undoubtedly, the study has limitations related to the use of FGs that do not allow for the generalization of results; however, further empirical studies could be performed focusing on specific stakeholder groups in order to validate the research results. The results from the national and policy FGs fed into the complimentary development of a quantitative European-wide survey on skills needs and will form the basis for the implementation of a future scenario analysis at both sectorial and national levels. For that purpose, the FGs were found to be successful activities for the identification of the most important skills in the topics of sustainability, bioeconomy, digitalization, soft skills, and business entrepreneurship skills.

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**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.

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## Appendix A Skill Lists

**Table A1.** Sustainability skills.

Skill No.	Climate Change
1.1	Mitigation and adaptation to climate change incl. climate change competences (weather extremes; interdependency of climate systems and biospheres) and climate change mitigation (e.g., fostered CO <sub>2</sub> sequestration) and adaptation (e.g., species composition) via sustainable forest management
	<b>Sustainable management of resources</b>
1.2	Efficient use of resources and logistics
1.3	Improved agri-food system productivity incl. the sustainable management of water, streams, and energy in the food industry
1.4	Active management of natural resources
1.5	Integrated pest management (incl. the sustainable use of pesticides)
1.6	Biodiversity (incl. the detection and support of biodiversity of plants and animals)
1.7	Sustainable metrics and certification incl. public and private schemes for certification (e.g., green labels) and Life Cycle Assessment, Life Cycle Analysis data, including PEF (Product Environmental Footprint)
	<b>Sustainable Business and Governance Models and Environmental Policy</b>
1.8	Environmental Management Systems
1.9	Corporate social responsibility associated with sustainability reporting/press releases
1.10	National, EU, and international environmental policies, regulation, subsidy, and support programs
	<b>Circularity</b>
1.11	By-products and co-products valorization incl. the treatment and reuse of reclaimed water; inorganic waste management practices; the agricultural valorization of organic fertilizers; the management of slurry in livestock farms; biodegradable and compostable materials (incl. packaging); the valorization of forestry residues and new industrial technologies in pulp and paper manufacturing; the use of by-products of timber harvesting (nutrients circulation vs. nutrients removal); circular economy and recycling in the pulp and paper industry; and the reuse, recycling, and valorization of raw materials, contact materials (packaging), by-products, and waste in the food industry
	<b>Energy</b>
1.12	Generation, storage, and the use of renewable energies incl. the next generation bio-refineries and bio-product mills and their outlets, residual forest wood products to produce energy and design, and the building and operation of renewable energy systems
1.13	The identification of renewable energy systems suitable for farm/business enterprises
1.14	The identification of raw materials and waste for energy production in farm/business enterprises
1.15	The identification of energy consumption and demand on farm/business enterprises

**Table A1.** *Cont.*

<b>Skill No.</b>	<b>Climate Change</b>
1.16	National and EU energy markets
	<b>Specific skills for sustainable agriculture</b>
1.17	Good Agricultural Practices incl. the global GAP and international standards of good practices in agriculture
1.18	Water management incl. water quality control and protection, water saving cultivation, tools, and models for saving water and selecting the proper crop pattern at the farm level, irrigation management and techniques, advisor services for irrigation water management to improve training, information and knowledge transfer, and the optimization of irrigation system design and management and associated energies
1.19	Soil Nutrient and Health Management incl. soil protection and improvement, the maintenance of permanent vegetal soil cover and minimum tillage, and techniques for carbon sequestration in the soil
	<b>Specific skills for sustainable forestry</b>
1.20	The impact of timber harvesting and other forest management practices in wildlife populations and habitats
1.21	The protective role of forests and their management in mountainous areas
1.22	Multifunctional forests and ecosystem-services  Specific skills for sustainable food industry
1.23	Organic production requirements
1.24	The analysis of contaminants
1.25	Sustainable packaging

**Table A2.** Digitalization skills.

<b>Skill No.</b>	<b>General Digital Skills</b>
2.1	Everyday usage of digital technology to communicate incl. the use of computers, tablets or mobile phones; word processing; sending emails; browsing the internet safely; making video calls; and social media networks
2.2	Data handling and analysis
2.3	Data protection
2.4	Cloud technology
2.5	Smart connected devices incl., general principles, categories, requirements, limitations, and vulnerabilities
	<b>Digitalization for business</b>
2.6	E-commerce and e-marketing
2.7	Digital entrepreneurship
2.8	Digital information and services (e.g., product prices and standards, payment services, advisory services)
	<b>Digital tools to support production and production management</b>
2.9	Digital supplier management systems
2.10	Digital product quality management systems
2.11	Warehouse management systems
2.12	Digital food traceability systems
2.13	Digital reversed logistics systems
2.14	Digital pest control systems

**Table A2.** *Cont.*

<b>Skill No.</b>	<b>General Digital Skills</b>
2.15	Decision support systems incl. control technology with decision support tools (DST) and the use of web SIG platforms (or ICT platforms) including sensors network models and tools for DSS within a feedback process
2.16	Robot and drone technology
<b>Specific skills for digital (smart) farming</b>	
2.17	Farm Management Information Systems (FMIS)
2.18	Precision animal health and productivity management systems (incl. feed intake management)
2.19	Field operations management systems (incl. soil, plant, seed, and yield management systems)
2.20	Digital irrigation control systems
2.21	Digital soil nutrient control systems
2.22	Weather data management systems/software
2.23	Climate control systems (incl. indoor and roofed farming (greenhouses and roofed fields))
2.24	Robot and drone technology in agriculture

**Table A3.** Bioeconomy skills.

<b>(a) Bioeconomy Skills—Agriculture</b>	
<b>Skill No.</b>	<b>Basic Skills in Production Operations and Production Management</b>
3.1.1	Planning and coordinating production
3.1.2	Performing farming operations
3.1.3	Equipment maintenance
3.1.4	Logistics and storage incl. storage techniques and requirements of different raw materials, the transportation of livestock (incl. droving), produce and supplies and warehouse management
3.1.5	Calculating, handling, and managing risk
3.1.6	Health and safety management and operations incl. to drive and operate agricultural machines safely
3.1.7	Product traceability
<b>Technologies, products, and production approaches</b>	
3.1.8	Urban, peri-urban, and rural area agriculture
3.1.9	Conventional versus/and organic farming incl. organic farming and hybrid farming (the combination of organic and conventional farming methods)
3.1.10	Controlled Environment Agriculture
3.1.11	Crop diversification and rotation
3.1.12	New plant breeding techniques
3.1.13	Agricultural biodiversity
3.1.14	Genetically Modified Crops
3.1.15	New industrial crops and bioproducts for the bioeconomy incl. bioproducts: biofuels, bioplastics, biochemicals, textiles, cosmetics and pharmaceuticals and new industrial crops: cameline, hemp, castor, guayule, etc.
3.1.16	Biofertilizers, compost, and bio-digestates
<b>Healthy farm</b>	
3.1.17	Animal care and animal welfare during transport and production

Table A3. Cont.

<b>(a) Bioeconomy Skills—Agriculture</b>	
3.1.18	Livestock efficiency/management/biosecurity
3.1.19	Crop protection (incl. the prevention of crop disorders and the use of plant protection products)
3.1.20	Integrated pest/disease management
3.1.21	Plant and animal breeding for resilience and robustness
<b>(b) Bioeconomy skills—Forestry and related industries</b>	
<b>Skill No.</b>	<b>Production operations, technologies, and production approaches</b>
3.2.1	Characteristics of forests, geographical differences, and ownership patterns
3.2.2	Sustainable forest management practices, and planning
3.2.3	The reforestation, afforestation, and restoration of forest ecosystems
3.2.4	Forest equipment/machinery and maintenance
3.2.5	Health and safety management and operations
3.2.6	Calculating, handling, and managing risk
3.2.7	Products of forestry incl. harvesting on the focus of high quality/high value logs (right shaping of logs), logs for construction, timber for the pulp and paper industry, and timber for energy supply (material use before energy use)
3.2.8	Process operations in the pulp, paper, timber, and cork industry
3.2.9	Safety and health in the pulp, paper, timber, and cork industry
3.2.10	Equipment/machinery and maintenance in the pulp, paper, timber, and cork industry
3.2.11	Automation in the pulp, paper timber and cork industry
3.2.12	New technologies in pulp, paper, timber, and cork manufacturing
<b>Healthy forest</b>	
3.2.13	The prevention and management of natural disturbances (e.g., floods, drought, and forest fires)
3.2.14	Seedling damage incl. that caused by e.g., deer, moose, and other mammals
3.2.15	Forest disease control and prevention
3.2.16	Water quality in forests
<b>(c) Bioeconomy skills—Food industry</b>	
<b>Skill No.</b>	<b>Skills for food quality and food safety</b>
3.3.1	Quality management, quality assurance, and quality control incl. sensory evaluation
3.3.2	Food safety management, food hygiene, and food safety control
<b>Skills for food production and manufacturing (industrial performance)</b>	
3.3.3	Cleaning and preparation
3.3.4	Production operations and management (incl. milk processing)
3.3.5	Health and safety management
3.3.6	Engineering maintenance
3.3.7	Preservation and packaging
3.3.8	Shop floor control and other control operations
3.3.9	Risk assessment and management
3.3.10	Continuous improvement
<b>Logistics and supply chain skills</b>	
3.3.11	Supply to production and supplier management
3.3.12	Transportation (modalities and planning) and logistics management



**Table A3.** *Cont.*

<b>(a) Bioeconomy Skills—Agriculture</b>	
3.3.13	Management of inventories incl. goods received, pick and pack, storage and storage systems (FIFO), and stock management
3.3.14	Traceability
	<b>Other skills</b>
3.3.15	Food security
3.3.16	Ethics for food
3.3.17	Emerging technologies
3.3.18	Food labelling/certifications
3.3.19	Food defense
3.3.20	Food fraud

**Table A4.** Soft skills.

<b>Skill No.</b>	<b>Fundamental Soft Skills</b>
4.1	Communication with others at work and in the daily life, languages, reporting and briefing, public speaking, and press releases
4.2	Problem solving
4.3	Analytical, critical, and creative thinking
	<b>Self-management skills</b>
4.4	Demonstrating positive attitudes and behaviors
4.5	Being resilient, adaptable, and proactive
4.6	Organization, planning, visioning, and strategic thinking
4.7	Equality skills interculturalism, gender, empowerment, harassment
4.8	Safety awareness
4.9	Reflecting on own performance
	<b>Team working and interpersonal skills</b>
4.10	Team building incl. conflict resolution, negotiation, flexibility
4.11	Teamwork character incl. responsibility, honesty, empathy
4.12	Conflict management
4.13	Change management
	<b>Business soft skills</b>
4.14	Providing leadership
4.15	Managing personnel incl. delegating, motivating, assessing
4.16	Networking
4.17	Innovative thinking

**Table A4.** *Cont.*

<b>Skill No.</b>	<b>Fundamental Soft Skills</b>
	<b>Education skills</b>
4.18	Digital tools to support learning and distance learning
4.19	Learning at work incl. learning by doing, learning from others (mentoring, shadowing, etc.) and teaching each other
4.20	Learning continuously (lifelong learning)
4.21	Training others incl. training skills, training tools, course design, assessment, etc.
4.22	STEM knowledge (Science, Technology, Engineering and Mathematics) to understand and cooperate through the whole food/bioproducts value chains

**Table A5.** Business entrepreneurship skills.

<b>Skill No.</b>	<b>Marketing Skills</b>
5.1	Monitoring market activity and conditions
5.2	Direct marketing in agriculture, food industry, and forestry
5.3	Sales and marketing
5.4	Local marketing associations
5.5	Selling skills building buy-in to an idea, a decision, an action, a product, or a service
5.6	Customers service
	<b>Financial skills</b>
5.7	Business planning/model and strategic management incl. scenario foresighting/forecasting; recognizing and realizing business opportunities; Key Performance Indicators (KPIs) management, knowledge management, and stakeholder management
5.8	The basics of financial issues incl. balance sheets analysis
5.9	Purchasing/renting incl. equipment, structures, seeds, fertilizers, herbicides, animal feed, and other supplies)
	<b>Fair, collaborative, and competitive value chains</b>
5.10	Cooperatives (values, legal framework, and management)
5.11	New value chains/new business models (incl. values-based supply chains and short food supply chains)
5.12	Collaboration/cooperation across all sectors in the food chain
	<b>Skills for research, development, and innovation</b>
5.13	Social expectations/consumer science and behavior
5.14	Interdisciplinary knowledge to assess the whole value chain
5.15	Funding opportunities
5.16	Product development incl. laboratory and desk research
5.17	Project management
5.18	Knowledge transfer in the bioeconomy chains
5.19	Innovation management and its deployment on-site
5.20	Scale-up issues per sector incl. technical difficulties, costs, and volume calculations
5.21	The protection of intellectual property rights

Table A5. Cont.

Skill No.	Marketing Skills
	<b>Compliance with policy and legislation</b>
5.22	Fiscal basis and regulations
5.23	Specific sector legislation incl. agricultural policy and legislation, food policy and legislation, and forest- and nature-related policies (EU and national legislations and marked-based systems covering natural resources and their management)
5.24	Food labelling/certifications
5.25	Farm environmental management plan

## References

- IPCC. Summary for Policymakers Climate Change 2022: Impacts, Adaptation and Vulnerability. In *Proceedings of the Climate Change 2022: Impacts, Adaptation, and Vulnerability*; Pörtner, H.-O., Roberts, D.C., Poloczanska, E.S., Mintenbeck, K., Tignor, M., Alegría, A., Craig, M., Langsdorf, S., Lösschke, S., Möller, V., et al., Eds.; Cambridge University Press: Cambridge, UK; New York, NY, USA, 2022; *in press*.
- FAO. *Climate Change and Food Systems: Global Assessments and Implications for Food Security and Trade*; Elbehri, A., Ed.; Food and Agriculture Organization of the United Nations (FAO): Rome, Italy, 2015; ISBN 9251086990.
- European Commission. *The European Green Deal*; Communication No. COM/2019/640; European Commission: Brussels, Belgium, 2019.
- European Commission. Farm to Fork Strategy for a Fair, Healthy and Environmentally-Friendly Food System. In *Proceedings of the Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions 2020*, Brussels, Belgium, 14 January 2020.
- 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 2017*; ILO: Geneva, Switzerland, 2017.
- Aver, B.; Fošner, A.; Alfirić, N. Higher Education Challenges: Developing Skills to Address Contemporary Economic and Sustainability Issues. *Sustainability* **2021**, *13*, 12567. [[CrossRef](#)]
- Dias, C.S.L.; Rodrigues, R.G.; Ferreira, J.J. Agricultural Entrepreneurship: Going Back to the Basics. *J. Rural Stud.* **2019**, *70*, 125–138. [[CrossRef](#)]
- 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](#)]
- 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](#)]
- Easterly, R.G., III; 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](#)]
- 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](#)]
- 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](#)]
- 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](#)]
- Handayani, M.N.; Ali, M.; Mukhidin, D.W. Industry Perceptions on the Need of Green Skills in Agribusiness Vocational Graduates. *J. Tech. Educ. Train.* **2020**, *12*, 24–33.
- 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](#)]
- Forestry Skills Forum. Forestry Workforce Research; 2021. Available online: <https://www.lantra.co.uk/sites/default/files/2021-08/Forestry%20Workforce%20Research%20Final%20Report%2013.08.21.pdf> (accessed on 31 July 2022).
- 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](#)]
- Blanc, S.; Lingua, F.; Bioglio, L.; Pensa, R.G.; Brun, F.; Mosso, A. Implementing Participatory Processes in Forestry Training Using Social Network Analysis Techniques. *Forests* **2018**, *9*, 463. [[CrossRef](#)]
- Marrelli, A.F. Collecting Data through Focus Groups. *Perform. Improv.* **2008**, *47*, 39–45. [[CrossRef](#)]
- Farrell, M.; Murtagh, A.; Weir, L.; Conway, S.F.; McDonagh, J.; Mahon, M. Irish Organics, Innovation and Farm Collaboration: A Pathway to Farm Viability and Generational Renewal. *Sustainability* **2021**, *14*, 93. [[CrossRef](#)]
- Subramony, D.P.; Lindsay, N.; Middlebrook, R.H.; Fosse, C. Using Focus Group Interviews. *Perform. Improv.* **2002**, *41*, 38–45. [[CrossRef](#)]

22. Nazzaro, C.; Stanco, M.; Marotta, G. The Life Cycle of Corporate Social Responsibility in Agri-Food: Value Creation Models. *Sustainability* **2020**, *12*, 1287. [CrossRef]
23. Williams, A.; Katz, L. The Use of Focus Group Methodology in Education: Some Theoretical and Practical Considerations, 5 (3). *IEJLL Int. Electron. J. Leadersh. Learn.* **2001**, *5*. Available online: <https://journals.library.ualberta.ca/iejll/index.php/iejll/article/view/496> (accessed on 31 July 2022).
24. Carvalho, C.; Almeida, A.C. The Adequacy of Accounting Education in the Development of Transversal Skills Needed to Meet Market Demands. *Sustainability* **2022**, *14*, 5755. [CrossRef]
25. Robertson, R.W. Local Economic Development and the Skills Gap: Observations on the Case of Tampa, Florida. *High. Educ. Ski. Work. Based Learn.* **2018**, *8*, 451–468. [CrossRef]
26. Halliday, M.; Mill, D.; Johnson, J.; Lee, K. Let's Talk Virtual! Online Focus Group Facilitation for the Modern Researcher. *Res. Soc. Adm. Pharm.* **2021**, *17*, 2145–2150. [CrossRef]
27. Ramalho, A.; Goodburn, B.; Lindner, L.F.; Mayor, L.; Knöbl, K.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* **2022**, submitted.
28. Bröring, S.; Vanacker, A. Designing Business Models for the Bioeconomy: What Are the Major Challenges? *EFB Bioeconomy J.* **2022**, *2*, 100032. [CrossRef]
29. Commission, E.; Media, D.-G. *For the I.S. and Survey of Schools: ICT in Education: Benchmarking Access, Use and Attitudes to Technology in Europe's Schools*; Publications Office: Luxembourg, 2013.
30. Bikse, V.; Grinevica, L.; Rivza, B.; Rivza, P. Consequences and Challenges of the Fourth Industrial Revolution and the Impact on the Development of Employability Skills. *Sustainability* **2022**, *14*, 6970. [CrossRef]
31. European Commission, Executive Agency for Small and Medium-sized Enterprises. *Blueprint for Sectoral Cooperation on Skills: Towards an EU Strategy Addressing the Skills Needs of the Steel Sector: European Vision on Steel-Related Skills of Today and Tomorrow*; Publications Office: Luxembourg, 2019.
32. McElwee, G. A Taxonomy of Entrepreneurial Farmers. *Int. J. Entrep. Small Bus.* **2008**, *6*, 465–478. [CrossRef]
33. Augère-Granier, M.-L. *Agricultural Education and Lifelong Training in the EU*; European Parliamentary Research Service: Brussels, Belgium, 2017; Available online: [https://www.europarl.europa.eu/RegData/etudes/BRIE/2017/608788/EPRS\\_BRI\(2017\)60878\\_8\\_EN.pdf](https://www.europarl.europa.eu/RegData/etudes/BRIE/2017/608788/EPRS_BRI(2017)60878_8_EN.pdf) (accessed on 2 June 2020).
34. 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]
35. Phelan, C.; Sharpley, R. Exploring Entrepreneurial Skills and Competencies in Farm Tourism. *Local Econ. J. Local Econ. Policy Unit* **2012**, *27*, 103–118. [CrossRef]
36. Couzy, C.; Dockes, A.C. Are Farmers Businesspeople? Highlighting Transformations in the Profession of Farmers in France. *Int. J. Entrep. Small Bus.* **2008**, *6*, 407–420. [CrossRef]
37. George, D.A.; Clewett, J.F.; Wright, A.; Birch, C.; Allen, W. Improving Farmer Knowledge and Skills to Better Manage Climate Variability and Climate Change. *J. Int. Agric. Ext. Educ.* **2007**, *14*, 5–19. [CrossRef]
38. Silva, L.L.; Baptista, F.; Cruz, V.F. Analysis of Skills Needs for Agricultural Workers for a “Sustainable Agriculture.” Silva: 2017. Available online: [http://www.sagriproject.eu/wp-content/uploads/2018/11/D2.1\\_Analysis-of-skills-needs-for-agricultural-workers\\_EN\\_VFinal.pdf](http://www.sagriproject.eu/wp-content/uploads/2018/11/D2.1_Analysis-of-skills-needs-for-agricultural-workers_EN_VFinal.pdf) (accessed on 31 July 2022).
39. Bijman, J.; Iliopoulos, C.; Poppe, K.J.; Gijssels, C.; Hagedorn, K.; Hanisch, M.; Hendrikse, G.W.J.; Kühl, R.; Ollila, P.; Pyykkönen, P. *Support for Farmers' Cooperatives*; Wageningen UR: Wageningen, The Netherlands, 2012.
40. European Commission (EC). Directorate-General for Employment, Social Affairs and Inclusion. In *ESCO, European Classification of Skills/Competences, Qualifications and Occupations: The First Public Release: A Europe 2020 Initiative*; European Union: Brussels, Belgium, 2014.
41. Jack, C.; Anderson, D.; Connolly, N. Innovation and Skills: Implications for the Agri-Food Sector. *Educ. Train.* **2014**, *56*, 271–286. [CrossRef]
42. Topliceanu, L.; Bibire, L.; Nistor, D. Professional Competences of the Personnel Working on Quality Control and Food Safety in the Food Industry. *Procedia Soc. Behav. Sci.* **2015**, *180*, 1030–1037. [CrossRef]
43. Lertpiromsuk, S.; Ueasangkomsate, P.; Sudharatna, Y. Skills and Human Resource Management for Industry 4.0 of Small and Medium Enterprises. In *Proceedings of Sixth International Congress on Information and Communication Technology*; Springer: Berlin/Heidelberg, Germany, 2022; pp. 613–621.
44. Barrett, J.W. The Role of Humanities and Other Liberal Courses in the Professional Forestry Curriculum. *J. For.* **1953**, *51*, 574–578.
45. 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]
46. Brown, T.L.; Lassoie, J.P. Entry-Level Competency and Skill Requirements of Foresters: What Do Employers Want? *J. For.* **1998**, *96*, 8–14.
47. Straka, T.J.; Marsinko, A.P.; Childers, C.J. Individual Characteristics Affecting Participation in Urban and Community Forestry Programs in South Carolina, US. *Arboric. Urban For.* **2005**, *31*, 131–137. [CrossRef]
48. Bullard, S.H.; Stephens Williams, P.; Coble, T.; Coble, D.W.; Darville, R.; Rogers, L. Producing “Society-Ready” Foresters: A Research-Based Process to Revise the Bachelor of Science in Forestry Curriculum at Stephen F. Austin State University. *J. For.* **2014**, *112*, 354–360. [CrossRef]

49. Bullard, S.H. Forestry Curricula for the 21st Century—Maintaining Rigor, Communicating Relevance, Building Relationships. *J. For.* **2015**, *113*, 552–556. [[CrossRef](#)]
50. Schuh, B.; Maucorps, A.; Munch, A.; Brkanovic, S.; Dwyer, J.; Vigani, M.; Khafagy, A.; Coto Sauras, M.; Deschelette, P.; López, A. Research for AGRI Committee—The EU Farming Employment: Current Challenges and Future Prospects, European Parliament, Policy Department for Structural and Cohesion Policies, Brussels. 2019. Available online: [https://www.europarl.europa.eu/thinktank/en/document/IPOL\\_STU\(2019\)629209](https://www.europarl.europa.eu/thinktank/en/document/IPOL_STU(2019)629209) (accessed on 31 July 2022).
51. Francis, C.A.; Jensen, E.S.; Lieblein, G.; Breland, T.A. Agroecologist Education for Sustainable Development of Farming and Food Systems. *Agron. J.* **2017**, *109*, 23–32. [[CrossRef](#)]