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Views of Farmers and Other Agri-Food Stakeholders on Generic Skills for Transitioning toward Sustainable Food Systems

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Abstract: Sustainable agricultural education is a fundamental base for the sustainable development of the agri-food systems. Sustainable education should provide the necessary skills to the practical world. This paper is focused on skills and competences required by the agri-food stakeholders for their current work and for future sustainable development around the world. An online survey was disseminated for data collection, and quantitative and qualitative analyses were employed to understand the impact of the demographic factors on the variety of skills mentioned by the different stakeholders. As a result, according to all of the stakeholders, the skills of navigating in a changing world, networking and strategic development are relevant for their current work, and technical skills were mentioned as relevant for future sustainable development. The age factor, rather than geography and gender, was found to have a stronger impact on defining the aforementioned skills.

Keywords: agricultural education; sustainable education; agri-food stakeholders; skills and competences; sustainability; H2020; NextFood

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1. Introduction

A sustainable food system is a food system that delivers food security and nutrition for all in such a way that the economic, social and environmental bases to generate food security and nutrition for future generations are not compromised [1]. According to El Bilali et al. [2], different strategies such as sustainable intensification, sustainable diets and alternative food systems can be pursued in order to foster a transition towards sustainable food systems [2].

A sustainable food system is a part of sustainable agricultural development [2,3], that contributes to improving resource efficiency, strengthening resilience and securing social equity/responsibility of agriculture and food systems in order to ensure food security and nutrition for all, now and in the future [2,3].

Agri-food systems are shaped through the interaction of different systems including natural, institutional and social systems [4]. Furthermore, agri-food systems are considered as self-organizing systems that are formed by various actors [4]. Interactions between heterogeneous actors and their reaction with the environment are crucial for innovating agri-food systems and for future sustainable agricultural development [5,6]. Thus, the actors or stakeholders should have strategic vision and should be prepared for appropriate decision making and sustainable management.

Notwithstanding that the concept of sustainability is differently defined by the authors [7], higher education institutions can significantly increase general sustainability awareness, develop practical insights and motivate young people to behave responsibly [8].

In the contemporary paradigm, Education for Sustainable Development (ESD), or Quality Education (Sustainable Development Goal 4), was born from the need for education to address growing sustainability challenges [9]; it was considered as a force for social transformation, influencing teaching–learning approaches and policy, including the 2030 Sustainable Development Agenda [10]. The agricultural education system as a part of ESD has been a major contributor to agricultural research, extension, production and institutional successes over the past one hundred years [11]. However, contemporary agricultural education does not adequately focus on skills for young professionals that could improve their employability in agri-food systems [11–13]. Furthermore, in the dramatically changing world, there is a necessity to anticipate future skills needs [14,15].

Usually, the scientists discuss soft skills and subject-specific competencies [16] in the context of sustainable education. Soft skills have been defined in different ways in the workforce literature, such as "key skills", "core skills", "essential skills", "generic skills" and "soft skills". Besides these, skills are called "domain independent knowledge" and refer to employability skills: literacy, numeracy, computer skills, communication skills, interpersonal skills and problem-solving skills [17]. In this paper, the term "generic skills" is used in order to identify these types of skills, and the term "sector-specific skills" is used to define subject-specific competencies or the specific knowledge needed by the agri-food stakeholders in their work.

Various attempts have been made by scientists to define skills and competencies needed for change agents to effectively contribute to sustainable development [18–23]. These researchers were focused on a certain geographic area, such as only European countries [18–23] or only poor countries [24]. Given this, the impact of geographical factors on the needed skills was not examined by the researchers. At the same time, there are many papers which have focused on other demographic factors (age, gender, level of education) which determine the necessity type and propensity of skills.

Authors have discussed the impact of the gender factor on different competences such as entrepreneurial skills [25], innovative behavior in the agri-food sector [26] and skills needed to succeed in short food supply chains [27]. Furthermore, there is a female bias in agricultural higher education, and the agri-food sector is traditionally male-dominated [28]. Gender differences were studied in ranking social skills, as the gender differences most often have to do with the students' study performance, motivation or attitudes toward learning [29]. Apart from the gender factor, authors found a contribution of the family background to the skill gaps [30] and connected the age factor and education level with the need for certain skills [31–33].

Few studies have discussed the skills and competences needed for sustainable development of the agri-food sector. Trivellas et al. [34] examined the gap in skills for the agri-food supply chain [34] and Flynn et al. [35] and Mayor et al. [36] identified the most desired skills based on the focus groups in the EU countries.

However, these researchers did not distinguish between skills for current daily work and for future sustainable development. Akyazi et al. [37] have investigated skills for current and future digital transformation, but focused only on the food sector and food industry without consideration for the agricultural world. A set of skills for future sustainability will allow for better preparation of young professionals, and will improve the organization of vocational education and training. Given that few studies have focused on the skills needed for the future sustainable development of the agri-food sector, this research aims to compare the skills needed by the different agri-food stakeholders from the different countries of the world, and to define gaps between the skills needed for current daily work and the skills required for the future sustainable development of the agri-food systems.

Furthermore, the same skills may be interpreted, understood and recognized differently in different contexts, and by different stakeholders [38]. In order to avoid misinterpretations, this research is based on the comparison of skills datasets which include groups of similar skills. The datasets were developed in Deliverable 1.1. [39], elaborated for the NextFood (NextFood—educating the next generation of professionals in the agri-food system, funded by H2020, grant agreement no. 771738, https://www.nextfood-project.eu/, accessed on 26 December 2022) project. The Deliverable was based on the results of three main methods: (1) focus groups organized in different countries where the stakeholders of the agri-food systems have discussed skills and competences; (2) a literature review of peer-reviewed articles and (3) a literature review of non-reviewed sources. The Deliverable was based on the results of focus groups received from 20 project partners. This is why it was limited to answers from 20 countries. This research aims at a wider geographical extent; its added value is found in the attempt to assess and to compare skills that were mentioned by the respondents worldwide.

RQ1: What are the most important skills, according to the stakeholders, for developing sustainable food systems?

RQ2: What are the gaps between the skills needed for current daily work and skills for future development?

RQ3: How do the three demographic factors (age, gender and geography) examined affect the stakeholders' perspectives on the required skills?

2. Materials and Methods

2.1. Data Collection

An online questionnaire via the Qualtrics platform was used for data collection (Appendix A). The 28 questions assessed the respondents' views on the current and future skills needed for sustainable agri-food work. The questions were divided into two groups: All stakeholders answered 20 questions: 2 open, 11 ranking (6-point Likert Scale) and 7 demographic (stakeholder type, age, country of origin, country of work, gender). Farmers, advisors and agri-food students answered 8 additional questions (3 demographic, 4 open, 1 multiple choice). The 11 ranking questions were about skills identified in Deliverable 1.1 [39] and included skill names, e.g., planning for the future (visioning), and their short explanations, e.g., visioning means the ability to think about or plan the future with imagination or wisdom.

The questionnaire was drawn up in English, translated into 12 languages and distributed according to a dissemination strategy developed by the authors to target international agri-food stakeholders and particularly farmers, students and advisors. The dissemination strategy included different channels such as NGOs, other projects and national and international networks used by the project partners. The questionnaire was available between July 2020 and February 2021.

The questionnaire used here was based on a draft questionnaire tested during the NextFood project with a much smaller sample of 35 respondents, and it was later validated in a series of focus group interviews in several countries. Iterative review by the four authors, all of whom have published questionnaire-based studies, validated the changes to this initial questionnaire. The research method used here required a minimum sample size of 100 for robust statistical analyses, and the sampling technique was based on outreach to the networks of the 18 partners in NextFood located throughout Europe, the Near East and Africa.

2.2. Data Analysis

All respondents who answered at least one question of the questionnaire were included in the analyses. Thus, the number of respondents (n) varies for the different analyses based upon the number of respondents for the required questions.

Demographic data were analyzed as follows: by stakeholder type, meaning that respondents could choose as many as desired from 16 pre-identified categories defined by the academic, industry and non-profit partners of the NextFood project, and these are visible in Table 1 of the Results. Any respondent choosing "Farmer", "Agricultural student" or "Advisor to farmer" was placed in the farmer/student/advisor ("FSA") group for analyses, whether or not they also chose one of the other 13 stakeholder types offered (academia: faculty and administration; researcher; student in another field; forestry student; authority; policy maker; processor; agri-business manager; forestry official; sustainable agriculture activist; NGO activist; retailer/supermarket and other). Respondents who did not choose an FSA stakeholder type were classified as other and placed in the "OTH" group. As for age, respondents could choose one of four age ranges: 20 and under, 21 to 40, 41 to 60 or over 60. Age groups were combined into 2 big groups (40 and under, 41 and over) for questionnaire analyses. As for gender, respondents could choose one of three possibilities: male, female or other. If other was less than 1% of respondents, this group would not be included in the analyses. As for country, respondents could choose one country of nationality and one working country from a drop-down menu of 195 choices. If less than 20% had different nationalities and working countries, the working country would be used in the analyses. Since less than 20% of respondents had different nationalities and working countries, the working country was used in the analyses. For further analysis, all countries were divided into two groups: EU and non-EU countries. This division was determined by the fact that the NextFood project was funded by H2020 and addressed, first of all, to EU higher education. Thus, the demographic factor "country" was renamed into "geography"; it had two variables: EU and non-EU countries.

Table 1. Distribution of the stakeholders' types mentioned by the respondents (n = 1107).

Stakeholder Type	Number of Respondents, n	%
farmer	100	9.0
agricultural student	110	9.9
advisor to farmer	82	7.4
academia: faculty and administration	175	15.8
researcher	176	15.9
student in another field	135	12.2
forestry student	9	0.8
authority	45	4.1
policy maker	13	1.2
food processor	28	2.5
agri-business manager	23	2.1
forestry official	16	1.4
sustainable agriculture activist	60	5.4
NGO activist	31	2.8
retailer/supermarket	10	0.9
not mentioned above	94	8.5

2.2.1. Quantitative Data Analysis

A 6-point Likert scale was used to evaluate the future importance of 11 skills including networking, communication, collaboration, interdisciplinary skills, visioning, efficiency at daily tasks, ability to adapt to changes, skills in using resources, real-life complex problem solving, thinking about the entire system and applying holistic knowledge and shortening (localizing) the value chain. All skills were presented individually and respondents could not go back and change any answers; thus, the evaluation of each of the 11 skills is considered independent. The statistical analyses chosen were based on the need for robust comparison among groups followed by post-hoc analyses to detect potential differences between any two groups. Non-parametric tests were not used as multiple comparisons here required the use of relatively complex data transformation [40]. Since parametric tests were validated for use on ranking data, and on Likert scale data [41,42], these were used. Univariate ANOVA followed by Tukey–Kramer post hoc compared the 11 skills as evaluated by FSA and by others. Significance was calculated using the most conservative degrees of freedom. Multiple ANOVA followed by univariate t-tests with the Bonferroni correction for multiple tests compared the four demographic variables for each skill (type of stakeholder, age, country and gender).

2.2.2. Qualitative Data Analysis

The answers to two open questions, “What skills are needed for your current daily work?” and “What skills will be important in your future sustainable development?”, were deductively coded by two of the authors using NVivo 12 software. Given that the starting point of this research was the NextFood project Deliverable 1.1 [32], its seven skill datasets were used as skill codes including “Building and maintaining networks”, “Collaboration”, “Strategic development & marketing”, “Digital and technical skill”, “Navigating in a changing world”, “System perspective” and “Interpretation and negotiation of sustainability”. During the coding process, these were supplemented by two additional inductively determined skill codes, “Sector-specific skills” and “Teaching”, added to accommodate the diversity of responses. Each response could be assigned to more than one skill code.

Free text responses were compared by calculating the percentage of total responses per skill code for each question for FSA and for OTH.

Demographic factors were considered for FSA only by calculating, for each skill code, the percentage of responses for each of two demographic possibilities: in EU vs. non-EU, 40 and under vs. 41 and over and male vs. female. As a part of experimental methodology, an indicator (I) was defined as the result of the division of the two percentages for each demographic factor, and this showed the relative difference between the two demographic variables for free text responses belonging to each skill code.

If the value of the indicator was equal to 1 ± 0.5, this ($0.5 < I < 1.5$) was not considered to be a great difference between the shares, and, consequently, the impact of the demographic factors could not be considered for the stakeholders’ skill preferences. Whilst other values of the indicator ($I \leq 0.5$ and $I \geq 1.5$) were interpreted as great differences between the shares, an impact of the demographic factors (gender, age or country) could be considered for the stakeholders’ skill preferences.

3. Results

3.1. General Results

The number of people who accessed the online questionnaire was 1079. Of these, 844 agreed to participate in the survey, 10 did not agree and 225 did not answer the agreement question. Of the 844 who agreed to participate, 459 completed the entire questionnaire. Of the 385 who partially completed the questionnaire, 32 were removed from the analysis because they answered no questions at all other than agreeing to participate.

The remaining 353 who agreed to participate and answered at least one other question were analyzed with the 459 completed questionnaires, when possible, as specified for each of the analyses. Thus, a total of 812 questionnaires were analyzed to the fullest possible extent based on the number of questions answered.

All 812 respondents specified their stakeholder type: 622 identified as only one stakeholder type, 121 identified as two, 39 identified as three, 24 identified as four and 6 identified as five stakeholder types. Thus, a total of 1107 stakeholder types were chosen by the 812 respondents. The choice of 16 stakeholder types and the opportunity for each respondent to choose multiple stakeholder types returned an uneven distribution, ranging from 176 for researcher to 9 for forestry student (Table 1). In order to facilitate the analyses of farmer skills, the stakeholders were grouped into two broad types as detailed in the Methods section. “FSA” represented 292 (36%) respondents and “Other” applied to the remaining 520 (64%).

The 459 respondents who completed the entire questionnaire specified their nationality and the country in which they work, and these represented 53 nationalities working in 61 countries. Out of only 71 respondents, 15.5% worked in a country different from their nationality; therefore, the working country was chosen as the analysis unit. There was a large and uneven distribution of working countries, ranging from 14.4% working in Italy to 0.2% working in the 21 countries with only one respondent. This uneven distribution of responses suggests that the sample may not be representative of international agri-food professionals; nonetheless, it is a relatively large sample who provided answers in a relatively new field of inquiry. To facilitate the analyses of European skills in the agri-food sector, respondents were grouped into European (the EU area), 60.6%, and non-European (non-EU area), 39.4%.

The 459 respondents who completed the entire questionnaire chose one of four categories to specify their age: 2% were 20 or under, 46% were 21 to 40, 40% were 41 to 60 and 12% were 61 and over. To facilitate analyses, a group of 40 and under with 48% and a group of 41 and over with 52% of respondents were formed.

Finally, the 459 respondents who completed the entire questionnaire specified gender: 218 female, 240 male and 1 other. We analyzed gender-based interactions using male and female and considering the one other as an outlier not included in the analyses.

3.2. Comparison among Skills

The six-point Likert scale ranking the future importance of 11 skills was used with an average of 464 respondents (range of 461–466). The 11 skills were presented independently to respondents and independent of each other. In order to facilitate the comparison with qualitative data, four of the eleven skills were combined to have seven of the same skills used in the qualitative coding (Table 2):

- 'Communication' and 'Networking' were combined to form 'Building and Maintaining Networks';
- 'Collaboration' and 'Interdisciplinary' were combined to form 'Collaboration;
- 'Adaptation' and 'Problem Solving' were combined to form 'Navigating in a Changing World';
- 'Using Resources Efficiently' and 'Shortening Supply Chains' were combined to form 'Sector-Specific Skills'.

Table 2. Comparison of skills used for quantitative and qualitative analysis.

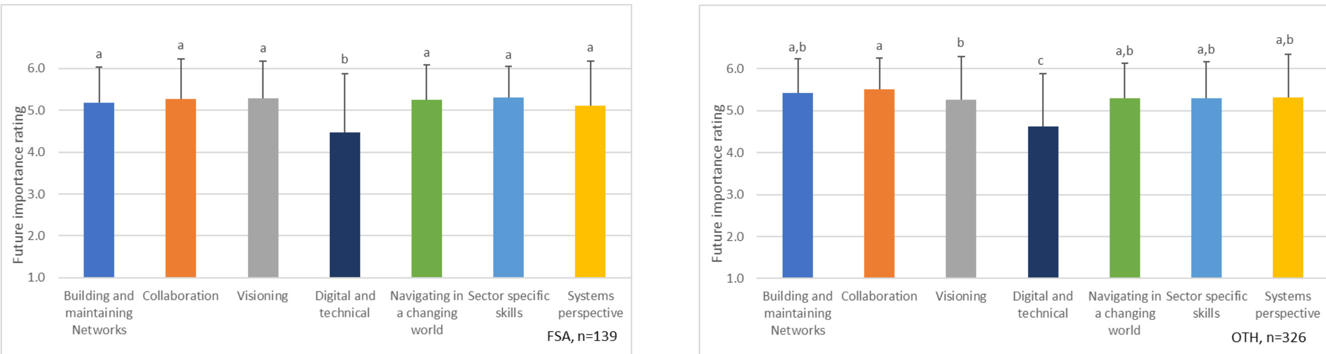
Nine Skill Datasets	Seven Combined Skills	Eleven Assessed Skills
Building and maintaining networks	Building and maintaining networks	Networking Communication
Collaboration	Collaboration	Collaboration Interdisciplinary skills
Strategic development and marketing	Visioning	Visioning
Digital and technical skills	Digital and technical skills	Efficiency at daily tasks through the use of digital, robotics and other technology
Navigating in a changing world	Navigating in a changing world	Ability to adapt to changes Real-life complex problem solving
System perspective	System perspective	Thinking about entire system and applying holistic knowledge
Sector-specific skills	Sector-specific skills	Shortening (localizing) the value chain Skill to use resources
Teaching		
Interpretation and negotiation of sustainability		

As for the combined skills, the rating responses for the two questions were averaged by person and then the overall responses for all of the respondents were averaged. The overall ratings for the seven skills were between 4.5 and 5.5 on a scale of 6.

A series of correlation tests between the random variables of future importance rating for each of the seven skills in each of the two groups (FSA and OTH) returned results ranging from 0.1 to 0.6, indicating no to minimal correlation (where 1.0 indicates a positive correlation and −1.0 indicates a negative correlation). This lack of correlation allowed for the use of a one-way ANOVA to test for significant differences among the skill ratings within each group [41,43].

Data analyses via one-way ANOVA for the seven future importance ratings within each of the two stakeholder groups, FSA (n = 136–139) and OTH (n = 324–327), indicated a significant difference in the future importance of the seven skills at $p < 1 \times 10 - 13$ in FSA and $p < 1 \times 10 - 33$ in OTH. Using ANOVA on non-parametric data, such as from the Likert scales used here, has been validated [41,43]. Its use here allowed for follow-up with the robust Tukey–Kramer post hoc to look for differences between individual skills. Tukey–Kramer post hoc analyses for each stakeholder group, using the most conservative degree of freedom, revealed that among FSAs there was no most important skill or skills. Six of the seven skills were considered to have equal importance and only "Digital & Technical" was significantly different, being considered to be less important than all of the other skills.

Among OTH, however, "Collaboration" was significantly more important than both "Visioning" and "Digital and Technical" but not different from the four other skills. As for FSA, OTH found "Digital & Technical" to be significantly less important than all of the other skills ($p < 0.05$) (Figure 1).



(**a**) (**b**)

Figure 1. Average ratings and SD of the future importance of seven skills according to (**a**) FSA stakeholders (n = 139) and (**b**) OTH stakeholders (n = 326). The same letter above a bar indicates no significant difference.

Two open-ended questions asking for the three most relevant skills in current work and the three most important skills for future work in the sustainable agri-food sector were answered by 123–125 FSA and by 290–354 OTH. The number of responses in each category are expressed as a percentage of all responses given by the stakeholder group to the question (Table 3).

Within FSA, the most common response for the most important skill was "Sector-Specific", both for current daily work and for future sustainable development, receiving 21.6 and 28.5% of responses, respectively. Skills for "Strategic Development & Marketing" and "Building & Maintaining Networks" were also mentioned frequently as being important for current work: 18.2 and 17.4% of all responses. Thus, these three skill categories ("Sector Specific", "Strategic Development & Marketing" and "Building & Maintaining Networks") accounted for almost 60% of FSA responses to the open-ended question of "What are the most important skills for your current work?".

For future work in sustainable agri-food (in the sustainable agri-food sector/context), FSA responses were, after "Sector Specific" with 28.5%, most commonly in the categories of "Digital & Technical Skills" and "Strategic Development & Marketing": 14.9 and 13.9%, respectively. Again, close to 60% of responses fell into three categories.

Table 3. Percentage of text coded to each skill for current and future work, %.

Type of Skills	Skill Code *	FSA		Other	
		Skills for Current Work (n = 125)	Skills for Future Work (n = 123)	Skills for Current Work (n = 354)	Skills for Future Work (n = 290)
Generic	1. Navigating in a changing world	16.7	7.6	12.4	13.7
	2. Collaboration	3.4	8.3	5.2	6.4
	3. Systems perspective	3.7	11.6	2.4	11.3
	4. Building and maintaining networks	17.4	9.9	13.9	13.3
	5. Digital and technical skills	12.9	14.9	6.2	12.3
	6. Strategic development and marketing	18.2	13.9	15.8	9.1
	7. Interpretation and negotiation of sustainability	3.7	4.3	2.2	3.8
	8. Teaching	2.4	1.0	4.1	3.1
Sector-specific	9. Sector-specific skills	21.6	28.5	37.8	27.0
	Total text coded	100	100	100	100

* Numbers of the skills as shown in Section 3.3.

Within others, the most common skill was again "Sector Specific"; here, it was 37.8% and 27.0% of responses for current and future work, respectively. As for FSA, others most commonly mentioned skills related to "Strategic Development & Marketing" and "Building & Maintaining Networks" as being important for their current work: 15.8% and 13.9% of all responses, respectively. Thus, the same three skill categories as for FSA ("Sector Specific", "Strategic Development & Marketing" and "Building & Maintaining Networks") accounted for most (>70%) responses.

As for future work in sustainable agri-food, other responses were, after "Sector Specific" at 27.0%, most commonly in the categories of "Navigating in a Changing World" and "Building & Maintaining Networks": 13.7 and 13.3%, respectively. Here, 54% of all responses fell into these three categories.

Notably, of the nine skill code categories, only "Sector Specific" was mentioned both by FSA and by OTH as being important for both current and future work in sustainable agri-food.

3.3. Demographic Factors and Skills

The Likert scale ratings of both FSAs and OTHs were analyzed using multiple multi-way ANOVAs to test for overall significant differences between the four demographic factors (stakeholder type, age, country and gender) and for interactions between these factors for each of the seven skills. The ranking data for FSA stakeholders were analyzed independently using multiple multi-way ANOVAs to test for overall effects and interactions between age, geography and gender in this stakeholder group. Here, the number of respondents decreased from 139 to 135 as four FSA respondents did not provide these demographic variables.

Table 4 demonstrates the calculated indicator value (I) that compares values for the two possibilities for each demographic variable (geography, age and gender) for text answers of FSA stakeholders (results of I for OTH stakeholders are not demonstrated in this study). Values of 0.5 or less and 1.5 or more (highlighted in bold) indicate a 50% or more difference between values and are considered "significant" (e.g., the variable might have an impact on the stakeholders' responses).

Table 4. Values of I for answers of FSA stakeholders.

Skill Code	Responses	Geographic Factor EU/Non-EU	Age Factor <40/>40	Gender Factor F/M
Navigating in a changing world	for current daily work	0.6	**1.7**	0.7
	for future	**2.3**	**1.9**	0.8
Collaboration	for current daily work	0.9	**2.2**	**2**
	for future	0.8	0.6	**0.5**
System perspective	for current daily work	1	1	1
	for future	0.8	1.3	**0.5**
Building and maintaining networks	for current daily work	0.9	1.1	0.6
	for future	**2.7**	**2**	**0.5**
Digital and technical skills	for current daily work	**0.2**	1.1	0.6
	for future	1.1	0.6	**0.5**
Strategic development and marketing	for current daily work	0.6	**1.9**	0.6
	for future	0.6	**1.6**	0.8
Interpretation and negotiation of sustainability	for current daily work	0.6	**1.8**	1
	for future	0.9	**2.2**	1.2
Teaching	for current daily work	1.3	1.3	0.8
	for future	**0**	**2**	**0.5**
Sector-specific skills	for current daily work	**19.4**	1	0.6
	for future	0.7	**1.7**	1.2

3.3.1. Navigating in a Changing World

The navigating a changing world dataset includes the following types of skills: adaptability, lifelong learning, mindset as a driver for change, skills for innovation and problem solving.

There was no overall effect of the stakeholder type on "Navigating in a Changing World" and no interaction of the stakeholder type with any other demographic factor.

Among FSAs, there was an overall effect of age ($p < 0.02$), whereby the under 40 group rated navigating in a changing world at 5.4 ± 0.8 and the 40 and over group rated it at 5.2 ± 0.8 (Figure 2). There were no other overall effects of demographic factors and no interactions with this skill.

Qualitative analyses showed that FSAs under 40 talked about "Navigating in a Changing World" almost twice as much as those over 40 for both current and future work. Additionally, those FSAs based in the EU mentioned this skill more than twice as much as the non-EU group as being important for future work (Table 4).

For OTH stakeholders, demographic influences on this skill were similar: the under 40 s talked about it twice as much as the over 40 s (for current work) and the EU group talked about it almost twice as much as the non-EU group for future work.

3.3.2. Collaboration

The data were coded as "collaboration" when they included any comments referring to teamwork, group work and cross-sectoral work with colleagues in other specialties, community collaboration and interdisciplinary collaboration.

There was an overall effect of stakeholder type on collaboration ($p > 0.009$): OTH rated this skill higher at 5.5 ± 0.8 compared to FSA at 5.3 ± 1.0 (Figure 2). There was also a three-way interaction ($p < 0.03$) between stakeholder type, gender and age. A series of 12 t-tests with Bonferroni correction compared all possibilities of age, gender and stakeholder type and revealed that female OTH rated collaboration at 5.6 ± 0.6 while male FSA rated this skill at 5.2 ± 1.0 ($p < 0.0004$). Additionally, the under 40 OTH rated it at 5.9 ± 0.8 and the 40 and over FSA rated it at 5.1 ± 1.1 ($p < 0.0003$). Among FSAs, there were no overall effects of age, gender or country, and there were no interactions between these variables.

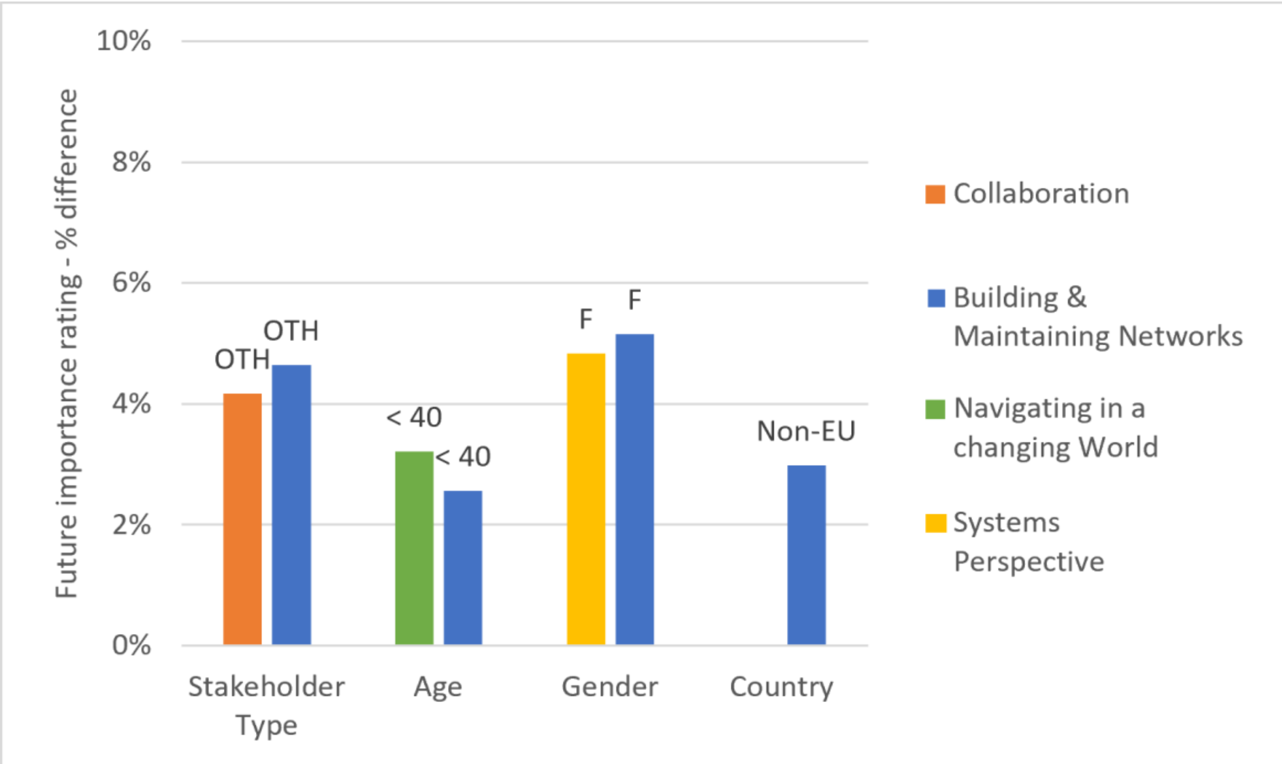


Figure 2. Percentage difference between average ratings of the future importance of skills based on demographic variables. OTH rated "Collaboration" and "Building & Maintaining Networks" higher than FSA ($p < 0.03$), under 40 rated "Navigating in a Changing World" and "Building & Maintaining Networks" higher than 40 and over, females rated "Systems Perspective" and "Building & Maintaining Networks" higher than males, and non-EU rated "Building & Maintaining Networks" higher than EU.

Qualitative analyses showed the effects of demographic variables within the FSA population from the view of "Collaboration" (Table 4). For current work, those under 40 mentioned collaboration-related skills twice as much as those over 40 and females mentioned these skills twice as often as males. For future work, males specified the importance of "Collaboration" twice as much as females.

Other stakeholders (data not shown) had a similar age-related view of the importance of "Collaboration" for current work; those under 40 mentioned this skill twice as often as those over 40.

3.3.3. Systems Perspective

A systems perspective dataset includes the following types of skills: holistic understanding of food system frameworks, interaction with policy frameworks, and stakeholder management within food systems.

There was no overall effect of stakeholder type on the rating of "Systems Perspective" and no interaction of stakeholder type with any other demographic factor.

Among FSAs, there was an overall effect of gender ($p < 0.01$); females rated this skill at 5.4 ± 0.9 and males rated it at 5.1 ± 1.1 (Figure 2). There were no other overall effects of demographic factors and no interactions on the rating of this skill.

Qualitative analyses showed the opposite effect of gender on the importance of "Systems Perspective" for future work with male FSAs mentioning this skill twice as often as females (Table 4).

For OTH stakeholders, there was no gender effect on this skill but EU stakeholders mentioned it more often than non-EU ones, and the under 40 group mentioned it more often than the 40 and over group for both current and future work.

3.3.4. Building and Maintaining Networks

The building and maintaining networks dataset includes the following types of skills: communication, engagement with stakeholders, learning in social networks, building capacities for communication and facilitation.

There was an overall effect of stakeholder type on "Building & Maintaining Networks" ($p < 0.03$): OTH rated this skill higher at 5.4 ± 0.8 vs. FSA at 5.2 ± 0.9. There were no interactions between stakeholder type and any other demographic factors in the rating of this skill (Figure 1).

Among FSAs, there were overall effects of age ($p < 0.04$), gender ($p < 0.05$) and working country ($p < 0.04$), showing that the under 40s rated "Building & Maintaining Networks" at 5.4 ± 0.8 and the 40 and over group rated it at 5.3 ± 0.8; females rated this skill at 5.5 ± 0.7 and males rated it at 5.2 ± 0.9. The out of Europe group rated this skill at 5.5 ± 0.9 and the in Europe group rated it at 5.3 ± 0.8. There were no interactions between these factors (Figure 2).

Qualitative analyses showed the effects of demographic variables within the FSA population from the view of future importance, but not of the current one, for "Building & Maintaining Networks" (Table 4). In agreement with the Likert scale analyses, under-40 FSAs viewed this skill as more important than what the 40-and-over FSAs did. In contrast, the indicator value showed that European and male respondents mentioned "Building & Maintaining Networks" as being important for their future work more than the out of Europe group and female FSAs.

Other stakeholders viewed "Building & Maintaining Networks" similarly to FSAs; there were no demographic differences for current work and there was more than a 50% difference based on demographics, with the in Europe respondents more likely to mention "Building & Maintaining Networks" than the out of Europe ones.

3.3.5. Digital and Technical Skills

Digital and technical skills include the following: use and implementation of technologies, generic digital skills, digital tools for marketing (only FSAs), digital tools for communication (only other) and technical advice (only FSAs).

There was no overall effect of stakeholder type on the rating of digital and technical skills and there was no interaction of stakeholder type with any other demographic factor. Among FSAs, there were no overall effects and no interactions for any of the demographic factors.

Qualitative analyses showed that males were twice as likely than females to talk about (or possibly consider) "Digital & Technical Skills" as being important for future work. As for current work, the non-EU group found this skill to be more than twice as important than the EU-based FSAs (Table 4).

For OTH stakeholders, there was no influence of demographics on the views toward "Digital & Technical Skills".

3.3.6. Strategic Development and Marketing

Strategic Development and Marketing datasets include the following types of skills: organizational management, business management, planning and financial understanding and marketing.

There was no overall effect of stakeholder type on strategic development and marketing datasets and no interactions of stakeholder type with any other demographic factor. Among FSAs, there were no overall effects and no interactions for any of the demographic factors.

Qualitative analyses showed that FSAs under 40 were almost twice as likely than those aged 40 and over to talk about "Strategic Development & Marketing" for both current and future work. Other demographic factors did not influence the FSA view of this skill (Table 4).

For OTH stakeholders, there was no influence of demographics on the view of "Strategic Development & Marketing".

3.3.7. Interpretation and Negotiation of Sustainability

Interpretation and negotiation of sustainability datasets include the following subcodes used for qualitative data analysis: sustainability, consideration of nature and environmental considerations.

Values of I for the age factor demonstrate its impact on the skills related to the interpretation and negotiation of sustainability mentioned by FSA stakeholders both for current work and for future sustainable development (Table 4).

As for other stakeholders, values of I for the gender factor demonstrate its impact on the skills related to the interpretation and negotiation of sustainability both for current work and future sustainable development, whilst the value of I for the geographic factor demonstrates its impact on skill preferences only for current daily work.

3.3.8. Teaching

All skills related to teaching, training, education and pedagogy were coded as the teaching dataset for qualitative data analysis.

Values of indicators calculated for all three demographic factors demonstrate their impact on the skill preferences by FSA stakeholders only for future sustainable development. Even though the value of I for the geographic factor (which is zero) could seem to be another outlier, it demonstrates a strong impact of the geographic factor, seeing as all of the teaching skills were mentioned only by the non-EU stakeholders (Table 4).

As for other stakeholders, the value of the geographic factor indicator demonstrates its impact in the teaching skill preferences for future sustainable development, whilst the value of the indicator for the age factor demonstrates its impact on the teaching skill preferences for current daily work.

3.3.9. Sector-Specific Skills

Sector-specific skills is a dataset that includes a huge variety of skills that correspond with a variety of the stakeholders' backgrounds, such as chemistry, biology, soil biology, green energy, food safety, pest management, plant disease diagnostics, post-harvest skills and management, poultry farming, bee keeping, zootechnics, permaculture and other skills related to the specific activity of the respondents.

There was no overall effect of stakeholder type on the rating of sector-specific skills and no interaction of stakeholder type with any other demographic factor. Among FSAs, there were no overall effects and no interactions for any of the demographic factors.

Qualitative analysis showed that EU FSAs talked about the importance of "Sector-Specific Skills" for current work almost 20 times more than non-EU FSAs. For future work, under 40s were almost twice as likely to talk about this skill than those in the 40 and over group (Table 4).

For OTH stakeholders, there was no influence of demographic factors on this skill for future work. For current work, EU others found it to be twice as important as those in the non-EU group and the 40 and over group found it to be twice as important as the under 40 group.

4. Discussion

4.1. RQ1: What Are the Most Important Skills According to the Stakeholders for Developing Sustainable Food Systems?

According to the results of quantitative analysis, other stakeholders evaluated "Building & Maintaining Networks", "Interdisciplinary", "Systems Perspective" and "Collaboration" as being equally highly important skills and significantly more important than "Visioning", "Navigating in a Changing World" and "Sector-Specific Skills", whilst among the responses of FSA stakeholders, there was no most important skill or skills. Six of the seven combined skills were considered of equal importance and only "Digital & Technical" was significantly different, considered to be less important than all of the other skills. According to Lourenço et al. [44], "skilled farmers will need to be able to understand and apply new technologies related to primary production for both food and non-food uses, soil science, crop and livestock genetics, agri-chemicals and general-purpose technologies such as remote sensors, satellites and robotics" [44].

However, all of the stakeholders ranked digital and technical skills as being less important among all seven skills for the future (Figure 1). This is in line with the findings of Irwin and Poots [45], who stated that non-technical skills are relevant within agriculture for teams and lone workers [45]. At the same time, according to qualitative data analysis, "Digital and technical" has the highest share among generic skills mentioned by FSA stakeholders and was one of the three most-repeated generic skills mentioned by other stakeholders for future sustainable development. In other words, for future sustainable development, "Digital and technical skills" were mentioned by FSA stakeholders more times than other generic skills, and according to other stakeholders, these are the third most-mentioned skills (Table 4). This is in line with the research of Ammann et al. [46].

Furthermore, values of indicators I calculated for "Digital and Technical skills" in Table 4 demonstrate the impact of the geographic factor on skill preferences of the FSA stakeholders only for current daily work and the impact of the gender factor on skill preferences for future sustainable development, whilst for other stakeholders, all values demonstrate a lack of impact of the demographic factors on the digital and technical skill preferences.

In addition, according to the results of qualitative analysis, age was not considered as a strong impacting factor for the need of digital and technical skills. This is opposite to the results observed in previous research [31–33], in which authors only focused on one country, and this could limit the impact of demographic factors on stakeholders' needs in digital and technical skills.

4.2. RQ2: What Are the Gaps between the Skills Needed for Current Daily Work and Skills for Future Development?

The data show that there are few gaps between the skills needed for current daily work and skills for future development. While FSAs in the open-ended questions currently believe that "Sector Specific" skills, followed by "Strategic Development & Marketing" and "Building & Maintaining Networks", are important, they indicate that "Sector-Specific" followed by "Digital & Technical" and "Strategic Development & Marketing" will be important in the future. Thus, for FSAs, "Sector Specific" skills and "Strategic Development and Marketing" are currently relevant and will continue to be important skills in the future. The only discrepancy is that they believe "Building & Maintaining Networks" are currently important skills and that they will be replaced by "Digital and Technical" skills in the future.

The highest share (more than 20%) of the responses received from both groups of stakeholders was coded as "Sector specific skills". This means a strong need in specific knowledge and skills for all stakeholders in the agri-food systems.

FSA stakeholders mentioned more of these for the future, whilst OTH stakeholders mentioned these skills more for current work.

Within the generic skills, only two skill datasets demonstrate a similar result for both groups of the respondents: "System perspective" and "Strategic development and marketing". All of the stakeholders mentioned "System perspective" skills more for the future rather than for current daily work and mentioned "Strategic development and marketing" skills more for current daily work rather than for the future (Table 3).

Skills related to the negotiation and interpretation of sustainability for both groups of the stakeholders were mentioned more for future development rather than for current daily work. Skills and competences needed for the sustainable development of agricultural and food systems are widely discussed in the literature. These skills vary from "awareness of environmental problems and implementation of measures" [47] to "value-based approach" [8]. In our research, the stakeholders expressed their interest in sustainability more than in certain skills. Thus, this skill dataset includes different stakeholders' responses, such as "in-depth practical knowledge of sustainability", "methods for measuring sustainability (all aspects)" and "expertise on sustainable alternatives (raw materials, technical solutions, transport, etc.)".

Furthermore, according to all of the stakeholders, there are three common most-repeated skills needed for current work including "Navigating in a changing world", "Building and maintaining networks" and "Strategic development and marketing". Concerning future work, both groups of stakeholders mentioned only one most common skills dataset: "Digital and Technical skills". Partially, this echoes the study of Lourenço et al. [44], where digital and technical skills were mentioned by Greek and Portuguese respondents as future training needs [44].

There is a gap between two other skill datasets needed for the future, as reported by each group. FSA stakeholders mentioned "System perspective" and "Strategic development and marketing", thereby confirming the findings of Gallego et al. [48], whilst OTH stakeholders mentioned "Navigating in a changing world" and "Building and maintaining networks". According to the study of Aver et al. [8], there is a shortage of these skills in the EU industries besides the agri-food sector [8].

In other words, as for future development, besides digital and technical skills, FSA respondents would prefer skills related to system thinking, management, planning and marketing (including sales), whilst OTH respondents need more networking and personal skills such as adaptability, flexibility and language skills. Considering that most of the OTH stakeholders were researchers and academic people (Table 1), these generic skills (networking and personal skills) would be needed for the future development of research and education.

4.3. RQ3: How Do the Demographic Factors Examined Affect the View of Required Skills by FSAs?

This research employs experimental methodology based on qualitative analysis in order to clarify potential connections between several demographic factors and different skills mentioned by the stakeholders. The received results expressed in values of indicator I were interpreted as a presence or lack of a connection between factors and responses. This allowed us to use the term "impact" for interpreting the results of this research.

Thus, another interesting finding is a higher impact of demographic factors on skills mentioned for future development, rather than on skills needed for the current daily work of FSA stakeholders. Across three demographic factors (geography, age and gender), age has a stronger impact on skill preferences than geographic location or gender.

Particularly, the age factor affected the skill preferences of the three datasets "Strategic development and marketing", "Navigating in a changing world" and "Interpretation and negotiation of sustainability" for future and for current daily work. According to the results (Table 4), the younger stakeholders (under 40 years old) contributed more to the skill preferences of these three datasets.

The gender factor affected more skills mentioned for future development. Skills for current and for future work were affected by the gender factor only in "Collaboration", where more women mentioned these skills for current daily work, but more men specified theses skills for future development.

The geographic factor has the lowest impact on needed skills compared to the age and gender factors. However, it has a very strong impact on sector-specific skills and a lower impact on the generic skills. In other words, it was mostly farmers, students and agricultural advisors from the EU who specified the needs in sector-specific skills for current daily work. This could be explained by a sufficient level of the generic skills among these stakeholders, which is in line with the study of Irwin and Poots [45].

In addition, the skills for current daily work in the following three datasets were not affected by the demographic factors: "Building and maintaining networks", "System perspective" and "Teaching". This means that respondents use these skills in their current daily work regardless of their location, age and gender, and that these skills could be considered as more universal competences for the current work of agri-food stakeholders. At the same time, there are no skills for future development that are without an impact of demographic factors, e.g., FSA stakeholders have a very subjective view on the skills needed for future work and future sustainable development.

In order to have results better tailored to the agri-food sector, future research should be based on a higher number of responses from agri-food stakeholders, particularly from farmers and food producers.

5. Conclusions

The skills needed for agri-food stakeholders are differently discussed in the scientific literature. This research was focused on farmers, agricultural students and agricultural advisors as the main target group, and attempted to examine their skill preferences. Answers to the three research questions provided by this study could contribute to the literature focused on generic and specific skills. Thus, farmers, agricultural students and agricultural advisors highly evaluated almost all generic skills, thereby emphasizing a holistic approach to their activity and a need of several skills for their sustainable development. As for the skills needed for the future, according to this target group, the majority of the skills mentioned belong to three datasets: "System perspective", "Strategic development and marketing" and "Digital and technical skills". Besides the results for "Digital skills", the target group and other stakeholders have different points of view on the skills needed for the future due to their different activities.

Furthermore, this research has provided interesting results concerning the impact of demographic factors on the skill preferences of farmers, agricultural students and advisors. Thus, the demographic factors (age, gender and geography) have a higher impact on skills mentioned for the future; the age factor has the highest impact, compared to gender and geography. The demographic factors did not affect the three skills needed for the current daily work of the farmers, including "Building and maintaining networks", "System perspective" and "Teaching".

These findings could be used for enhancing agricultural higher education and vocational training in different countries. The understanding of the skill preferences will provide a useful insight to improve agricultural education around the world and to make it more efficient for future facilitators of change.

Furthermore, this research has several features. Firstly, notwithstanding the aforementioned main target group, the number of other stakeholders who participated in the survey was higher. This again demonstrates the challenges in reaching farmers for data collection, and provides pathways for further research in this field.

Secondly, the questionnaire was available during the COVID-19 period, which could have also distorted the received responses. Particularly, this might have affected the quantitative evaluation of digital and technical skills, as they were used much more during that period. At the same time, the stakeholders mentioned these skills more for future sustainable development rather for current daily work. Further research on digital and technical skills in agriculture could be another relevant topic for additional scientific papers in the future.

Thirdly, this research has attempted to use qualitative data for defining an impact of demographic factors. The fact that many stakeholders provided incomplete responses that could not be used for further analysis has affected the received results and could be considered as one of the research limitations.

Another aforementioned limiting factor of this research is the different understanding of sustainability of food systems by different stakeholders which might have created a bias in their responses concerning skills and competences for future sustainable development.

Further research could focus on a comparison of farmers' and students' views on needed skills and competences.

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Appendix A. Questions for the Questionnaire

1. In which of the following stakeholder roles do you work (check all that apply)?
    - Farmers *
    - Advisers to farmers *
    - Agriculture students *
    - Students in other fields
    - Academia: faculty and administration
    - Sustainable agriculture activists
    - Policy makers
    - Municipal authority
    - Retailers/supermarket
    - Processors
    - Agri-business managers
    - NGO activists
    - Forestry official
    - Researcher—institute
    - Other. Please specify

    (* These three categories of respondents see Questions 7–10, others do not).
2. What are the three most important skills in your daily work, in order of importance? (Three answer boxes, 100 character limit not including spaces per box)—Q2 for qualitative analysis
3. Which three skills would you most like to have for your future as a successful stakeholder in sustainable food and forestry? (Three answer boxes, 100 character limit not including spaces per box)—Q3 for qualitative analysis
4. I identify the farm where I most often work as (more than one choice possible):

    Biodynamic
    Conventional

Permaculture
Agroecological
Other, please specify

5. Which of the following take place on the farm where you work (more than one choice possible)?

Crop production
Education activities
Agritourism
Community-supported agriculture
Direct sales
Other, please specify

6. I have more than 10 years of experience in farming (yes/no)
7. What are the three most important skills missing in the current training of professional farmers? (Three answer boxes, 100 character limit not including spaces per box) *
8. What knowledge/skills would you like to learn online? (100 character limit not including spaces per box) *
9. How would you like to learn new knowledge/skills online? *

(Drop-down menu with the following: reading case studies, reading reports and factsheets, sharing best practices with others, short online courses, interactive tools, movie clips, stepwise guides, infographics, other)

10. In order for your (student) farm work to become part of a sustainable agri-food system, which three problems require research? (Three answer boxes, 100 character limit not including spaces per box) *

For the following statements about skills for the future of sustainable food/forestry, please indicate how much you agree (6) or disagree (1).

11. Networking skills will become more and more important

(Networking means the action or process of interacting with others to exchange information and develop professional or social contacts)

12. Interdisciplinary skills will become more and more important

(Interdisciplinary means relating to more than one branch of knowledge)

13. Specific technical skills will become more and more important

(Technical skills are the abilities and knowledge needed to perform specific tasks)

14. Planning for the future (visioning) will become more and more important

(Visioning means the ability to think about or plan the future with imagination or wisdom)

15. Efficiency at daily tasks will become more and more important
16. Ability to adapt to changes will become more and more important
17. Knowing about resource use efficiency (waste recycling/use of local resources) will become more and more important
18. Real-life complex problem solving will become more important
19. Understanding theory will become more and more important
20. Shortening/localizing of the (food/forest) value chain is necessary for the future of sustainability
21. Developing empathy in respect to nature will become more and more important

(Empathy means the ability to understand and share the feelings of another)

22. What is your nationality? (Drop-down menu)
23. In which country do you work? (Drop-down menu)
24. How do you identify your gender?

25. What is your age?
26. Are you personally involved in the NextFood project? (yes or no)
27. Did you hear about this questionnaire from a NextFood partner (yes/no/do not know). If yes, which partner? (Drop-down menu of partner names INCLUDE PARTNER COUNTRY HERE)
28. Which NextFood partner sent you the questionnaire?

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