Developing skills for introducing circular business models and digital technologies in olive oil sector

D2.3 National Report on current and future skill levels for transition of the olive oil sector to circular economy

- ITALY -

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National Report on current and future skills levels for transition of the olive oil sector to circular economy - Italy

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Contents

1. Executive Summary

This report analyzes the current and future skill levels in the Italian olive oil sector to facilitate the transition to a circular economy. The research highlights a growing awareness of sustainability's importance but also challenges related to the lack of specific skills, financial constraints, and limited digitalization in the sector.

The adoption of circular practices such as waste reduction and by-product valorization is already underway, but implementation remains inconsistent. Key drivers of this change include stricter environmental regulations, technological innovation, and increasing demand for sustainable products. However, significant obstacles persist, including inadequate incentives, limited knowledge of emerging technologies, and difficulties in accessing funding.

The study identifies key professional roles crucial for the industry's future, including waste valorization engineers, sustainability consultants, and circular economy managers. These roles will require advanced skills in waste management, renewable energy, and technological innovation.

To support this transition, the report recommends concrete measures, including the development of specialized training programs, financial incentives for the adoption of sustainable technologies, investments in research and development, and greater collaboration among businesses, academic institutions, and policymakers. Additionally, it is essential to raise consumer awareness of the benefits of sustainable production and promote marketing strategies focused on eco-friendly products.

By implementing these strategies, the olive oil sector can enhance sustainability, increase competitiveness, and ensure greater long-term economic resilience.

2. Introduction

2.1. Purpose and Objectives

This report presents the research on the current and future skills levels and/or emerging professions for transition of the olive oil sector to circular economy in Italy. The report is a part of Work Package 2 (Identification of olive sector circular needs and emerging skills and/or professions for transition of the olive oil sector to a circular economy in the 5 countries) of the CIRCOLIVE project (Developing skills for introducing circular business models and digital technologies in the olive oil sector) and represents deliverable D2.3. (National Report on current and future skill levels for transition of the olive oil sector to circular economy - Italy).

The aim of this report is to investigate and analyze current skill levels, factors shaping the demand for skills, skill gaps and future skill needs and occupations related to the circular economy in olive growing sector. The review of the available literature and the

analysis of the collected data determined current and future skills levels and/or emerging professions in Italy, which will be used as basis for further project activities and the creation of a curriculum for vocational education and training on circular business skills in the olive growing sector in Italy.

2.2. Key Findings

The transition of the Italian olive oil sector towards a circular economy is promising but requires further efforts from the operators. While some companies have adopted sustainable practices, the gaps in knowledge of circular practices, the financial constraints, and the limited digitalization of the enterprises hinder a full implementation.
On the other hand, the main driving factors include the development of sustainability regulations, the numerous technological advancements of recent years, and the growing market demand for sustainable products. However, challenges remain, such as insufficient governmental incentives and the lack of technical skills among operators. Among the emerging roles, waste valorization engineers and sustainability consultants stand out as crucial figures to bridge these gaps.
Despite progress, structured training, financial support, and innovation adoption are needed to accelerate the transition towards a fully sustainable olive oil sector.

3. Methodology

The chapter "Methodology" describes the methods of data collection and their analysis. The aim of the chapter is to inform the reader about the methodology used and the possibility of repeating the study using the same methodology.

3.1. Data collection methods

The data was collected from two data sources: primary and secondary data sources.

Primary data collection involves the process of preparing tools for data collection and collecting data from a planned sample of respondents (N = 30). Three data collection instruments were prepared for the purposes of this study: a questionnaire and two interview reminders. The questionnaire was designed with the aim of collecting quantitative data on a sample of professionals in the olive oil sector. The questionnaire (ANNEX 1 (D2.3): Online survey targeting MSMEs in the olive oil sector about current and future skills needs for transition of the olive oil sector to circular economy) contained multiple-choice questions, closed questions, open questions and questions in the form of a Likert scale. The questions related to current skill levels, factors shaping the demand for skills, skill gaps and future skill needs and occupations related to the circular economy in olive growing sector. ESCO occupation groups and skills were used, to the extent possible to identify the most demanded skills (Table 1, Table 2).

Table 1. Occupations from ESCO used in the questionnaire (ANNEX 1 (D2.3)

Occupations in the survey	ESCO occupations	ESCO occupation code
Agronomist	Agronomist	2132.2
Agricultural production manager	Agricultural and forestry production manager	1311
Agricultural labourer	Agricultural, forestry and fishery labourer	921
Environmental engineer	Environmental engineer	2143.1
Oil mill operator	Oil mill operator	7514.2
Food technologist	Food technologist	2145.1.4
Quality control and safety officer	Industrial quality control manager Health safety and environmental manager	1321.2.2 1213.7
Packaging production manager	Packaging production manager	2141.9
Logistics and supply chain manager	Supply chain manager Logistics engineer	1324.8 2149.2.6
Researcher and scientist in circular economy	Research engineer Soil scientist	2149.2.8 2133.11
Sustainability manager	Sustainability manager	1213.8
Alternative fuels engineer	Alternative fuels engineer	2149.9.1
Waste treatment engineer	Waste treatment engineer	2143.1.4
Recycling specialist	Recycling specialist	2143.1.3
Food technician	Food technician	3119.5
Product development engineering drafter	Product development engineering drafter	3118.3.12
Environmental programme coordinator	Environmental programme coordinator	2133.6

Table 2. Skills and knowledge from ESCO used in the questionnaire (ANNEX 1 (D2.3)

Skills in the survey	ESCO skills and knowledge	Concept URI
Knowledge of sustainable farming practices	Follow environmentally-sustainable work practices	http://data.europa.eu/esco/skill/a992f345-7c06-4982-8fc9-5fab55e316af
Knowledge of water and soil protection	Advise on soil and water protection	http://data.europa.eu/esco/skill/3e25fd3e-2bcd-4320-9587-0aadf7fb93b1
Organic farming and pest control techniques	Organic farming Perform pest control	http://data.europa.eu/esco/skill/186da517-9a3e-41cd-9158-4001e3694459 http://data.europa.eu/esco/skill/08881cb7-5331-4b11-9442-4d7c9fce749e

Understanding of food policies and regulations	Food policy Control food safety regulations	http://data.europa.eu/esco/skill/e591f458-93c4-4cc7-a441-2340545c33f3 http://data.europa.eu/esco/skill/4d7410df-51a9-42bc-83ec-363c201ee631
Waste and by-product management	Waste management By-products	http://data.europa.eu/esco/skill/40f65a56-ccbe-4601-9f32-1cc6cdd24f28 http://data.europa.eu/esco/skill/f2412a5c-8072-4cd7-8fa1-806864f91276
Energy efficiency in production	Energy efficiency	http://data.europa.eu/esco/skill/83fc0b2b-6cd2-46af-b1ff-d3fc83604c26
Supply chain management	Supply chain management	http://data.europa.eu/esco/skill/f929c89e-c363-4132-a918-e021d57b307c
Digital skills (e.g., data management, precision agriculture)	Product data management Agriculture not further defined	http://data.europa.eu/esco/skill/e2d0daae-2aa1-40cc-99e2-b340b02f97d3 http://data.europa.eu/esco/isced-f/0810
Produce sustainable products	Produce sustainable products	http://data.europa.eu/esco/skill/97725325-5287-4ebb-9f83-1ba2c38f465c
Develop and coordinate waste management processes	Develop waste management processes	http://data.europa.eu/esco/skill/114a79ef-1e62-475b-a862-954f5b4cca20
Develop recycling programs	Develop recycling programs	http://data.europa.eu/esco/skill/862920c8-f2d0-4058-8fb8-9f06fbfc2446
Renewable energy integration	Renewable energy	http://data.europa.eu/esco/skill/f8413360-6114-40de-a276-c59b764b9913
Product data management and digitalization	Product data management	http://data.europa.eu/esco/skill/e2d0daae-2aa1-40cc-99e2-b340b02f97d3
Ensure compliance with environmental legislation	Ensure compliance with environmental legislation	http://data.europa.eu/esco/skill/089ee650-297e-4716-87d1-440743b70a0d
Asses the life cycle of resources	Asses the life cycle of resources	http://data.europa.eu/esco/skill/4e87c852-602a-4a0e-b8d8-20709ce14ac5
Develop new food products	Develop new food products	http://data.europa.eu/esco/skill/090ae6b3-12ab-4c72-b98a-17b790cf416e
Plan digital marketing/digital skills	Plan digital marketing	http://data.europa.eu/esco/skill/736ef286-fbd3-4e5c-a4b4-d1e2008c9898
Implement marketing strategies	Implement marketing strategies	http://data.europa.eu/esco/skill/13e2378e-0d10-450d-843a-b3592575826e

Green marketing	Marketing principles	http://data.europa.eu/esco/skill/de03f4fd-c147-4477-a048-7109e5ba2d6f
Thinking creatively and innovatively	Thinking creatively and innovatively	http://data.europa.eu/esco/skill/e84d080a-ff6d-41a7-b7b9-133e97c7bf00
Entrepreneurial mindset	Show entrepreneurial spirit	http://data.europa.eu/esco/skill/bdcf429c-5ccf-4c3d-bb61-4c987573a35e
Deep tech knowledge	Principles of artificial intelligence Principles of artificial intelligence	http://data.europa.eu/esco/skill/e465a154-93f7-4973-9ce1-31659fe16dd2 http://data.europa.eu/esco/skill/f049d050-12da-4e40-813a-2b5eb6df6b51

The planned sample size was 30 respondents, but data was collected from 33 respondents (Table 3). The questionnaires were collected online via Google forms.

Table 3. Description of the sample of respondents who participated in the online questionnaire (N=33)

Variable	N	Percentage (%)
Gender		
Male	20	60.6
Female	13	39.4
Age		
Up to 36	9	27.3
37 - 56	9	27.3
57 and more	15	45.4
Education		
High school and lower	18	54.5
Bachelor degree	2	6.1
Master degree	12	36.3
PhD	1	3.1
Enterprise size		
Micro (<10 employees)	29	87.8
Small (<50 employees)	2	6.1
Medium sized (<250 employees)	2	6.1

Two interview reminders were also prepared for the qualitative data collection. One interview reminder was prepared for experts in the agri-food sector (ANNEX 2 (D2.3): Structured interview with circular business agro-food experts/professionals about

current and future skills needs for transition of the olive oil sector to circular economy). The other one for providers of education in Italy (ANNEX 3 (D2.3): Structured interview with VET providers about current and future skills needs for transition of the olive oil sector to circular economy). The reminders contained open ended questions with a selection of possible answers to guide the conversation and conduct the interview as efficiently as possible. The planned sample size was 5 respondents for experts in the agri-food sector and 5 respondents for providers of education. Interviews were conducted face-to-face with respondents and through an online meeting. The interviews were recorded, and a transcript of the conversation was made. Each respondent has voluntarily and expressly consented to the collection and further processing of personal data and has voluntarily agreed to answer questions for the purpose of research within the CIRCOLIVE project. Each respondent has confirmed this with their signature in the documents: a) Statement related to giving consent for the processing of personal data and b) Information form for participation in research – personal informed consent.

Secondary data are ready-collected data that come from various sources, e.g.: available studies, skills needs analysis, forecasts, etc. When using this data, the source is always cited in the report and the list of references used can be found in chapter 9 of this Report.

3.2. Data analysis methods

After the data collection was completed, the data analysis was carried out. Quantitative data collected through questionnaires were analysed using descriptive analysis and response frequencies. The data are presented in the form of tables, graphically through graphs and descriptively. The data collected through the interviews were processed through a content analysis.

4. Current Skill Levels regarding Circular Economy in the Olive Oil Sector

The olive oil production is one of the most important sectors of Italian food economy, but it might be thought to provide systemic technological innovation with selective and costly improvements (Martino et al., 2017). Moreover, the adoption of advanced analytical methods allows for rapid and precise quality assessment of olive oils. These methods facilitate quality control and contribute to the overall improvement of product standards in the market (Turkan Mutlu Keceli, 2023). Olive oil by-products can be used in different ways for resource recovery, improving the sustainability of oil production. Pruning residue consists of branches, which could be used as biomass for fuel production (Intini et al., 2014), and leaves, which could be useful for phenolic compound extraction or animal feeding (Cerri et al., 2024). Olive mill wastewaters and pomace are also a great source of polyphenols, that can possess antioxidant and antimicrobial activity (Pannucci et al., 2019; Ricelli et al., 2020).

Among the 33 respondents to the questionnaire, the majority work as olive mill operators (8) and as production managers in the agricultural company where they are

employed (7) (Fig. 1)

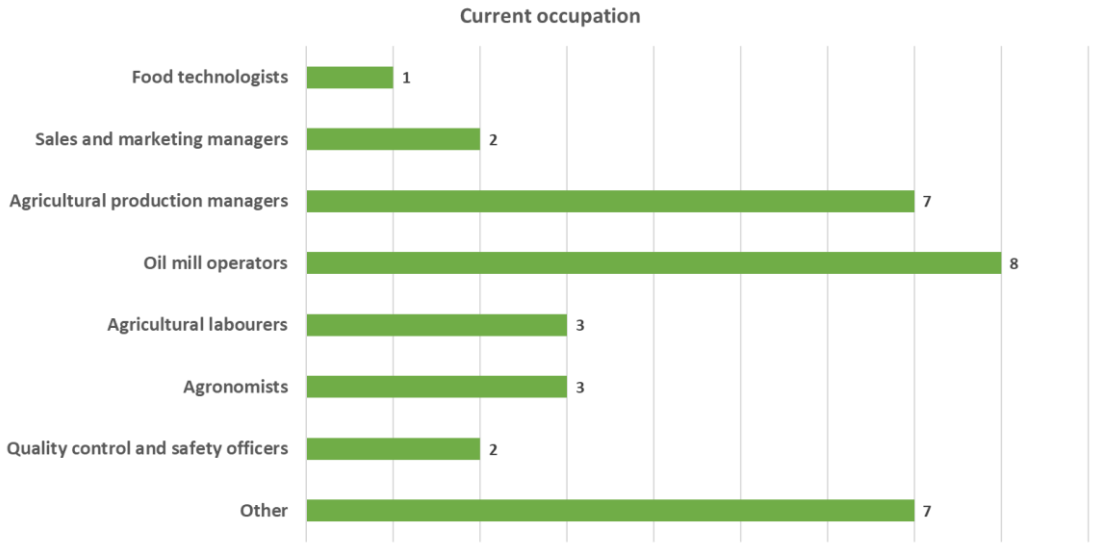

Fig. 1 *Current occupation of respondents (N = 33)*

Regarding circular economy practices being implemented in their workplaces, 48.5% of respondents indicated that the most common practice is waste reduction and by-product valorization, followed by the use of renewable energy (39.4%) and water recycling and efficient resource use (36.4%) (Fig. 2). This indicates that, compared to other circular economy practices implemented in the respondents' companies, those related to the sustainable use of energy resources and the valorization of by-products—which were previously considered waste but are now seen as valuable for the supply chain—hold greater significance.

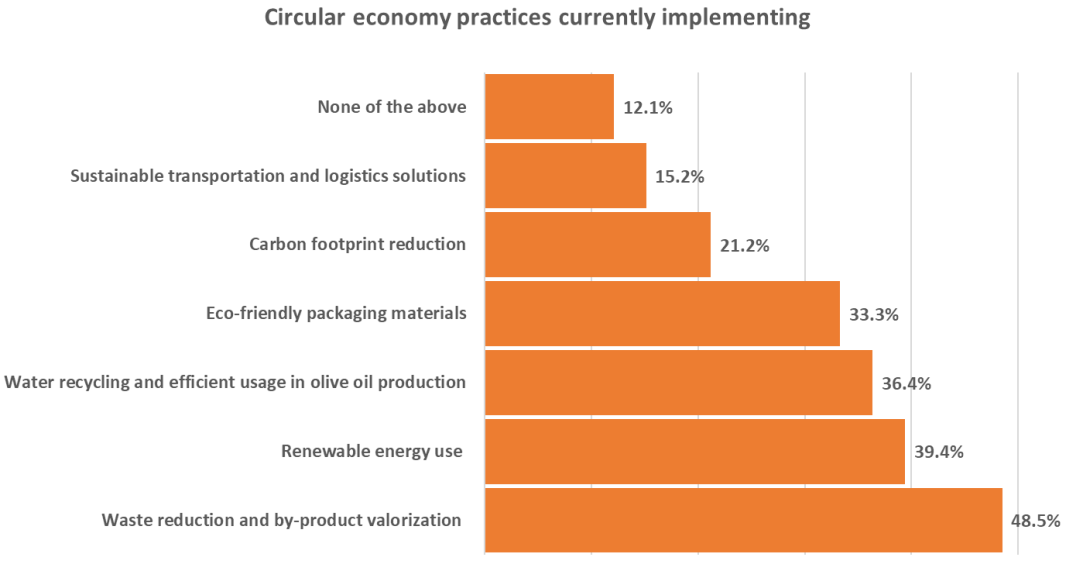

Fig. 2 *Circular economy practices currently implementing in the respondent's workplace (N = 33)*

Despite these efforts, only 27.3% of respondents consider the level of circular economy knowledge and skills within their company as "good", while 30.3% rate them as merely "acceptable," and none rated them as "excellent" on a 1 to 5 scale (Fig. 3). It is clear that, despite the importance given to these practices and the efforts made

to implement them, there is still neither sufficient awareness to define them as high-level nor integrated assessment methods that could help professionals in this field evaluate these competencies effectively.

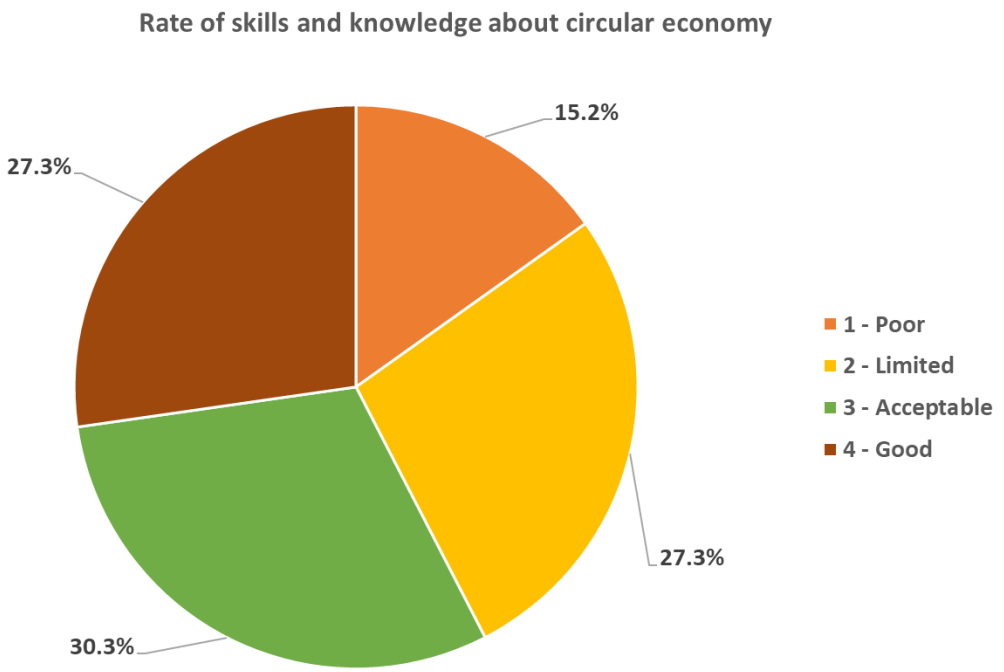

Fig. 3 *Rate of skills and knowledge about circular economy in the respondent's workplace (N = 33)*

Finally, when evaluating various circular economy competencies in the olive oil sector on a scale from 1 ("not important at all") to 5 ("the most important"), the most significant skill was considered to be waste and by-product management. In contrast, the implementation of digital skills was mostly rated as neutral (score of 3), a result that could be influenced by the age of the panel, with 45.4% being over 57 years old (Fig. 4). In general, almost none of these skills are considered unimportant: only 1 or 2 respondents stated that they do not consider them important at all. At most, 4 respondents indicated that they do not consider digital skills important, for example. However, for the other skills, there were only 1 or 2 responses in this category.

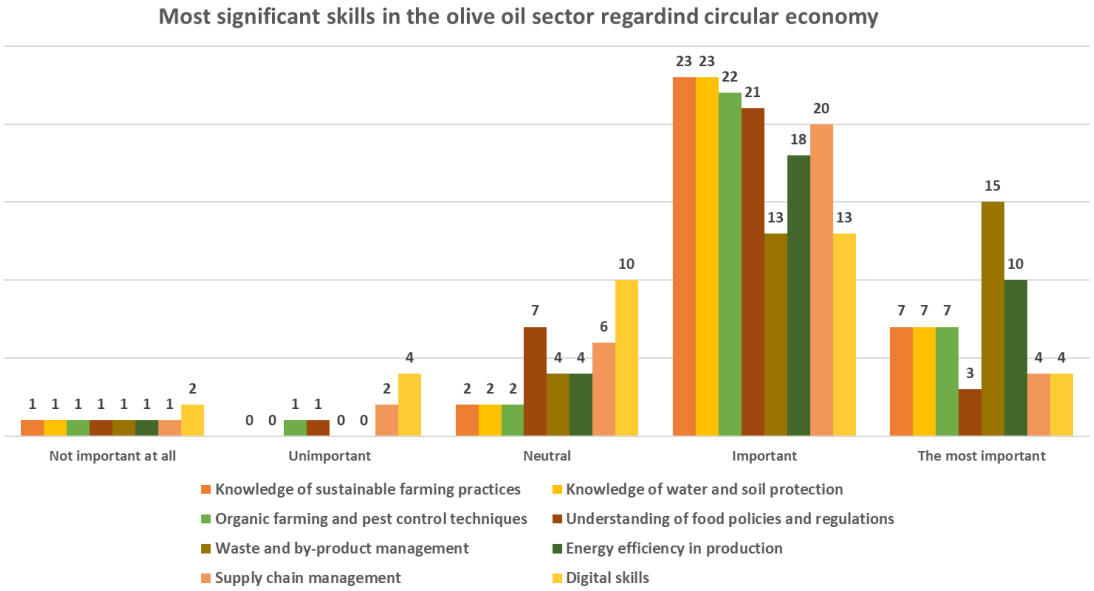

Fig. 4 *Most significant skills in the olive oil sector regarding circular economy (N = 33)*

Based on the interviews conducted, the five respondents (agronomists, farm and mill managers) generally demonstrated an acceptable knowledge of the circular economy practices regarding the olive oil sector. All the respondents have already in place sustainable practices, for example the by-products valorization (olive pomace, leaves, and pits mostly) for bioenergy production and animal feed (only one of the interviewees), and techniques to reduce their carbon footprint, such as the use of renewable energies (solar panels above all, but also photovoltaic and water tanks in one case) and ecological packaging (such as recycled paper and cardboard), which is indicated by two out of five respondents. Waste management and by-products valorization, energy efficiency, organic farming practices (like bio-products, water and soil protection, and parasites control) and the understanding of the current food policies and regulations were mentioned as the most significant skills towards circularity.

Analyzing the feedback from the five education sector professionals on the key skills in the olive oil industry related to circular economy, a variety of viewpoints emerge. Three interviewees emphasize the importance of understanding agri-food sustainability, waste management, and food regulations. On the other hand, two participants stress the significance of expertise in water and soil conservation, organic farming techniques, and pest control within the sector. Concerning current educational offerings on circular economy practices in the olive oil industry, two interviewees note that their institutions do not currently offer specialized courses in this area. However, three interviewees mention that their institutions provide mandatory courses within university and higher education training modules, along with tailored courses for aspiring tasters of virgin olive oils. These findings indicate a growing awareness of the essential circular economy skills in the olive oil sector, with some institutions already delivering focused courses while others might need to further develop their educational programs in this regard.

5. Current Skill Gaps regarding Circular Economy in the Olive Oil

Sector

Italy is one of the key players in the olive oil market, as witnessed by the income produced by this sector that is proved to be one of the pillars of the Italian economy (STATISTA, 2021). Nevertheless, in recent years, the Italian olive oil sector underwent a loss of competitiveness, due to the scarce technological improvement and unproper process management in the mill plants (Irene et al., 2018). The lack of technological innovation still needs to be addressed, being the high costs of machinery, the lack of infrastructures, the problems in waste disposal, and the small/medium industrial capacity the most severe limiting factors (Perone et al., 2022).

According to Italian respondents, the key factors driving the demand for new skills in the olive oil sector are pressure to improve sustainability performance (selected in more than half of the cases), followed by the development of new technologies and innovation (selected 48.5% of the time) (Fig. 5). In this case, the economic aspect is also highly relevant: economic changes driven by market demands, both national and global, also impact this sector. Consumer demand for products perceived as coming from a sustainable supply chain implies an increasing need for experts with such competencies.

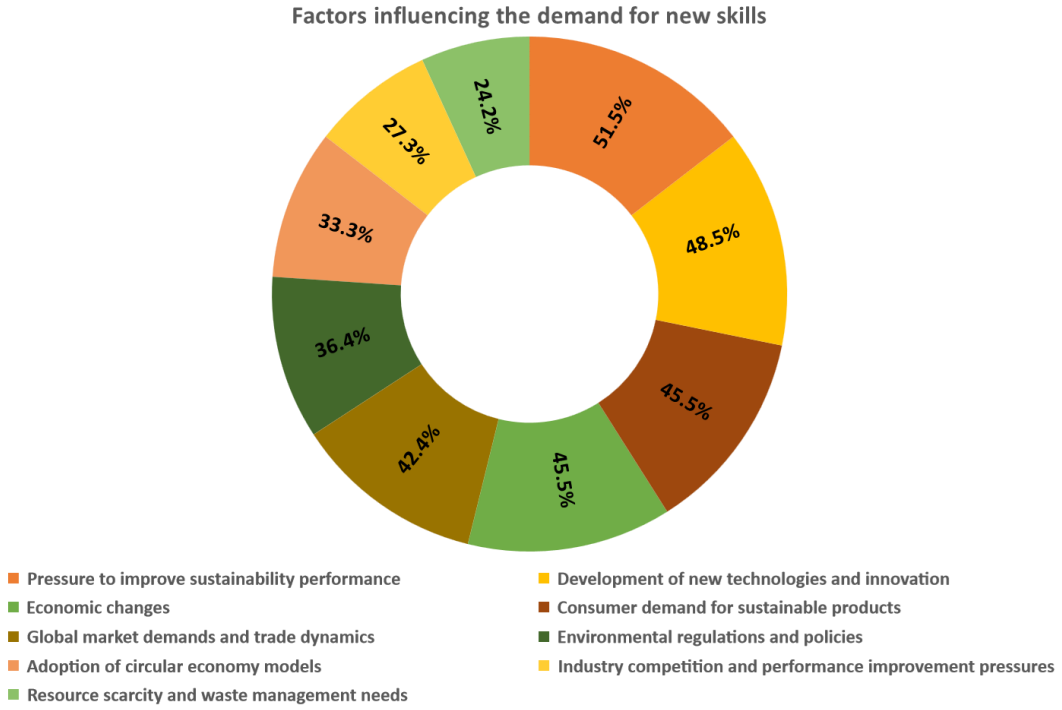

Fig. 5 *Factors influencing the demand for new skills in the olive oil sector (N = 33)*

Regarding the lack of skills in this area within the respondents' companies, the primary causes identified are financial constraints and the lack of regulatory incentives (both selected 54.5% of the time), indicating that the issue is mainly linked to economic factors (Fig. 6). This further confirms the economic trend: all other causes were mentioned significantly less than the top two. The financial issue remains a key challenge, which does not necessarily imply poor resource management but may also be due to limited governmental support in funding projects and investments related

to the circular economy.

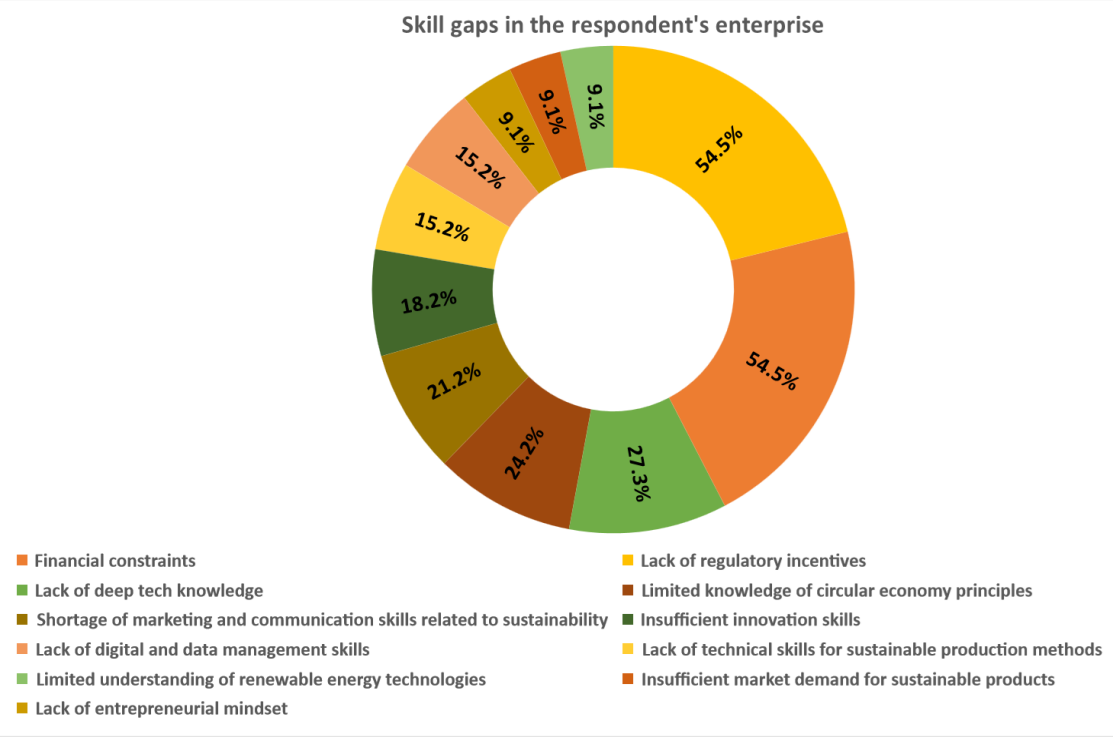

Fig. 6 *Skill gaps in the respondent's enterprise (N = 33)*

All respondents agreed that the professions listed in question 12 require enhanced circular economy skills, particularly the roles of "sustainability manager" and "waste treatment engineer" (Fig. 7). It is noted that the Alternative Fuel Engineer was the profession that received the fewest "Yes" (17) responses and the most "I don't know" (14) responses, suggesting that respondents likely struggle to clearly identify the role and responsibilities of this profession.

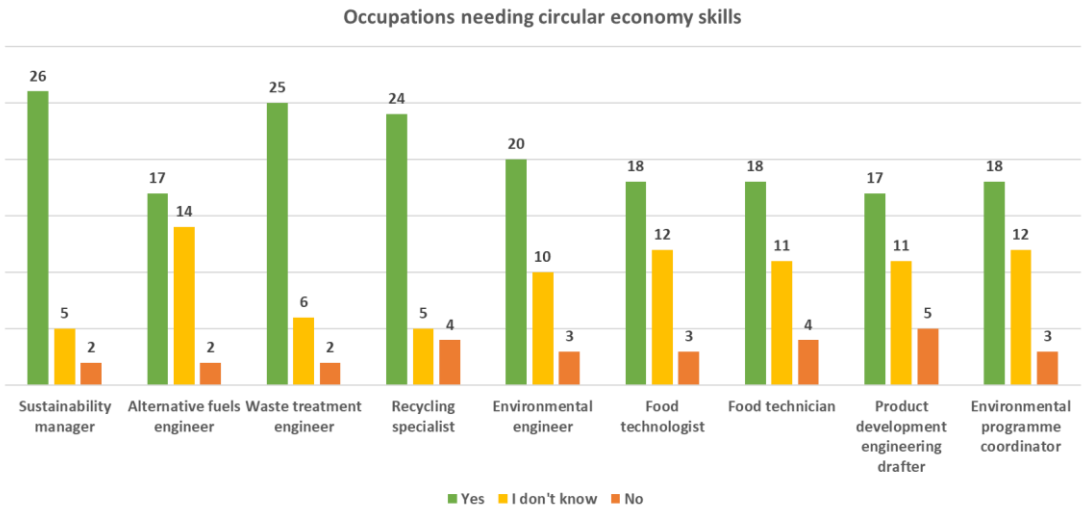

Fig. 7 *Occupation needing circular economy skills (N = 33)*

For the olive oil sector specifically, the most frequently cited professions in need of such skills are "agronomists" and "agricultural production managers", followed by "researchers and scientists" working in this field. Additionally, in question 14, an open-

ended response highlighted category association managers as another professional group facing increasing pressure to develop circular economy competencies (Fig. 8).

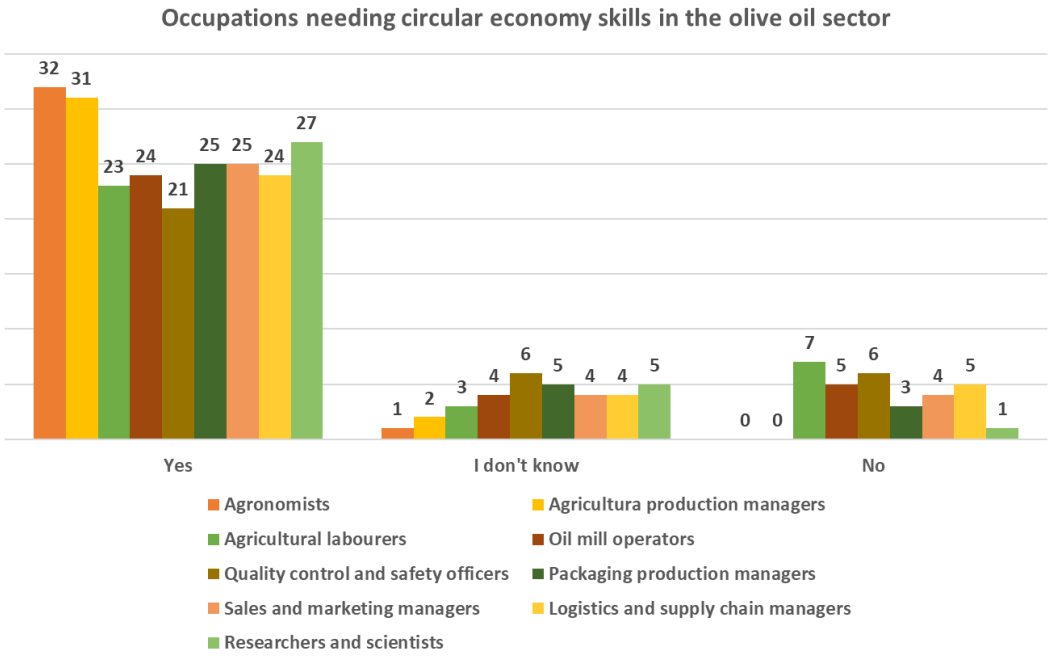

Fig. 8 *Occupations needing circular economy skills in the olive oil sector (N = 33)*

According to the responses to the online interviews, the factors that most encourage companies towards circular economy relate to the growing consumer demand for sustainable products and the development of new technologies to improve sustainability performance, but two out of five respondents also pointed to climate change and its economic consequences, along with a subjective factor that drives the transition. The biggest gaps related to circularity appear to be, for all of them, the lack of technical skills for sustainable production and the limited knowledge of current practices and regulations concerning circular economy, but two respondents indicated also the often-unclear financial constraints and incentives. Therefore, the professions most in need of more information include the base of the olive oil production chain, including agronomists, farm and mill workers, but also new figures (pointed out by two interviewees) such as researchers and scientists specialized in the proper adoption of circular economy practices.

From the analysis of the responses from the five interviewees regarding the factors influencing the demand for new skills in the olive oil sector, several perspectives emerge. Three participants highlight that the pressure to improve sustainability performance, economic changes, environmental regulations, industry competition, global market demands, and trade dynamics are the main drivers behind the need for additional skills. Two interviewees focus on the importance of adopting circular economy models and environmental regulations as the primary influences on the demand for new skills in the olive oil sector.

Regarding professions in the olive oil sector that may require skills related to the circular economy, the responses outline a variety of key roles. While some mention

agronomists, packaging production managers, and logistics and supply chain managers as relevant figures, other responses include agricultural laborers, oil mill operators, agricultural production managers, marketing and sales managers, scientists and researchers, and food technologists. These responses highlight the diversity of professions involved in the olive oil sector that could benefit from acquiring skills related to the circular economy, emphasizing the importance of targeted training to address the emerging challenges in this evolving industry.

6. Future Skill Needs and Emerging Professions for Transition of Olive Oil Sector to Circular Economy

Due to the particular importance of the olive oil sector, addressing new challenges is necessary, which include either the identification of innovation forms of the entire supply chain relevant to sustainability issues, the examination of innovative effective solutions aimed at transforming olive oil industry waste into precious resources with a view of the circular economy and ecological transition, or the identification of the most appropriate forms of green financing, suitable to support innovation processes. The ecological transition of the olive oil supply chain, achievable with technological innovation for the development of the circular economy and with the reduction in emissions in the olive oil sector, requires significant investments that can be made using sustainable finance tools, which direct financial resources towards activities that respect the environment (green finance) but also the correct organization and management of production activities (Intonti M., et al., 2025).

According to our panel, the most critical circular economy skills for the future success of a company in the olive oil sector are "creative and innovative thinking" (selected 48.5% of the time), followed by "waste and by-product management" and "green marketing implementation" (both selected 45.5% of the time). This is an interesting aspect: even in a sector still deeply connected to land and tradition, creative thinking becomes essential to make the product more appealing to consumers and to enhance its production-related aspects. Once again, "product data management and digitalization" ranked last (Fig. 9).

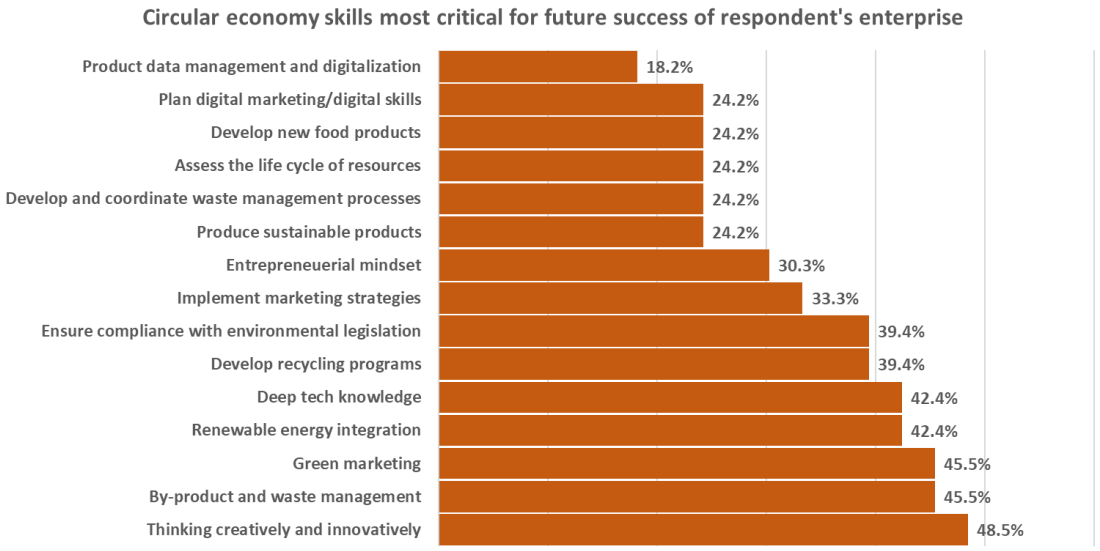

Fig. 9 *Circular economy skills most critical for future success of respondent's enterprise (N = 33)*

When looking at emerging professions considered important for the sector's future transition to a circular economy, the top-ranked role is "waste valorization engineers", further emphasizing the importance of waste management in the olive oil sector (Fig. 10). This reinforces the trend related to digital skills (the option "data analysts for sustainable agriculture" was selected only for the 12.1% of times), as the sector still does not seem fully prepared or particularly interested in considering these practices as important for the implementation of circular economy aspects.

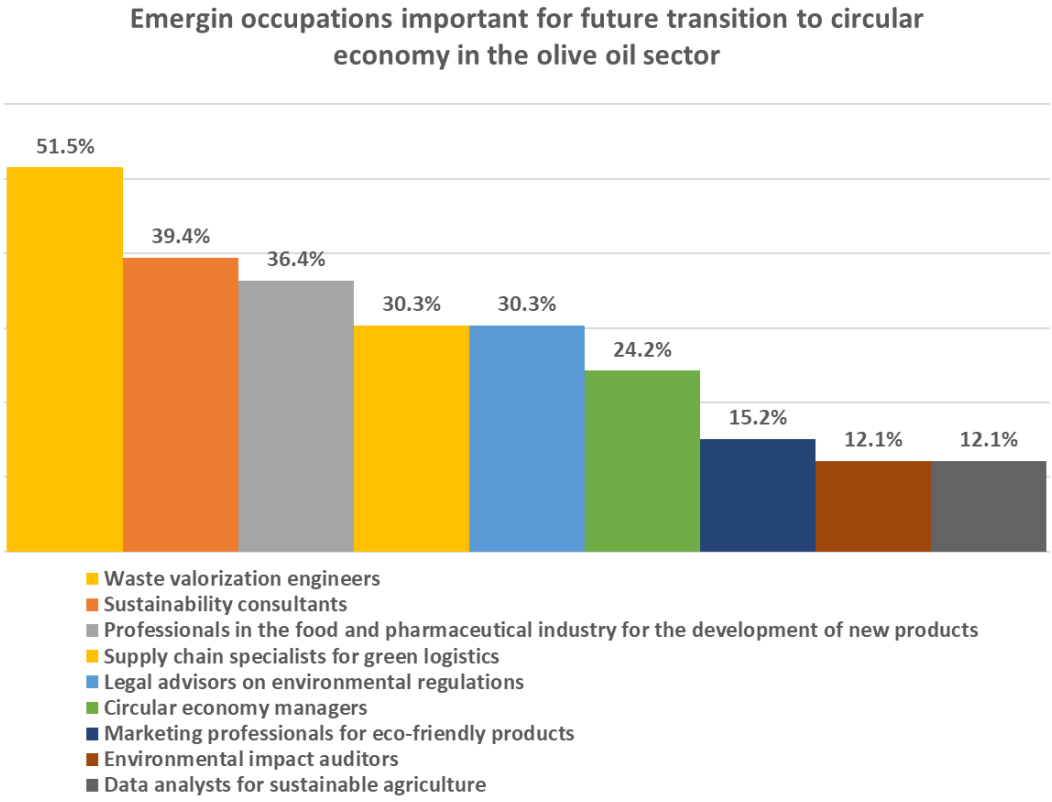

Fig. 10 *Emerging occupations important for future transition to circular economy in the olive oil sector (N = 33)*

Reinforcing this point, "knowledge of waste and by-product valorization" was identified as the most essential circular economy skill for emerging professions, standing out significantly from the other competencies (Fig. 11). In this case, economic aspects follow closely behind environmental concerns: there is a demand for expertise in green finance and investments, as well as for skilled managers capable of effectively managing sustainable resources.

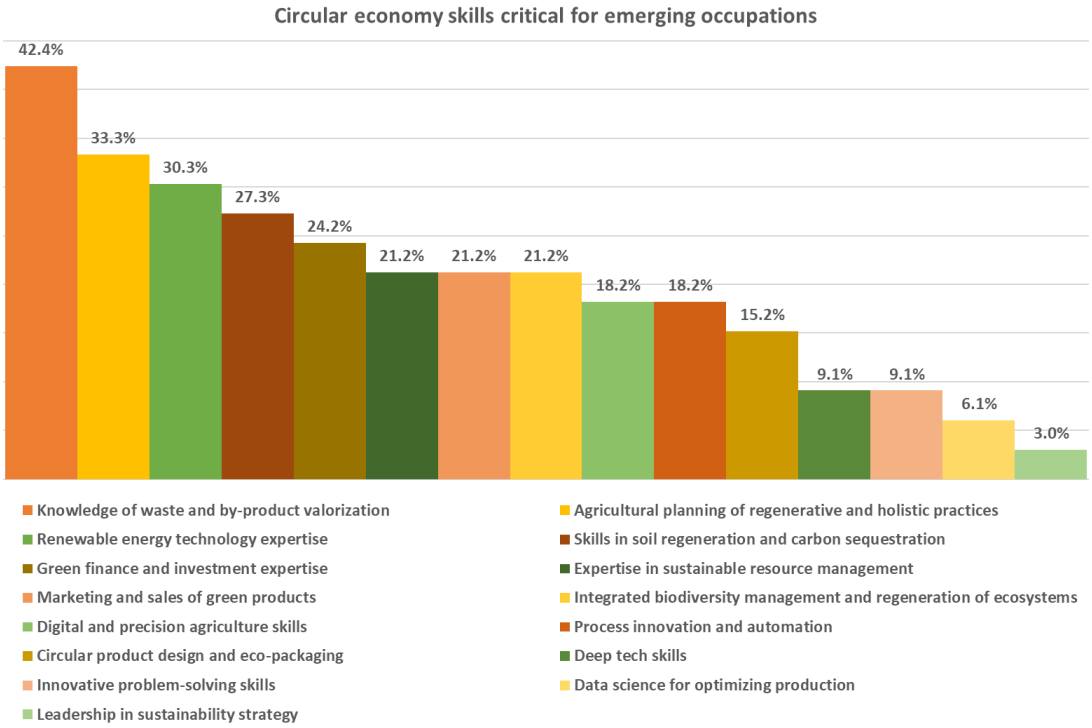

Fig. 11 *Circular economy skills critical for emerging occupations (N = 33)*

The interviews highlighted a growing future need for expertise in managing olive oil by-products and producing sustainable products. Furthermore, two respondents also emphasized the need for resource recycling programs and greater integration of renewable energy sources. The emerging professions that will play a crucial role in the transition to a circular economy in the olive oil sector will include legal and sustainability consultants and engineers specializing in the valorisation of waste and by-products from the olive oil supply chain (four out of five respondents), as well as renewable energy experts (for one of them). Three respondents also stressed the importance of marketing professionals to ensure the proper promotion of eco-friendly products. These new, highly specialized, and multifunctional roles will require in-depth knowledge of by-product valorisation techniques, human and natural resource management, as well as strong expertise in finance and green investments.

The analysis of interviews highlights various key competencies and professions for the future. Among the skills considered most critical are the management of by-products and waste, compliance with environmental legislation, and an entrepreneurial mindset, accompanied by in-depth technological knowledge.
Emerging professions expected to become important include sustainability

consultants, engineers specializing in waste and by-product valorization, and circular economy managers—essential figures to lead the transition toward sustainable practices. Necessary skills for these new occupations encompass waste and by-product valorization, expertise in the use of renewable energy technologies, and abilities in marketing and sales of green products.

The interviewees expressed a consensus on the importance of implementing courses on circular economy practices, suggesting an assessment of sector needs and active involvement of stakeholders to develop relevant training content. Finally, it emerged that the competencies required to enroll in these courses vary depending on the role but include a solid foundation of knowledge about the environment and sustainability. This overall framework underscores the need for an integrated and innovation-oriented training approach, capable of preparing the sector to address the challenges of sustainability.

7. Conclusions

The transition of the Italian olive oil sector towards a circular economy presents both significant opportunities and notable challenges. The findings of this study highlight a growing awareness of environmental sustainability within the sector. However, skills gaps among operators, financial constraints for businesses, and the need for further technological advancements to fully embrace circular practices remain key challenges.

Some circular economy initiatives, such as waste reduction, by-product valorization, and the adoption of renewable energy sources, have already been implemented by certain industry players. However, their adoption remains uneven, and many businesses struggle to integrate them effectively. The main barriers identified include insufficient regulatory incentives, limited financial resources, and a shortage of specialized expertise in sustainable production processes and digital technologies. Additionally, the lack of standardized assessment tools makes it difficult for companies to measure the effectiveness of circular practices, further hindering their widespread implementation.

The demand for new skills in the olive oil sector is driven by regulatory changes, increasing consumer preferences for sustainable products, and technological advancements. The industry requires professionals skilled in waste management, renewable energy use, and circular economy strategies. Emerging professions, such as sustainability consultants, waste valorization engineers, and circular economy managers, will play a crucial role in facilitating the transition. Additionally, enhancing training and education programs is essential to bridge skill gaps and prepare the workforce for future challenges. Companies must also invest in professional development programs to ensure that employees can effectively implement sustainability practices.

To accelerate the adoption of circular economy principles, collaboration between businesses, research institutions, and policymakers is crucial. Increased investment in research and development, the introduction of targeted financial incentives, and the creation of knowledge-sharing platforms will foster innovation and technology transfer within the sector. Stronger partnerships across the supply chain can also

enhance resource efficiency and drive the adoption of best practices on a larger scale.

While the transition of the olive oil sector towards a circular economy presents promising prospects, targeted efforts are necessary to overcome current limitations. By investing in education, technological innovation, and regulatory support, the sector can achieve greater sustainability, improve competitiveness, and contribute to a more resilient and environmentally sustainable agriculture. With the right strategic framework, the olive oil industry can become a leading example of sustainable agri-food production, balancing economic growth with environmental responsibility.

8. Recommendations

With the growing environmental challenges and the urgent need for sustainable practices, the olive oil sector stands at a crucial crossroads. As the global demand for olive oil increases, so does the responsibility to ensure that production methods are not only economically viable but also ecologically sustainable. This chapter presents a set of recommendations aimed at promoting a circular economy within the sector, addressing and implementing key measures such as those listed below.

1. **Education & Training:**
    - Develop specialized training on circular economy practices.
    - Foster collaboration between academia and industry.
    - Promote continuous learning in sustainability and digitalization.
2. **Financial & Policy Support:**
    - Provide grants and subsidies for circular economy initiatives.
    - Implement regulatory incentives for sustainability adoption.
    - Align policies with industry needs for streamlined integration.
3. **Technology & Innovation:**
    - Invest in waste valorization and smart farming technologies.
    - Promote R&D in sustainable production methods.
    - Share best practices and case studies to encourage adoption.
4. **Industry Collaboration:**
    - Establish knowledge-sharing networks and certifications.
    - Encourage cross-sector partnerships for innovation.
    - Create sustainability benchmarks to guide industry efforts.
5. **Consumer Engagement:**
    - Raise awareness about sustainable olive oil production.
    - Implement marketing strategies that highlight eco-friendly products.
    - Foster direct connections between consumers and sustainable producers.

By implementing these actions, the olive oil sector can enhance sustainability, improve competitiveness, and ensure long-term resilience.

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10. Appendices

10.1. Survey Questionnaires and Interviews

10.1.1. Annex 1 (D2.3) – Online Survey targeting MSMEs in the Olive Oil Sector about Current and Future Skills Needs for Transition of the Olive Oil Sector to Circular Economy

ANNEX 1 (D2.3): Online Survey targeting MSMEs in the Olive Oil Sector about Current and Future Skills Needs for transition of the Olive Oil Sector to Circular Economy

This survey is launched as the second consultation activity of the project *"Developing skills for introducing circular business models and digital technologies in olive oil sector (CIRCOLIVE)"*, a three-year project co-funded by the European Union under the Erasmus+ Programme.

The project aims to support the EU transition to the Circular Economy by improving/enhancing the circular business skills in the olive oil sector in Spain, Italy, Greece, Portugal and Croatia, in order to promote the adoption of circular entrepreneurial models for waste and by-product valorization of the whole olive value chain.

The answers to this survey will help us in the identification of skills for developing VET curricula on circular business models and digital technologies in olive oil sector.

In this survey definition of *Circular Economy* presents methods and possibilities of using olive by-products and waste in the olive oil sector. *ESCO* (European Skills, Competences, Qualifications and Occupations), the European multilingual classification of Skills, Competences, Qualifications and Occupations, was used to identify and select existing occupations and skills relevant to circular economy in the olive oil sector.

The survey takes about 10 minutes. Responses will be treated anonymously and the results will be used for CIRCOLIVE project purposes only.

Your answer is valuable to us and we thank you in advance for your time and effort.

Part 1: General Information

1) Respondent's gender
a) Male
b) Female
c) I prefer not to answer

2) Respondent's age _____ years old

3) Enterprise size:
a) Micro (<10 employees)
b) Small (<50 employees)
c) Medium sized (<250 employees)
d) Large size (>250 employees)

4) Respondent's education

a) High school and lower
b) Bachelor degree
c) Licenciatura degree
d) Master degree
e) PhD
f) Other _____

5) Which segment of the olive oil sector does your enterprise operate in?
o Olive growing
o Olive oil production
o Olive growing and olive oil production
o Other (Please specify): _____

6) Which of the following best describes your current occupation/profession* in the olive oil sector? (Select the most relevant)

*selected occupations from ESCO relevant to olive oil sector. ESCO - the European multilingual classification of Skills, Competences, Qualifications and Occupations

- Agronomists
- Agricultural production managers
- Agricultural labourers
- Environmental engineers
- Oil mill operators
- Food technologists
- Quality control and safety officers
- Packaging production managers
- Sales and marketing managers
- Logistics and supply chain managers
- Researchers and scientists
- Other (Please specify): _____

Part 2: Current Skill Levels

7) Which of the following circular economy practices are you currently implementing or aware of in your enterprise? (Select all that apply)

- Waste reduction and by-product valorization (e.g., olive pomace composting)
- Water recycling and efficient usage in olive oil production
- Renewable energy use
- Eco-friendly packaging materials
- Sustainable transportation and logistics solutions
- Carbon footprint reduction
- None of the above

8) How do you rate skills and knowledge about circular economy (methods and possibilities of using olive by-products and waste in olive sector) in your enterprise?

a) 1 - Poor
b) 2 - Limited
c) 3 - Acceptable
d) 4 - Good
e) 5 - Excellent

9) According to your opinion, which of the following skills* are most significant in the olive oil sector regarding circular economy? (Rank in order of importance, 1 not important at all to 5 being the most important)
* selected skills from ESCO adapted to olive oil sector. ESCO - the European multilingual classification of Skills, Competences, Qualifications and Occupations

- Knowledge of sustainable farming practices
- Knowledge of water and soil protection
- Organic farming and pest control techniques
- Understanding of food policies and regulations
- Waste and by-product management
- Energy efficiency in production
- Supply chain management

- Digital skills (e.g., data management, precision agriculture)

Part 3: Factors Shaping Skills Demand

10) In your opinion, which of the following factors are most influencing the demand for new skills in your enterprise? (Select all that apply):

- Pressure to improve sustainability performance (e.g., need for cost reduction, supply chain issues)
- Economic changes (e.g., global markets, trade policies)
- Adoption of circular economy models
- Environmental regulations and policies
- Consumer demand for sustainable products
- Industry competition and performance improvement pressures
- Development of new technologies and innovation
- Resource scarcity and waste management needs
- Global market demands and trade dynamics

Part 4: Skill Gaps

11) Are there any noticeable skills gaps in your enterprise that limit your ability to transition to a circular economy? (Select all that apply)

- Lack of technical skills for sustainable production methods
- Financial constraints
- Lack of regulatory incentives
- Limited knowledge of circular economy principles
- Lack of digital and data management skills
- Insufficient innovation skills
- Insufficient market demand for sustainable products
- Limited understanding of renewable energy technologies
- Shortage of marketing and communication skills related to sustainability
- Lack of entrepreneurial mindset
- Lack of deep tech knowledge (e.g. artificial intelligence, smart farming technologies...)

12) Do you think that the following occupations, identified by ESCO, need circular economy skills in the olive oil sector? (Yes/No/I don't know)

- Sustainability manager
- Alternative fuels engineer
- Waste treatment engineer
- Recycling specialist
- Environmental engineer
- Food technologist
- Food technician
- Product development engineering drafter
- Environmental programme coordinator

13) In the olive oil sector, do you think that following occupations* would also need circular economy skills? (Yes/No/I don't know)

*selected occupations from ESCO relevant to olive oil sector. ESCO - the European multilingual classification of Skills, Competences, Qualifications and Occupations

- Agronomists
- Agricultural production managers
- Agricultural labourers
- Oil mill operators
- Quality control and safety officers
- Packaging production managers
- Sales and marketing managers
- Logistics and supply chain managers
- Researchers and scientists

14) If you think that any other occupation in olive oil sector not listed above would also need circular economy skills, please list them below: _____

Part 5: Future Skill Needs and Occupations

15) Which of the following skills* are most critical for your company's future success in adopting circular economy practices? (Select all that apply):
*skills from ESCO adapted to olive oil sector. ESCO - the European multilingual classification of Skills, Competences, Qualifications and Occupations

- By-product and waste management
- Produce sustainable products
- Develop and coordinate waste management processes
- Develop recycling programs
- Renewable energy integration
- Product data management and digitalization
- Ensure compliance with environmental legislation
- Assess the life cycle of resources
- Develop new food products
- Plan digital marketing /digital skills
- Implement marketing strategies
- Green marketing
- Thinking creatively and innovatively
- Entrepreneurial mindset
- Deep tech knowledge (e.g. artificial intelligence, smart farming technologies…)

16) In your opinion, what emerging occupations do you expect will become important in the future in the olive oil sector for transition to circular economy? (Please, select 3)

- Circular economy managers
- Sustainability consultants
- Renewable energy specialists
- Waste valorization engineers (e.g., biofuel production from waste)
- Environmental impact auditors
- Data analysts for sustainable agriculture
- Marketing professionals for eco-friendly products

- Supply chain specialists for green logistics
- Legal advisors on environmental regulations
- Professionals in the food and pharmaceutical industry for the development of new products

17) In your opinion, which future skills, regarding circular economy, will be critical for these emerging occupations in the olive oil sector? (Please, select 3)

- Knowledge of waste and by-product valorization
- Expertise in sustainable resource management
- Digital and precision agriculture skills
- Circular product design and eco-packaging
- Data science and analytics for optimizing production
- Renewable energy technology expertise
- Process innovation and automation
- Marketing and sales of green products
- Green finance and investment expertise
- Leadership in sustainability strategy
- Specific skills in soil regeneration and carbon sequestration
- Integrated biodiversity management and ecological practices that regenerate ecosystems
- Agricultural planning with a focus on regenerative and holistic practices
- Deep tech skills (e.g. robotics, blockchain…)
- Innovative problem-solving skills

18) Dear respondent,
Thank you for your time and contribution to CIRCOLIVE project

19) I consent to have the information stated above used by the CIRCOLIVE project partners solely for meeting the purposes of this survey.
Yes – No

20) In case you want receive information about the project and activities, please enter your e-mail_____

10.1.2. Annex 2 (D2.3) – Structured Interview with Circular Business Agro-food Experts/professionals about Current and Future Skills Needs for transition of the Olive Oil Sector to Circular Economy

Instructions for Structured interview
General information:
- useful tool of quantitative research and social surveys
- standardized interview schedule
- each interviewee gets the same questions, in the same way and order
- minimizes variation between interviews

Conducting structured interviews:
- Introduce the research

(identify yourself, general information about CIRCOLIVE project, purposes of research and procedure of interview)

- Ethical issues

(GDPR, recording interview) – need to be signed

ANNEX 2 (D2.3): Structured Interview with Circular Business Agro-food Experts/professionals about Current and Future Skills Needs for transition of the Olive Oil Sector to Circular Economy

In this interview definition of *Circular Economy* presents methods and possibilities of using olive by-products and waste in olive sector. *ESCO* (European Skills, Competences, Qualifications and Occupations), the European multilingual classification of Skills, Competences, Qualifications and Occupations, was used to identify and select existing occupations and skills relevant to circular economy in the olive oil sector.

Part 1. General Information

Date:
Location:
Interviewees' years:
Interviewees' educational level:
Enterprise name:
Enterprise email address (in case you want receive further information about the Circolive project):
Enterprise size:

- Micro (< 10 employees)
- Small (< 50 employees)
- Medium sized (< 250 employees)
- Large size (> 250 employees)

Which segment of the olive oil sector does your enterprise operate in?

- Olive growing
- Olive oil production
- Olive growing and olive oil production
- Other (Please specify): _____

1. What is your occupation/profession in the olive oil sector?

- For e.g. agronomist, agricultural production manager, agricultural labourer, environmental engineer, oil mill operator, food technologist, quality control and safety officer, etc.

Part 2. Current Skill Levels

2. Which circular economy practices are you currently implementing, or aware of in your enterprise?

- For e.g. waste reduction and by-product valorization, water recycling and efficient usage in olive oil production, renewable energy use, eco-friendly packaging materials, sustainable transportation and logistics solutions, carbon footprint reduction

3. How would you rate skills and knowledge about circular economy in your enterprise?
- 1 - Poor
- 2 - Limited
- 3 - Acceptable
- 4 - Good
- 5 - Excellent

4. According to your opinion, which skills are most significant in the olive oil sector regarding circular economy?
- For e.g. knowledge of sustainable farming practices, knowledge of water and soil protection, organic farming and pest control techniques, understanding of food policies and regulations, waste and by-product management, energy efficiency in production, supply chain management, digital skills

Part 3. Factors Shaping Skills Demand

5. In your opinion, which factors are influencing the demand for new skills in your enterprise the most?
- For e.g. pressure to improve sustainability performance, economic changes, adoption of circular economy models, environmental regulations and policies, consumer demand for sustainable products, industry competition and performance improvement pressures, development of new technologies and innovation, resource scarcity and waste management needs, global market demands and trade dynamics

Part 4. Skill Gaps

6. Are there any noticeable skills gaps in your enterprise that limit your ability to transition to a circular economy?
- For e.g. lack of technical skills for sustainable production methods, financial constraints, lack of regulatory incentives, limited knowledge of circular economy principles, lack of digital and data management skills, insufficient innovation skills, insufficient marked demand for sustainable products, limited understanding of renewable energy technologies, shortage of marketing and communication skills related to sustainability, lack of entrepreneurial mindset, lack of deep tech knowledge (e.g. artificial intelligence, smart farming technologies...)

7. In the olive oil sector, which occupations do you think would need circular economy skills?
- For e.g. agronomists, agricultural production managers, agricultural labourers, oil mill operators, quality control and safety officers, packaging production managers, sales and marketing managers, logistics and supply chain managers, researchers and scientists in circular economy

Part 5. Future Skill Needs and Occupation

8. In your opinion, which skills are most critical for your company's future success in adopting circular economy practices?
- For e.g. by-product and waste management, produce sustainable products, develop and coordinate waste management processes, develop recycling programs, renewable energy integration, product data management and digitalization, ensure

compliance with environmental legislation, assess the life cycle of resources, entrepreneurial mindset, deep tech knowledge

9. What emerging occupations do you expect will become important in the future in the olive oil sector for transition to circular economy?
- For e.g. circular economy managers, sustainability consultants, renewable energy specialists, waste valorization engineers, environmental impact auditors, data analysts for sustainable agriculture, marketing professionals for eco-friendly products, supply chain specialists for green logistics, legal advisors on environmental regulations, professionals in the food/pharmaceutical industry for the development of new products

10. In your opinion, which future skills, regarding circular economy, will be critical for these emerging occupations in the olive oil sector?
- For e.g. knowledge of waste and by-product valorization, expertise in sustainable resource management, digital and precision agriculture skills, circular product design and eco-packaging, data science and analytics for optimizing production, renewable energy technology expertise, process innovation and automation, marketing and sales of green products, green finance and investment expertise, leadership in sustainability strategy, deep tech skills, innovative problem-solving skills

10.1.3. Annex 3 (D2.3) – Structured Interview with VET Providers about Current and Future Skills Needs for transition of the Olive Oil Sector to Circular Economy

Instructions for Structured interview
General information:
- useful tool of quantitative research and social surveys
- standardized interview schedule
- each interviewee gets the same questions, in the same way and order
- minimizes variation between interviews

Conducting structured interviews:
- Introduce the research - (identify yourself, general information about CIRCOLIVE project, purposes of research and procedure of interview)
- Ethical issues - (GDPR, recording interview) – need to be signed

ANNEX 3 (D2.3): Structured Interview with VET Providers about Current and Future Skills Needs for transition of the Olive Oil Sector to Circular Economy

In this interview definition of *Circular Economy* presents methods and possibilities of using olive by-products and waste in olive sector. *ESCO* (European Skills, Competences, Qualifications and Occupations), the European multilingual classification of Skills, Competences, Qualifications and Occupations, was used to identify and select existing occupations and skills relevant to circular economy in the olive oil sector.

Part 1. General Information
Date:
Location:
VET name:
VET email address (in case you want receive further information about the CIRCOLIVE project): _____

Interviewees' years:
Interviewees' educational level:
Type of Education/VET Institution:
1. University
2. Polytechnic
3. Institute
4. Public Open University
5. VET provider
6. Private VET provider
7. Other (specify): _____

Interviewees' role:
1. Executive
2. Manager
3. Lecturer
4. VET specialist
5. Other_____

Main information about educational/VET provider
- Length of business
- Number and type of employees by role (teaching, training, administrative…)
- Area of expertise/subject provided (agronomy, forestry, economy, other)
- Other information

Part 2. Current Skill Levels

11. According to your opinion, which skills are most significant in the olive oil sector regarding circular economy?
- For e.g. knowledge of sustainable farming practices, knowledge of water and soil protection, organic farming and pest control techniques, understanding of food policies and regulations, waste and by-product management, energy efficiency in production, supply chain management, digital skills

Part 3. Factors Shaping Skills Demand

12. In your opinion, which factors are influencing the demand for new skills in the olive oil sector?
- For e.g. pressure to improve sustainability performance, economic changes, adoption of circular economy models, environmental regulations and policies, consumer demand for sustainable products, industry competition and performance improvement pressures, development of new technologies and innovation, resource scarcity and waste management needs, global market demands and trade dynamics

Part 4. Skill Gaps

13. In the olive oil sector, which occupations do you think would need circular economy skills?
- For e.g. agronomists, agricultural production managers, agricultural labourers, oil mill operators, quality control and safety officers, packaging production managers, sales and marketing managers, logistics and supply chain managers, researchers and scientists

Part 5. Future Skill Needs and Occupation

14. In your opinion, which skills are generally most critical for future success in adopting circular economy practices in the olive oil sector?
- For e.g. by-product and waste management, produce sustainable products, develop and coordinate waste management processes, develop recycling programs, renewable energy integration, product data management and digitalization, ensure compliance with environmental legislation, assess the life cycle of resources, entrepreneurial mindset, deep tech knowledge

15. What emerging occupations do you expect will become important in the future in the olive oil sector for transition to circular economy?
- For e.g. circular economy managers, sustainability consultants, renewable energy specialists, waste valorization engineers, environmental impact auditors, data analysts for sustainable agriculture, marketing professionals for eco-friendly products, supply chain specialists for green logistics, legal advisors on environmental regulations, professionals in the food/pharmaceutical industry for the development of new products

16. In your opinion, which future skills, regarding circular economy, will be critical for these emerging occupations in the olive oil sector?
- For e.g. knowledge of waste and by-product valorization, expertise in sustainable resource management, digital and precision agriculture skills, circular product design and eco-packaging, data science and analytics for optimizing production, renewable energy technology expertise, process innovation and automation, marketing and sales of green products, green finance and investment expertise, leadership in sustainability strategy, deep tech skills, innovative problem-solving skills

Part 6. Education

17. Does your institution currently provide courses on circular economy practices in the olive oil sector?
- If YES, in what format? If NO, go to question 8.

18. In your opinion, do you think your institution could implement courses on circular economy practices in the olive oil sector?
- If YES, in what format?

19. In your opinion, which competences should the participant/student have before attending a course about circular economy?

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