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Transforming Vocational Education and Training for Sustainable Agri-Food Systems: Insights from Four European Think Tanks

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Abstract

The European Green Deal is Europe's ambitious and multi-layered response to climate change. Translating its objectives into action for a green transition has created a need for new skills and competencies. Vocational and Education Training (VET) systems are uniquely positioned to equip learners with these emerging green and transversal competences through their dual focus on knowledge dissemination and applied practice. However, current VET curricula remain oriented towards traditional occupations and are not adequately aligned with the sustainability and skills needs of the agri-food sector. This study, as part of a joint European-funded project (2023-1-IE01-KA220-VET-00156916: Train to Sustain), aimed to: (1) identify practical strategies for integrating sustainability concepts and innovative pedagogy into VET programs, and (2) gather multi-stakeholder perspectives on how VET agri-food education can be adapted for greater alignment with the green skills required by the sector. Following ethical approval, data were collected through semi-structured focus groups involving key agri-food stakeholder groups across Ireland, Slovenia, Poland and Italy. The data were qualitatively analysed using Reflexive Thematic Analysis (RTA). Five themes were identified: (1) Innovative and Sustainable Practices in Agri-Food systems, (2) Education, Awareness and Consumer Engagement, (3) Institutional and Structural Approaches, (4) Community and Localised Responses, and (5) Barriers, Opportunities and Future Directions. The findings highlight the significant potential VET offers in preparing a workforce with the cross-cutting sustainability competences and sector-specific skills needed to drive the innovation and growth of the agri-food sector. However, achieving this requires institutional change, strengthened collaboration, and a shift from traditional technical training toward curriculum models that embed sustainability principles across diverse local and regional contexts.

Keywords: sustainability education; innovative pedagogy; agri-food sustainability; adapting food education; transformative learning; green skills; sustainable futures

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1. Introduction

The shift toward sustainable development in the agri-food sector represents one of the most profound global transformations of the twenty-first century. Supporting this transition requires education systems to evolve beyond knowledge transmission, embracing transformative learning that reshapes worldviews, values, and behaviours (Sterling, 2024;

Wals, 2010). Within this broader context, the United Nations Educational, Scientific and Cultural Organization (UNESCO)-framed Sustainable Development Goal 4.7 highlights education's role in fostering sustainable lifestyles, human rights, gender equality and global citizenship (UNESCO, 2015). Under this umbrella, the concept of Education for Sustainable Development (ESD) has emerged as a key element of international policy, promoting pedagogical approaches that empower learners to act as change-agents (UNESCO, 2020). At the same time, achieving this kind of educational transformation requires systemic reform across all layers of the education system, including vocational education and training (VET), a domain uniquely situated at the nexus of education, work and industry (Cedefop, 2022). The dual orientation of VET, both skills acquisition and applied practice make it a particularly promising context in which to embed sustainability into curricula. Yet, as Kurtsal et al. (2024) point out, many VET institutions remain oriented toward traditional occupational competences, lacking embedded sustainability-literacy or transversal green skills. Existing research on sustainability in education has largely centred on universities' policies and pedagogical reforms, leaving VET comparatively underexplored. While higher education institutions have been at the forefront of Education for Sustainable Development (Žalėnienė & Pereira, 2021), studies indicate that systematic integration of sustainability principles in VET curricula particularly in the agri-food sector remains limited (Cedefop, 2022; Persson Thunqvist et al., 2023; Kurtsal et al., 2024).

In many European VET agri-food programmes, curricula remain strongly oriented toward conventional technical training in areas such as production management, processing techniques, and supply-chain logistics. While these competencies remain essential, sustainability-related capabilities including circular resource management, climate-responsive farming, sustainable packaging design, and sustainability communication are often only partially integrated. As a result, VET systems face increasing pressure to adapt their programmes to reflect evolving environmental challenges and labour market expectations.

In order to build a workforce capable of innovating to meet the sustainability challenges of the agri-food sector, there is growing demand for integrating green skills into teaching. The European Commission (2022) defines green skills as "the knowledge, abilities, values and attitudes needed to live, develop and support a resource-efficient, sustainable society." Within the agri-food context, such skills stretch beyond technical competences (e.g., waste reduction, sustainable production, eco-efficient packaging) to encompass transversal competencies such as systems thinking, critical reflection and collaboration (Cedefop, 2023). Yet empirical evidence indicates a persistent mismatch between labour market demand for sustainability-related expertise and the training provided in formal VET systems (Persson Thunqvist et al., 2023). Recent studies further confirm this skills gap within the European agri-food sector, highlighting employers' growing need for graduates equipped with green and transversal competencies, while educators report insufficient pedagogical resources and institutional support to deliver them effectively (McDonagh et al., 2024, 2025). This gap underscores the relevance of capacity-building initiatives aimed at up-skilling educators in sustainability teaching and curriculum design. Aligning educational provision with emerging market needs can contribute to the broader Green Transition and support the EU's "Pact for Skills" agenda, which positions sustainability and digitalisation as twin priorities for future work (European Commission, 2020). An expanding body of research indicates that developing sustainability competencies requires transformative learning, a process by which learners' assumptions are challenged, critical reflection is fostered, and behavioural change is encouraged (Mezirow, 2000; Wals & Corcoran, 2012). In contrast to conventional, content-driven education, transformative learning situates learners as active agents in meaning-making often via experiential, problem-based or community-engaged approaches (Brundiers & Wiek, 2013). Recent empirical studies in VET further demonstrate

how such approaches can cultivate sustainability mindsets among learners and educators, particularly within the agri-food context (McDonagh et al., 2024, 2025)

In the VET context this pedagogical shift is particularly significant. Rehman et al. (2023) argue that traditional VET training models are overly narrow, typically focused on technical proficiency alone, and therefore limit learners' ability to deploy knowledge in complex, real-world sustainability contexts. Thus, embedding sustainability in vocational education calls for a paradigm shift from rote learning toward inquiry-based, interdisciplinary and reflective approaches that link classroom learning with practical experience. This aligns with the "whole-institution approach" promoted by UNESCO and the European Training Foundation, which positions sustainability not merely as a topic but as a guiding institutional principle encompassing curriculum design, institutional culture and community engagement (UNESCO-UNEVOC, 2022).

Several pedagogical frameworks have emerged to operationalise sustainability in vocational contexts. For example, project-based learning (PBL) and place-based learning immerse learners in authentic sustainability challenges situated within their local communities, fostering collaboration, problem-solving and systems thinking (Parr & Trexler, 2011; Brundiers & Wiek, 2013). These pedagogies not only deepen learners' cognitive understanding of sustainability issues, but also cultivate affective and behavioural competencies such as empathy, agency and commitment to sustainable practices (Sterling, 2024). Within the agri-food sector, evidence indicates that learners engaged in hands-on project work develop a greater awareness of ecological interdependence and a stronger sense of social responsibility (Fomina et al., 2022; Šūmane et al., 2018).

Beyond pedagogy, the governance of sustainability education also matters in shaping outcomes. Education systems operate within complex ecosystems of policy, industry and community actors, making multi-stakeholder collaboration essential to aligning educational practices with sustainability goals (Miles et al., 2017). Partnerships among government agencies, private enterprises and educational institutions can foster innovation, bridge knowledge gaps, and create enabling environments for sustainable transformation (Persson Thunqvist et al., 2023).

In this study we implemented a Think Tank (TT) approach to convene educators, researchers, policymakers, and industry representatives across four European partner countries. The study aimed to identify practical strategies for integrating sustainability into VET agri-food curricula and to explore how multi-actor collaboration can enhance responsiveness to evolving environmental and labour-market needs. Specifically, it sought to capture insights from multiple stakeholders on how best to adapt VET agri-food education, integrate sustainability and climate-action principles, and develop graduates equipped with the knowledge and skills to sustain the agri-food sector in Europe. By addressing these objectives, the study contributes to ongoing discussions on how VET systems can support the EU's broader transition toward sustainable and resilient food systems. While previous studies have examined sustainability integration in higher education and policy contexts, limited empirical research has explored multi-stakeholder perspectives on embedding sustainability within VET agri-food systems across different European contexts. This study addresses this gap by using a cross-national Think Tank methodology to generate practice-oriented insights grounded in stakeholder dialogue. The study positions sustainability not simply as a thematic concern within the agri-food sector, but as a catalyst for examining how VET systems must adapt their curricula, pedagogies, and institutional practices to support the sector's transition toward more sustainable production and consumption models.

2. Materials and Methods

2.1. The Study Design

This study was conducted as part of a joint Erasmus+ KA2 European project, Train to Sustain (2023-1-IE01-KA220-VET-00156916), led by the Atlantic Technological University (ATU), Galway, Ireland, in partnership with the Confederazione Italiana Agricoltori Toscana (CIA Toscana, Italy), the Biotehniški Center Naklo (Slovenia), and the Education Agency for Development and Innovation (IDEA, Poland). Four semi-structured Think Tank (TT) sessions conceptualised as semi-structured focus groups were held across the partner countries to explore stakeholder perspectives on how VET systems can support sustainability transitions within the agri-food sector. This qualitative design was selected for its suitability in eliciting an in-depth understanding of participant experiences and facilitating interactive, reflective discussion (McGrath et al., 2019; Adeoye-Olatunde & Olenik, 2021). The TT format was deliberately chosen because it emphasises multi-stakeholder collaboration and collective problem-solving rather than solely data generation through discussion. TTs encourage co-creation of ideas, reflection across disciplines, and joint identification of practical strategies (Krueger & Casey, 2015). This format was therefore particularly well-suited to the aims of the Train to Sustain project, which sought to generate actionable recommendations for integrating sustainability in VET agri-food curricula through dialogue between educators, policymakers, industry representatives, and researchers. A collaboratively developed TT protocol guided the organisation and structure of each session, specifying eligibility criteria, discussion topics, and facilitation procedures. The shared framework ensured methodological consistency while allowing local adaptation. Each session explored four thematic pillars of food sustainability: food waste management, food production, farm practices, and food packaging. The primary objective was to promote multi-actor and multi-cultural collaboration and to identify actionable strategies to support VET educators in embedding sustainability principles within agri-food curricula.

2.2. Participants

Across the four countries, a total of 109 participants engaged in the TTs (Poland (n = 30), Ireland (n = 26), Slovenia (n = 30), Italy (n = 23)). Participants comprised educators, learners, farmers, distributors, retailers, policymakers, and consumers. All participants were aged 18 years or older, with a gender distribution of 42 men and 67 women. Recruitment was achieved through targeted invitations and open calls on project social media channels. Efforts were made to achieve gender balance and ensure diversity across stakeholder groups. Ethical approval for the study was granted by the Atlantic Technological University Research Ethics Committee (Ref. No. REC_ATUDG_24_0049). All procedures adhered to recognised ethical standards. Participants were provided with detailed information about the study's aims, confidentiality measures, and data handling, and written informed consent was obtained prior to participation. Data were anonymised at all stages of collection, analysis, and reporting.

2.3. Data Collection

Data were generated through four in-person Think Tank (TT) workshops held in each partner country. Sessions lasted three to four hours and involved 20–35 participants per workshop. Each TT followed a shared protocol and combined structured facilitation with open dialogue to encourage cross-sectoral reflection on sustainable food practices.

Each session opened with an introduction outlining the project objectives, ethical procedures, and expected outcomes. An initial expert presentation was delivered in each TT to situate discussions within the broader context of regional and European food sustainability challenges. The central component of each TT consisted of facilitated group discussions

and interactive exercises guided by the four thematic pillars: food waste management, food production, farm practices, and food packaging. Participants explored current practices, identified barriers, and proposed strategies to enhance sustainability in their respective domains. Discussions were supported by facilitators from the research group who ensured inclusivity, encouraged dialogue, and managed group dynamics.

The facilitators employed a semi-structured discussion guide containing open-ended prompts. As participant numbers were high, discussions were organised into smaller facilitated breakout groups (5–8 participants), followed by plenary synthesis sessions. This structure enabled in-depth discussion while retaining the benefits of cross-sector dialogue. Multiple facilitators were present to ensure balanced participation and systematic note capture. This flexible approach allowed participants to contribute insights freely while maintaining alignment with the research objectives. Rather than capturing verbatim transcripts, facilitators recorded real-time summaries of key discussion points, areas of agreement and divergence, and illustrative examples using structured field templates. This approach aligns with established participatory and deliberative methods that focus on capturing collective insights rather than individual narratives (see Braun & Clarke, 2022; Kindon et al., 2007).

To enhance the richness of the data, field notes were supplemented with artefacts from the workshops including outputs from collaborative ranking exercises and anonymous inputs gathered through Vevox and Mentimeter. Data generated through these tools were exported and integrated with the qualitative records to provide additional insight into participant perspectives. This multi-source approach combining transcripts, field notes, and digital response data produced a rich and triangulated dataset, capturing both the depth of participants' experiences and the diversity of stakeholder perspectives. Each national team subsequently synthesised their country-specific dataset into a structured report summarising emergent insights and key takeaways. These reports provided the foundation for the cross-national thematic analysis.

2.4. Data Analysis

A reflexive thematic analysis (Braun & Clarke, 2006, 2022) was undertaken to interpret the collective insights generated through the four TTs. Given that the TTs were designed as facilitated discussions rather than verbatim-recorded focus groups, the analytic process focused on identifying patterns of meaning within the synthesised national reports and facilitator field notes.

Following data cleaning and preparation, transcripts from the four focus groups were compiled and analysed using a deductive analytical approach, guided by the study's research objectives. In Phase 1, the lead researcher familiarised themselves with the data through iterative reading of the national reports and systematic notetaking to capture initial impressions, analytical observations and cross-country patterns. In Phase 2, meaningful units of text were coded according to relevance to the research objectives, while remaining open to concepts arising inductively from the data. These codes were then organised into potential subthemes and overarching themes (Phase 3), which were reviewed collaboratively by the research team (Phase 4) to ensure analytical coherence and distinctiveness. A thematic map was developed to illustrate relationships between themes and subthemes and to support an integrated understanding of the dataset. In Phase 5, the themes were further refined and clearly defined in relation to the study's aims. Finally, in Phase 6, detailed analytical narratives were written, synthesising data extracts and contextual interpretations to construct a coherent representation of participants' collective perspectives on food sustainability. The resulting thematic framework reflects the shared stakeholder perspectives developed through facilitated dialogue, rather than direct quotations from participants.

This interpretive synthesis is consistent with participatory qualitative methodologies where facilitators co-construct knowledge through real-time reflection and thematic abstraction. The final themes, subthemes, and selected illustrative insights are presented in Table 1, providing transparency and evidencing the credibility of the analytical process.

Table 1. Themes, Subthemes and Illustrative insights.

Themes	Subthemes	Illustrative Insights from Participants
Innovative and Sustainable Practices in Agri-food systems	Sustainable practices & techniques	Regenerative farming, agroecology, and precision agriculture were highlighted as essential for restoring soil health, enhancing biodiversity, and increasing carbon sequestration. These insights emphasised the need for training that connects these practices to real-world farm decision-making.
	Creative waste solutions	Practical methods for transforming surplus food into value-added products (e.g., preserves, sauces) and converting organic waste into biogas or bio-based materials were described, demonstrating circular-economy thinking.
	Eco-friendly materials	A rapid shift from petroleum-based to biodegradable and compostable packaging was called for but limited availability and cost barriers were noted.
	Technological advancements	Innovations such as AI-driven irrigation, vertical farming, aquaponics, and gamified agricultural learning were viewed as promising tools to improve efficiency and attract younger generations to the sector.
Education, Awareness and Consumer Engagement	Educating Consumers	Food waste often linked to limited understanding of storage, date labels, and portioning, underscoring the need for early and ongoing sustainability education.
	Consumer Impact	Clearer and more intuitive packaging such as resealable formats, improved recycling instructions, and inclusive design was regarded as crucial for reducing household waste.
	Participation and Engagement	Community fridges, workshops, and school-based garden projects were recognised as effective mechanisms for fostering shared responsibility and hands-on sustainability learning.
	Marketing and Innovation	Storytelling tools such as QR codes, along with smart or sensory-based packaging, were seen as effective ways to build trust, reduce waste, and enhance consumer connection to producers.

Table 1. *Cont.*

Themes	Subthemes	Illustrative Insights from Participants
Institutional and Structural Approaches	Institutional initiatives	Co-designed menus, campus waste-reduction initiatives, and integrating sustainability into school culture were viewed as impactful ways to model sustainable behaviour.
	Regulations and incentives	Participants stressed that subsidies, fair-practice policies, and supply-chain transparency are necessary to make sustainable options viable for producers and consumers
	Support mechanisms	Local food hubs, refill stations, and policy-aligned infrastructures were highlighted as essential supports for scaling sustainable practices.
	Business approaches	Improvements in portioning, inventory management, and collaboration with food banks were identified as direct ways businesses can reduce waste and model sustainability
Community and Localised Responses	Localised agriculture	Participants emphasised the benefits of reducing food miles, strengthening local economies, and reconnecting consumers with seasonal, locally grown foods.
	Community-based farming	Urban and community gardens were viewed as important for increasing food access, fostering social cohesion, and engaging younger people in sustainability
Barriers, Opportunities & Future Directions		Participants identified cost, regulatory complexity, limited infrastructure, and consumer resistance as key barriers. At the same time, they pointed to opportunities for innovation through improved packaging design, refill systems, targeted incentives, and education that encourages behavioural change.

3. Results

Through reflexive thematic analysis, five overarching themes were identified from the data, each with several subthemes derived from the collective synthesis of stakeholder insights across the four national TTs, reflecting co-constructed understandings rather than verbatim participant quotations. The themes illustrate patterns across participant experiences, insights and recommendations on the practical strategies and actions that need to be taken by VET educators to develop and adapt innovative food sustainability education programmes that can shape the future of the agri-food sector. The themes represent patterns that were identified across stakeholder discussions in all four participating countries, reflecting shared sustainability priorities within European agri-food systems while acknowledging contextual variation in local practices.

These themes included (1) innovative and sustainable practices in agri-food systems, (2) education, awareness and consumer engagement, (3) Institutional and structural approaches, (4) community and localised responses and (5) barriers, opportunities and future directions. The developed themes, subthemes and illustrative insights are presented in Table 1.

3.1. Theme 1: Innovative and Sustainable Practices in Agri-Food Systems

Innovative and Sustainable Practices in Agri-Food systems was broken down into four subthemes: (a) Sustainable Practices and techniques, (b) Creative waste solutions, (c) Eco-friendly materials and (d) Technological advancement. This theme captures participants' shared recognition that innovation and the adoption of sustainable practices are fundamental to addressing the environmental, social, and economic challenges confronting the agri-food sector. Participants across all partner countries discussed a wide range of sustainable production and farming practices, highlighting the integration of agroecology, regenerative agriculture, and precision farming as methods to improve soil health, enhance biodiversity, increase carbon sequestration, and use water and tillage resources more efficiently. The creative management of food waste emerged as a recurring topic, with participants describing how surplus or near-expiry food could be repurposed into value-added products such as sauces or condiments. Others described industrial-symbiosis approaches that turn food waste into new materials, including biogas or bio-based dyes and proteins, thereby reducing environmental impact and creating additional economic value. Participants also expressed concern about the slow pace of progress in developing eco-friendly packaging, noting strong support for biodegradable or compostable alternatives to conventional plastics. Participants frequently linked these emerging sustainable practices with perceived gaps in existing VET provision. Discussions highlighted that while regenerative agriculture, precision farming, and circular waste innovations are gaining momentum within the sector, current VET curricula were often described as remaining focused on conventional technical competencies. Technological advancement was raised across groups, mentioning innovations such as vertical farming, aquaponics, and artificial intelligence (AI) as promising tools to optimise production efficiency, reduce resource inputs, and diversify food systems. Participants emphasised the need for training pathways that reflect these evolving practices, particularly in relation to digital agriculture, resource-efficiency technologies, and applied sustainability decision-making.

3.2. Theme 2: Education, Awareness and Consumer Engagement

The second theme comprised four subthemes (a) Educating consumers, (b) Consumer impact, (c) Participation and engagement and (d) Marketing and innovation. The theme highlights the pivotal role of education, knowledge exchange, and community participation in shaping sustainable food systems and transforming consumer and stakeholder behaviour. Participants consistently highlighted education and awareness as vital for promoting sustainable food behaviours. They emphasised the importance of introducing sustainability topics early in VET curricula, particularly relating to packaging, purchasing habits, and waste literacy. Improving consumer understanding of food labels, best-before and use-by dates, and the acceptance of imperfect produce were seen as essential to reducing waste. Participants also emphasised that food waste often arises from gaps in knowledge regarding storage practices, date labels, and portioning. Participants noted the value of community engagement and peer learning in encouraging responsible consumption. Workshops and TT events were praised for offering collaborative spaces where ideas and practical solutions could be shared. Several participants described local initiatives such as community gardens, fridges, and local food hubs as visible examples of sustainability in

practice, fostering collaboration and community responsibility. Participants acknowledged that VET environments represent a critical interface between production knowledge and consumer-facing practices, positioning VET as a key site for integrating technical and behavioural sustainability competencies.

3.3. Theme 3: Institutional and Structural Approaches

This theme encapsulates the institutional, organisational, and policy-level responses required to enable the transition to sustainable food systems. Four subthemes were identified within this theme: (a) Institutional initiatives, (b) Regulations and incentives, (c) Support mechanisms and (d) Business approaches. Participants described how institutional settings can influence sustainability practices. Within educational institutions, examples included co-developing school menus with students to reduce food waste and introducing flexible portion sizes to align with preferences. Participants viewed these actions as effective ways to engage learners and encourage sustainable habits. Partnerships between schools and community organisations, such as donating surplus food to local support groups, were also highlighted as positive examples of institutional responsibility. Participants additionally discussed business-level inefficiencies including poor inventory control, unrealistic portioning, and the rejection of imperfect produce as major contributors to food waste. They suggested that targeted training and awareness initiatives could help businesses identify the operational and financial advantages of sustainable practices. These reflections positioned VET not only as a training provider but also as an institutional actor embedded within broader sustainability governance structures, highlighting the broader societal role VET institutions play in sustainability transitions

3.4. Theme 4: Community and Localised Responses

This theme reflects participants' belief that sustainable transformation must also be grounded in local, community-based action that reconnects people with food production and fosters place-based resilience. The theme comprised two subthemes (a) Localised agriculture and (b) Community-based farming. Across the TTs, participants emphasised the role of local and community-based farming in strengthening food security and supporting sustainability. Alternative farming models such as co-operative, shared land, and social farming were discussed as means to reduce food miles and enhance local economies. However, participants acknowledged that many small producers lack awareness, resources, or financial incentives to transition towards sustainable practices. Community-based farming initiatives, including urban gardens, community gardens, and community fridges, were celebrated for their dual social and environmental benefits. Participants also highlighted their educational value teaching community members, especially children, about soil health, biodiversity, and sustainable consumption. Across countries, stakeholders associated these community initiatives with opportunities for place-based and practice-oriented training within VET programmes.

3.5. Theme 5: Barriers, Opportunities and Future Directions

This theme acknowledges that while the momentum toward sustainability is growing, multiple interrelated barriers continue to hinder progress across the agri-food sector. Participants identified financial, logistical, regulatory, and behavioural challenges but also emphasised emerging opportunities for innovation, collaboration, and consumer engagement. A recurrent concern for participants was the economic cost of sustainability. Participants called for pricing structures, incentives, and subsidies that make sustainable products financially viable and accessible to all stakeholders.

Infrastructure limitations such as insufficient refill stations, local markets, and sustainable-material supply chains were reported as major barriers. Some participants

also noted regulatory and safety concerns, particularly the difficulty small businesses face in meeting packaging and hygiene requirements. Behavioural and attitudinal factors were seen as additional challenges. Participants described how convenience, resistance to change, and limited awareness restrict adoption of sustainable practices. At the same time, participants identified opportunities for innovation within VET systems, particularly through educator upskilling, digital integration, and strengthened collaboration with industry actors.

While the themes presented above reflect cross-national stakeholder perspectives on sustainability within the agri-food sector, the analysis also examined how these insights relate to the development of VET systems. Table 2 summarises how the identified themes translate into practical implications for VET curriculum development, institutional practice, and educator training.

Table 2. Translation of thematic findings into implications for VET programme development.

Theme	Key Insight from Stakeholders	Implications for VET Systems
Innovative and Sustainable Practices	Emerging practices such as regenerative agriculture, circular waste systems, and digital farming are reshaping the agri-food sector	VET curricula should integrate training on sustainable production methods, circular economy principles, and digital agriculture technologies to ensure learners develop competencies aligned with emerging industry practices
Education, Awareness and Consumer Engagement	Sustainability literacy and behavioural awareness were seen as essential to reducing waste and promoting responsible consumption	VET programmes should embed sustainability literacy, food-waste awareness, and consumer communication skills within technical training to help learners understand the behavioural dimensions of sustainable food systems
Institutional and Structural Approaches	Policies, incentives, and institutional practices shape sustainability adoption across the sector	VET institutions should adopt a whole-institution approach to sustainability by aligning governance, procurement practices, and external partnerships with sustainability principles and industry expectations
Community and Localised Responses	Local food systems and community initiatives were identified as important learning environments	VET programmes should incorporate place-based and community-engaged learning opportunities such as partnerships with local producers, food hubs, and community initiatives to support experiential sustainability education

Table 2. *Cont.*

Theme	Key Insight from Stakeholders	Implications for VET Systems
Barriers, Opportunities and Future Directions	Financial, regulatory, and behavioural barriers constrain sustainability adoption	VET systems should support educator upskilling, regulatory literacy, and access to sustainability-related training resources to enable educators and learners to respond effectively to evolving industry and policy demands

4. Discussion

This study convened multi-actor dialogue across four European countries to examine how VET systems can foster sustainability within the agri-food sector. The Think Tank (TT) process revealed a complex, interconnected web of factors shaping sustainable transformation spanning education, innovation, institutional governance, and community participation. Across all partner countries, discussions emphasised the interdependence of technological progress, creative resource use, and environmentally conscious production as critical to ensuring the sector's long-term resilience and sustainability. Collectively, the findings underscore that advancing sustainability in VET and the agri-food sector requires both individual and systemic change: strengthening education and awareness, embedding sustainability within institutional and policy frameworks, and enabling collaboration between stakeholders across the value chain. Participants frequently described sustainability as a dynamic process of adaptation in which innovation, collaboration, and research exchange were mutually reinforcing. They viewed technological progress and creative resource use as interdependent forces necessary to secure the agri-food sector's long-term resilience.

Taken together, the five themes indicate the need for systematic curricular reform within VET systems. Participants consistently framed education as central to behavioural and organisational change, highlighting the importance of embedding sustainability principles across curricula rather than treating them as isolated topics.

This emphasis on curricular reform is reinforced by participants' consistent framing of education as central to behavioural and organisational change. Participants argued that sustainability principles especially around food waste and packaging should be embedded across curricula, helping learners to translate abstract knowledge into concrete, everyday practices. Participants described sustainability knowledge as a critical enabler of action, echoing research highlighting that information and skills deficits inhibit the adoption of sustainable behaviours (Grunert, 2011; Wals, 2015). The findings suggest several practical avenues through which sustainability can be embedded within VET curricula. For example, modules on regenerative agriculture and soil health management could be integrated into existing crop production training to reflect emerging agroecological practices. Similarly, training on circular food systems and sustainable packaging technologies could be incorporated into food processing and agri-food supply chain programmes, enabling learners to understand waste reduction and material innovation within real industry contexts. Finally, digital agriculture tools such as precision farming technologies, AI technologies, and smart labelling solutions could be introduced within VET to equip learners with the competencies required to navigate both the green and digital transitions.

Participants emphasised that education is a central driver of change but that there is a need for formal and informal learning to cultivate awareness and responsibility. Participants emphasised that sustainable behaviour change requires continuity between formal education and informal, community-based learning. They perceived this continuum as vital for translating knowledge into daily practice and for building shared responsibility across generations and professional roles. The recurrent emphasis on community engagement, experiential learning, and behavioural awareness aligns with transformative and place-based pedagogies that move beyond traditional technical instruction. This suggests that VET systems may benefit from integrative models that connect classroom-based knowledge with applied community and industry contexts. Institutional practices within VET settings including procurement, waste management, and partnership structures were similarly identified as mechanisms through which sustainability principles can be operationalised. This reinforces the broader view of education as transformative shaping not only knowledge but also attitudes and values (Sterling, 2024; Mezirow, 2000). Participants' calls to embed sustainability throughout VET curricula align with UNESCO's (2015) and UNESCO-UNEVOC's (2022) frameworks for Education for Sustainable Development (ESD), which advocate for a whole-institution approach where sustainability permeates governance, pedagogy, and culture. Integrating green and digital competencies within VET therefore represents not simply curriculum reform, but an institutional paradigm shift consistent with the UNESCO Strategy for TVET (2022–2029) and Cedefop's (2023) forecast of skills demand to 2035.

Beyond the educational dimension, participants identified consumer awareness and market design as pivotal influences on sustainability outcomes. Marketing and innovation were seen as powerful tools to extend education and engagement beyond traditional settings. Technological innovations like sensory-based expiration indicators were viewed as promising mechanisms to support behaviour change by helping consumers discern when food remains safe to eat, reducing unnecessary waste. Participants advocated for creative marketing approaches such as storytelling through QR codes, transparent labelling, and smart packaging that build emotional connections between consumers and producers. Their observations resonate with European evidence that consumer misunderstanding of packaging and labelling remains a key driver of household food waste (Eurostat, 2024; Norton et al., 2022). Labelling clarity, information transparency, and consistent terminology have been shown to measurably reduce waste (WRAP, 2023). Participants stressed that material innovation in packaging must be accompanied by consumer education and supportive policy frameworks to ensure adoption and impact. From a pedagogical standpoint, these findings highlight the value of using such real-world challenges as case studies within VET programmes, helping learners to analyse behavioural drivers, communication design, and marketing ethics through a sustainability lens. Participants' insights also emphasised the potential of digital tools such as QR codes and smart packaging as educational and behavioural nudges that connect production practices with consumer values, reinforcing both circularity and transparency. The environmental footprint of packaging was widely recognised as a visible and symbolic indicator of the agri-food sector's overall sustainability performance.

The findings further suggest that technological and organisational innovation can act as accelerators of sustainable transformation when integrated with education and institutional support. Technologies such as AI-assisted monitoring, vertical farming, and aquaponics exemplify how innovation can enhance resource efficiency, biodiversity, and profitability. These perspectives reflect growing evidence that agroecology and precision agriculture, when coupled with digital literacy, can reconcile productivity with ecological integrity (Altieri, 2009; Gliessman, 2015). For VET systems, this implies a dual agenda:

developing technical skills for sustainable production and transversal competencies such as systems thinking and critical reflection needed to manage technological change responsibly (Cedefop, 2022; Persson Thunqvist et al., 2023). Embedding these capabilities within curricula can strengthen the sector's adaptive capacity to meet the dual imperatives of digitalisation and the green transition (European Commission, 2020). Participants also noted that integrating digital tools and interactive technologies such as game-based learning in agriculture could enhance the appeal of the sector for younger generations, positioning agri-food professions as dynamic, innovative, and socially relevant careers. Participants underscored that while individual behaviour change is essential, systemic transformation ultimately depends on supportive institutional practices, coherent regulations, and well-designed incentive structures. Strengthening links between practitioners and researchers was seen as a means to future-proof the industry, bridging the gap between scientific advancement and on-farm application.

At the institutional and structural level, the findings point to the need for supportive policy frameworks, incentives, and infrastructure that enable sustainable choices. Participants' emphasis on regulatory clarity and financial support reflects ongoing debates about the cost barriers facing small and medium-sized enterprises (SMEs) adopting sustainable practices. Incentives such as subsidies, tax breaks, or grants were discussed by participants as crucial for enabling farmers and businesses to invest in sustainable practices without jeopardising profitability. The recent EU Packaging and Packaging Waste Regulation (European Parliament and Council, 2025) (Regulation (EU) 2025/40) provides a new policy context for harmonising reuse and recycling standards, yet as participants observed, compliance requires capacity building in regulatory literacy, particularly among VET educators and SMEs. Educator upskilling, regulatory literacy, and infrastructure investment emerged as critical enabling conditions for embedding sustainability effectively. This highlights the potential for VET to act as a knowledge intermediary, bridging policy and practice by embedding current legislation, environmental compliance, and circular-economy principles within training programmes.

Participants also identified community and localised responses as vital complements to institutional reform. Localised agriculture, community-supported farming, and food hubs represent tangible pathways to integrate sustainability with place-based social and economic development. These locally focused systems were seen as supporting the triple bottom line environmental, economic, and social sustainability by ensuring fair income for farmers, access to nutritious local produce for consumers, and reduced ecological footprints. They described how closer relationships between producers and consumers foster mutual understanding and encourage more sustainable purchasing behaviours. Such initiatives parallel international research showing that community-based food systems can strengthen food security, enhance awareness, and reinforce social capital (Hinrichs, 2000; Fomina et al., 2022). In pedagogical terms, these models exemplify place-based and experiential learning approaches (Brundiers & Wiek, 2013), allowing learners to engage with sustainability as an applied, context-specific process. Embedding these approaches in VET can simultaneously address the educational and social dimensions of sustainability by connecting learners to their local environments and communities.

However, participants' reflections also revealed persistent barriers and tensions. High production costs, limited infrastructure, fragmented policy environments, and inconsistent consumer engagement remain significant challenges. These issues mirror broader EU-level evidence of stagnation in recycling and circularity indicators since 2018 (European Environmental Agency [EEA], 2024). Such findings underscore that awareness alone is insufficient: enabling conditions, economic, logistical, and institutional, must be aligned with behavioural change strategies. These insights support existing theories of

behavioural and structural interplay (Stern, 2000; Barr et al., 2001), which posit that pro-environmental behaviour is contingent on both motivation and opportunity. Addressing these dual dimensions requires integrated strategies that couple consumer education with systemic redesign, expanding infrastructure, introducing fiscal incentives, and embedding sustainability criteria into procurement and institutional policy.

Collectively, these interrelated dimensions of curriculum, pedagogy, innovation, governance, and community engagement coalesce into a systemic model of VET transformation.

Taken together, the findings reaffirm that education is core to the transformation within sustainable agri-food systems. Participants saw innovation both technological and social as the means to overcome existing barriers. Advancing sustainable packaging, scaling local food networks, and enhancing cross-sector collaboration were seen as key strategies for driving systemic change. Yet education in this context extends beyond formal teaching to encompass social learning, peer exchange, and institutional modelling (Redman & Redman, 2014; da Silva-Jean & Kneipp, 2024). Reorienting VET toward experiential, community-engaged, and reflexive pedagogies can develop not only the technical competencies required for sustainable production but also the critical and collaborative capacities essential for leading change. The integration of education, infrastructure, and incentives was viewed by participants as the path forward to make sustainability not only desirable but achievable. By aligning educational innovation with EU policy objectives such as the Green Deal, the Farm-to-Fork Strategy, and the Pact for Skills, VET institutions can play a central role in bridging knowledge and practice, supporting both workforce development and societal transition toward sustainability.

4.1. Study Limitations

While this study provides valuable cross-national insights into integrating sustainability within VET for the agri-food sector, there were some limitations. First, the TT design, while effective for generating collaborative and reflective dialogue, relied on a purposive sample of stakeholders, which may not represent the full diversity of perspectives across all European VET systems. Secondly, an additional limitation relates to the absence of verbatim audio recordings and full transcripts. While the Think Tank methodology prioritised collaborative knowledge generation, reliance on facilitator summaries and workshop artefacts may limit the reproducibility typically associated with transcript-based qualitative analysis. Finally, contextual variations such as differences in national policy frameworks, institutional capacities, and cultural attitudes toward sustainability may have influenced participants' contributions. Future research could address these limitations through mixed-methods designs, longitudinal studies, or comparative analyses of specific VET institutions to examine how sustainability competencies are implemented in practice.

4.2. Practical Implications

The findings of this study point to several practical considerations for educators, institutions, policymakers, and industry stakeholders working to advance sustainability within the European agri-food sector. The participants' insights also translate into concrete implications for the design of VET curricula and training provision.

For VET educators, the results highlight the need to integrate sustainability across teaching and learning rather than treating it as an isolated topic. Embedding project-based, experiential, and place-based activities can help learners apply concepts directly to real agri-food challenges. Developing transversal green skills is essential for preparing learners to navigate complex sustainability issues. This may include integrating training on regenerative agriculture, circular food systems, sustainable packaging innovation, and digital agriculture technologies within existing VET programmes, enabling learners to

develop both technical and sustainability competencies aligned with evolving industry demands. Educators may also require upskilling in areas such as EU sustainability regulations, circular-economy principles, and emerging technologies.

For VET institutions and policymakers, the study underscores the value of adopting a whole-institution approach where sustainability informs governance, curricula, procurement, and campus operations. Institutional practices such as co-designed menus, food-waste prevention initiatives, and partnerships with community organisations can serve as visible models for learners. Policymakers can support these initiatives by providing targeted financial incentives, grants, or tax measures that lower the cost of sustainable materials and technologies, and by investing in supportive infrastructure.

For industry and community stakeholders, the findings highlight that strengthened collaboration between VET providers, researchers, industry actors, and local authorities can further ensure that training provision aligns with evolving environmental standards and labour market needs. Multi-actor engagement through Think Tanks or similar forums supports continuous knowledge exchange and helps bridge gaps between policy aspirations and on-the-ground practice.

4.3. Future Research

Future research should further explore how sustainability competencies develop within VET over time, particularly through longitudinal or mixed methods studies that track how learners apply green and transversal skills in real workplace settings. Additional work is needed to examine how innovative agricultural technologies can be effectively integrated into VET curricula and what training educators require to deliver them. Comparative studies across different European VET systems would help clarify how policy environments, institutional capacities, and cultural factors shape the integration of sustainability principles.

5. Conclusions

This study provides cross-national insights into how VET systems can support Europe's transition toward more sustainable agri-food practices. The Think Tank approach highlighted the importance of integrating sustainability across curricula, pedagogy, and institutional practice, alongside the need for technological innovation, supportive policy frameworks, and strengthened community engagement. Stakeholders emphasised that developing green and transversal competencies requires experiential and whole institution approaches that connect learning with real-world challenges. At the same time, progress depends on enabling conditions, clear regulatory guidance, adequate infrastructure, and financial incentives that reduce the barriers faced by educators, learners, and industry actors. These findings suggest that VET transformation requires three interconnected reforms: integrating sustainability competencies across curricula, adopting experiential and community-engaged pedagogies, and strengthening institutional capacity through educator upskilling and policy alignment. Overall, the findings underscore that advancing sustainable agri-food systems requires coordinated, multi-level action, with VET playing a pivotal role in bridging policy and practice and preparing a workforce capable of responding to emerging environmental, economic, and social challenges.

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