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D2.2 REPORT ON LEARNING ECOSYSTEM DESIGN

Partners

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EXECUTIVE SUMMARY

This report sets out the design of the AGRITECH Learning Ecosystem, a coherent, interoperable environment that connects VET providers, higher education institutions, industry partners and learners across the consortium.
The objective is to accelerate skills for digital and sustainable agriculture through flexible pathways, recognized micro-credentials, and high-quality practical learning experiences.

Approach and evidence base

The design is grounded in four inputs:

- a state-of-the-art review of relevant learning ecosystems and edtech practices;
- national HEI and VET reports from partner countries;
- a multi-country stakeholder survey;
- consortium implementation experience.

Evidence was synthesized into an evidence-to-design traceability matrix to ensure that each design choice is justified and testable.

Key needs and gaps

Across countries and stakeholder groups, the approach is consistent:

- current AGRITECH learning offers are uneven and overly theoretical;
- practical and interactive experiences are limited;
- alignment with industry needs is inconsistent; and recognition of short, modular learning is poor.

Stakeholders strongly prefer project- and problem-based learning, blended delivery, and asynchronous options. Accessibility, multilingual provision and inclusion remain cross-cutting requirements, particularly for rural learners and those with limited digital access.

Implications for design

1. **Prioritize practice:** The ecosystem centers on practical learning hubs that combine physical spaces, remote labs, challenges set by employers, and virtual collaboration.
2. **VET-HEI bridge:** Pathways enable learners to move between VET and HEI offers without loss of progression, using common metadata, workload conventions and recognition rules.
3. **Micro-credentials by design:** Short, assessable modules are the fundamental currency, stackable into larger awards and mappable to national frameworks. Initial stacks focus on Sustainable Practices, Precision Agriculture, Remote Sensing and AI/Data.
4. **Accessibility and inclusion:** Multilingual content, WCAG-compliant platforms, offline/low-bandwidth options, and targeted learner support are design requirements, not enhancements.

Learning Ecosystem architecture

The architecture is specified across four layers:

- **Engagement:** stakeholder communities of practice, industry challenge briefs, and shared calendars for co-delivery.
- **Learning:** LMS, content library, e-portfolios, remote/virtual labs, assessment engine, project spaces.

- **Recognition:** micro-credential framework with verifiable digital badges, credit mapping, recognition of prior learning, and cross-institution agreements.
- **Operations:** interoperability (SSO, LTI 1.3, xAPI), data model and analytics, governance, QA and compliance.

Digital platform specification

The platform blueprint includes:

- single sign-on;
- tool interoperability;
- multilingual UI;
- accessibility at WCAG 2.2 AA;
- analytics for cohort, engagement and assessment;
- verifiable credentialing;
- data protection aligned with *Data Protection Impact Assessment* (DPIA) outcomes.

A platform readiness checklist will be used at acceptance to verify each capability.

Quality assurance and recognition

To secure acceptance across HEI and VET contexts, the design embeds:

- explicit learning outcomes and assessment rubrics;
- external moderation for capstone or high-stakes tasks;
- workload and credit transparency;
- institution-level agreements for recognition.

Country-specific annexes capture regulatory nuances and evidence requirements for both HEI and VET quality bodies.

Implementation roadmap

Delivery proceeds in three phases with clear gates:

- **P1 Design freeze:** finalize architecture, data model, micro-credential templates, and pilot selection; complete risk and QA plans.
- **P2 Pilot:** run in selected VET and HEI sites with industry partners, gathering analytics and qualitative evidence against acceptance criteria.
- **P3 Scale:** expand the module library, broaden employer co-delivery, refine governance and funding, and establish cross-border recognition processes.

Risks and mitigations

Principal risks include uneven recognition of micro-credentials, administrative and regulatory friction, variable digital readiness, and funding continuity.
Mitigations are built into governance (country annexes and recognition agreements), the platform specification (interoperability and), and change management (training and support for staff and learners).

Monitoring and evaluation

A compact Key Performance Indicators (KPI) set tracks access, relevance, quality and portability:

- participation and completion by groups;
- proportion of learners applying skills in the workplace;

- assessment reliability and external moderation rates;
- micro-credentials recognized across partners;
- learner engagement time.

Analytics and periodic review inform iterative improvement.

Sustainability and scalability

Three governance options are defined for post-pilot continuity, consisting in lead-partner hosting, consortium-as-a-service, and a federated hub model. Each is costed at a high level and linked to licensing, IP, staffing and maintenance assumptions. Open standards and shared templates support replication in additional regions and sectors.

Conclusion

The AGRITECH Learning Ecosystem is a build-ready, evidence-based design that answers the consortium's most persistent problems: it makes learning practical, portable and recognized; it connects VET, HEI and industry around real work; and it does so on a platform that is interoperable, accessible and measurable. The immediate next steps are to finalize the recognition agreements, lock the pilot portfolio, and execute Phase 1 to design freeze.

1. INTRODUCTION & BACKGROUND

Agriculture faces accelerating pressure to modernize, balancing productivity, sustainability, and digital transition. The **AGRITECH** project addresses these needs by shaping a learning ecosystem that equips the sector with the competences required for smart, data-driven, and sustainable practices.

Deliverable D2.2 builds the conceptual and evidence base for that ecosystem. It draws on comparative analysis of **VET** and **HEI** systems, survey results, and stakeholder feedback to define the core competences, learning pathways, and interaction models needed for an integrated **AGRITECH education framework**.

The chapter outlines the context in which AGRITECH operates - marked by uneven digital readiness, fragmented training provision, and emerging needs for cross-sector innovation management. It positions **D2.2** as a bridge between research, policy, and practical implementation, setting the ground for the design specifications developed in the following sections.

1.1. Purpose and Scope

Deliverable D2.2 defines the conceptual and operational framework of the **AGRITECH Learning Ecosystem**. Its purpose is to connect the project's analytical findings with the practical design of learning structures that can strengthen digital transformation and innovation capacity in agriculture. It explains how the ecosystem translates identified skill needs into structured learning pathways, resources, and collaborative mechanisms among education, research, and industry.

The scope of this deliverable covers both the strategic and technical dimensions of the ecosystem. Strategically, it aligns **AGRITECH** with European frameworks on digital skills, green transition, and lifelong learning, ensuring relevance across different qualification levels and institutional settings. Technically, it specifies the ecosystem components, including competence mapping, modular curricula, digital learning resources, and assessment design using interactive and scenario-based tools. **D2.2** does not restate policy analysis or survey findings already reported in previous tasks. Instead, it builds on them to propose an integrated model that links **VET** and **HEI**, supports stackable and flexible learning opportunities, and promotes recognition of outcomes across systems and borders. The document therefore serves as both a design blueprint and a practical reference for future piloting, implementation, and continuous development of the **AGRITECH Learning Ecosystem**.

1.2. Definitions and Key Concepts

For the purpose of this deliverable, several key terms are used consistently to ensure clarity and alignment across the AGRITECH project. These definitions reflect both project-specific interpretations and their correspondence with established European frameworks.

Learning Ecosystem **-** A structured yet flexible environment that connects actors, resources, and processes supporting competence development in digital and sustainable agriculture. It integrates educational institutions, businesses, research centres, and learners through interoperable learning pathways, shared resources, and digital tools.

Competence Framework - A structured description of the knowledge, skills, and attitudes required for effective performance in a given role or domain. In AGRITECH, the competence framework defines the foundations for curriculum design, learning outcomes, and assessment of the AGRITECH Manager profile.

AGRITECH Manager - A professional capable of bridging agricultural practice, digital innovation, and sustainability. The role involves managing the integration of smart technologies, data-driven decision-making, and sustainable business models across agri-food value chains.

VET (Vocational Education and Training) - Education and training that provides learners with skills and knowledge directly relevant to specific occupations or industries. Within AGRITECH, VET institutions contribute to applied learning and the development of practical competences for digital agriculture.

HEI (Higher Education Institution) - Universities and colleges delivering advanced education and research. In the AGRITECH context, HEIs support higher-level competences such as innovation management, data analytics, and system-level sustainability strategies.

Micro-credential - A short, targeted learning experience that certifies specific competences or skills. Micro-credentials in the AGRITECH ecosystem enable flexible, stackable learning pathways across VET and HEI levels.

Scenario-based Learning - A pedagogical approach using realistic agricultural or business scenarios to develop applied problem-solving and decision-making competences. It is central to AGRITECH's interactive learning materials and digital simulations.

Digital Transformation in Agriculture - The integration of digital technologies such as precision farming, IoT, data analytics, and automation to improve productivity, sustainability, and resilience in the agri-food sector.

These key concepts form the conceptual foundation of the AGRITECH Learning Ecosystem and provide a common reference for all subsequent chapters.

1.3. Alignment with AGRITECH Objectives and EU Priorities

Deliverable D2.2 is central to the AGRITECH project's mission of strengthening digital transformation capacity within the agricultural and agri-food education systems. The project aims to design an integrated learning ecosystem that builds competences in digital technologies, innovation management, and sustainability. D2.2 translates these strategic objectives into a functional framework, defining the structure, content, and mechanisms for competence-based learning across both VET and HEI contexts.

The deliverable contributes directly to the project's specific objectives by:

- **Developing the AGRITECH competence framework** that identifies key digital and green skills for future Agri-sector professionals.
- **Designing the Learning Ecosystem architecture** that connects education providers, industry actors, and learners through interoperable and flexible learning pathways.
- **Supporting the creation of innovative training resources** based on scenario-driven and interactive digital tools.
- **Facilitating cross-sector and cross-country transferability** through alignment with European recognition and qualification systems.

These outcomes position D2.2 as the operational link between AGRITECH's analytical activities (mapping, surveys, and needs assessment) and its implementation phase, ensuring that educational design is directly informed by evidence and real sector demands.
In parallel, the deliverable aligns AGRITECH with key European Union priorities that emphasize green and digital transitions:

- The **European Green Deal** and **Farm to Fork Strategy**, promoting sustainability, climate action, and responsible resource use in agriculture.
- The **Digital Education Action Plan (2021-2027)**, supporting innovative, data-driven, and technology-enhanced learning environments.
- The **European Skills Agenda** and **Pact for Skills**, encouraging competence recognition, lifelong learning, and cross-sector partnerships.
- The **Erasmus+ priorities** on digital readiness, inclusion, and sustainability, which provide the framework for project transferability and impact.

By integrating these strategic orientations, D2.2 ensures that the AGRITECH Learning Ecosystem contributes to both project-level goals and broader EU ambitions: a digitally competent, innovation-oriented, and environmentally responsible agri-food sector.

1.4 Key Design Principles and Intended Outcomes

AGRITECH Learning Ecosystem is designed around a set of guiding principles that ensure relevance, coherence, and usability across diverse educational and professional contexts. These principles translate the project's vision into operational design choices that can support competence development in digital and sustainable agriculture.

Key Design Principles

1. **Competence-based structure** - All modules are defined by measurable learning outcomes and aligned with the AGRITECH competence framework. This ensures consistency across EQF levels and facilitates recognition, transferability, and integration of learning results between VET and HEI systems.
2. **Modularity and flexibility** - Learning is organized into independent yet connected modules, enabling multiple entry and exit points. This supports personalized learning pathways, micro-credentials, and the combination of formal, non-formal, and work-based learning experiences.
3. **Digital and interactive learning** - Digital environments and scenario-based methods are used to simulate real agricultural challenges, encouraging problem-solving, decision-making, and innovation. Articulate-based learning materials and other digital tools enhance accessibility and engagement.
4. **Integration of green and digital competences** - Sustainability and digitalization are treated as interdependent pillars. Each learning component embeds both digital and environmental dimensions, reflecting the dual transition of the agri-food sector.
5. **Collaboration and ecosystem logic** - The design promotes active collaboration between education providers, enterprises, advisory services, and research organizations. This ecosystem approach ensures that content, tools, and learning experiences remain aligned with evolving technological and market realities.

6. **Quality and adaptability** - The framework includes mechanisms for continuous evaluation and updating of content and competences, allowing adaptation to emerging trends, technologies, and policy requirements.

Intended Outcomes

1. A **fully defined AGRITECH competence framework** that identifies and structures the key knowledge, skills, and attitudes for digital and sustainable agriculture.
2. A **comprehensive Learning Ecosystem model** linking VET, HEI, and industry actors through interoperable and stackable learning pathways.
3. A **set of modular curricula and digital learning resources** ready for integration into formal and non-formal education settings.
4. **Assessment and validation mechanisms** ensuring transparency, quality, and recognition of learning outcomes.
5. A **foundation for pilot testing and long-term scalability**, enabling future implementation across countries and education systems.

Through these design principles and outcomes, D2.2 provides the blueprint for transforming AGRITECH from a research-based initiative into a practical, operational system capable of supporting real competence development and sectoral innovation.

1.5 Document Structure

This deliverable is structured to present a clear and logical progression from analysis to design and application. Each chapter contributes a specific layer of understanding, leading the reader from the conceptual background toward the practical realization of the AGRITECH Learning Ecosystem. The sequence ensures transparency in how evidence, methodology, and design choices connect to the overall project objectives.

- **Chapter 1 - Introduction and Background** - Defines the context, purpose, and scope of the deliverable, clarifying how D2.2 aligns with the AGRITECH project objectives and broader EU priorities. It introduces key definitions, design principles, and the conceptual foundation of the Learning Ecosystem.
- **Chapter 2 - Methodological Approach** - Describes the analytical process used to develop the ecosystem design, including data sources, comparative analysis of national contexts, survey methodology, and validation through stakeholder consultations.
- **Chapter 3 - Summary of Findings from VET and HEI Analyses** - Synthesizes the main outcomes from the national reports and survey results. It identifies existing gaps in digital and green competences, institutional challenges, and areas of opportunity that guide the ecosystem's design.
- **Chapter 4 - AGRITECH Competence Framework and Manager Profile** - Presents the structure of the AGRITECH competence framework and defines the AGRITECH Manager profile as the central occupational and educational reference point for the project.
- **Chapter 5 - Design of the AGRITECH Learning Ecosystem** - Details the conceptual and functional architecture of the ecosystem, including its components, stakeholder roles, digital infrastructure, and operational logic.

- **Chapter 6 - Digital Platform Specification -** Explains how the competence framework is translated into modular curricula, digital resources, and scenario-based learning tools. It also defines assessment and validation mechanisms that ensure quality and recognition.
- **Chapter 7 - Implementation Roadmap -** Lays out the sequence, responsibilities, resources, and timeline needed to deploy the AGRITECH learning ecosystem in practice, turning recommendations into concrete, staged actions.
- **Chapter 8 - Sustainability, and Scalability -** Explains how the ecosystem will be maintained, funded, updated, and expanded over time so it can operate long-term and grow across institutions, regions, and countries.

Together, these chapters form a coherent narrative that connects research-based insights with practical design outcomes. The structure ensures that readers can follow the reasoning behind each decision and understand how the AGRITECH Learning Ecosystem evolves from analytical groundwork to an operational educational model.

2. METHODOLOGY

The development of the AGRITECH Learning Ecosystem required a structured methodological approach that ensured coherence between research findings, competence design, and educational implementation. Chapter 2 outlines the process through which evidence was collected, analysed, and translated into the conceptual and operational design presented in subsequent sections.

The methodology integrates both **quantitative and qualitative elements**, combining desk research, comparative analysis, and participatory validation. This mixed-methods approach allowed the project to capture the diversity of educational systems, institutional realities, and labour market needs across partner countries.

The design process followed a **three-phase logic**:

1. **Evidence collection and analysis**, drawing from national reports on VET and HEI systems, sectoral studies, and survey data that identified gaps in digital and green competences.
2. **Synthesis and framework development**, where analytical results were consolidated into the AGRITECH competence framework and the preliminary structure of the Learning Ecosystem.
3. **Validation and refinement**, through consultations with project partners, experts, and stakeholders to ensure alignment with real-world practice and European policy frameworks.

Throughout these phases, the project applied a **systemic perspective**, treating education, research, business, and advisory services as interconnected components of a wider innovation ecosystem. This approach ensured that the resulting design is not a theoretical model but a practical tool for capacity building and long-term cooperation between VET and HEI institutions.

The following sections detail each methodological component, explaining how data collection, analytical synthesis, and validation activities informed the key design decisions that underpin Deliverable D2.2.

2.1 Design Approach

The design approach of Deliverable D2.2 follows an evidence-driven and iterative methodology, integrating data from the evaluation of existing AgriTech learning materials, stakeholder feedback, and European policy frameworks. This process ensured that the AGRITECH Learning Ecosystem reflects both the realities of current educational provision and the emerging requirements of the digital and green transitions in agriculture within the boundaries of the European standards (EQF and ESCO).

The approach combined **systematic analysis, participatory validation, and iterative design cycles**, structured in three main stages:

1. **Assessment of the current learning landscape**, through desk research and structured evaluation of learning materials, digital platforms, and interactive tools used in AgriTech education.
2. **Empirical evidence collection**, through surveys, interviews, and stakeholder consultations across partner countries, ensuring representation of VET, HEI, and industry perspectives.
3. **Synthesis and co-design**, translating analytical results into the functional architecture, competence framework, and pedagogical principles of the AGRITECH Learning Ecosystem.

4. Integration of Evaluation Results

The first phase (Pilot implementation) drew extensively on the *AGRITECH* ***Methodology for Learning Materials Assessment*** and the ***Evaluation of Current Learning Materials, Digital Platforms, and Interactive Tools Used in AgriTech Education***.

This evaluation assessed over 40 sources, including formal academic curricula, vocational training materials, and commercial e-learning platforms. The review criteria covered relevance to industry needs, integration of emerging technologies (AI, IoT, robotics, blockchain), pedagogical quality, interactivity, accessibility, and compliance with European standards such as EQF and ESCO.

Key findings highlighted that most existing materials:

- provide only partial integration of digital technologies;
- insufficiently address sustainability;
- lack immersive and interactive learning tools (e.g., VR, AR, AI tutors); and
- rarely link competences to validated microcredentials.

These insights directly informed the structural and pedagogical choices for the AGRITECH Learning Ecosystem, particularly the integration of **AI-assisted, scenario-based learning modules** and **blockchain-certified microcredentials**, as recommended by the evaluation reports.

5. Stakeholder Evidence and Co-creation

The design approach also relied heavily on empirical data collected through the *AGRITECH Stakeholder Feedback Questionnaire* (71 respondents across 8 countries). The findings indicate indicates clear modernization priorities: **73%** would "very much" value microcredentials (48/66), **73%** rate current digital resources as **average or worse**, and **collaboration** is "important/very important" for **88%** of respondents (**60%** "very important"). Respondents view **project-based** (**89%** very/extremely) and **problem-based** learning (**82%** very/extremely) as most effective, with **blended** learning at **66%** very/extremely. These results underpin a competence-based, modular design with digital delivery and recognized microcredentials.

These findings validated the need for a **flexible, competence-based design**, supported by modular curricula, strong digital integration, and alignment with real employment pathways.

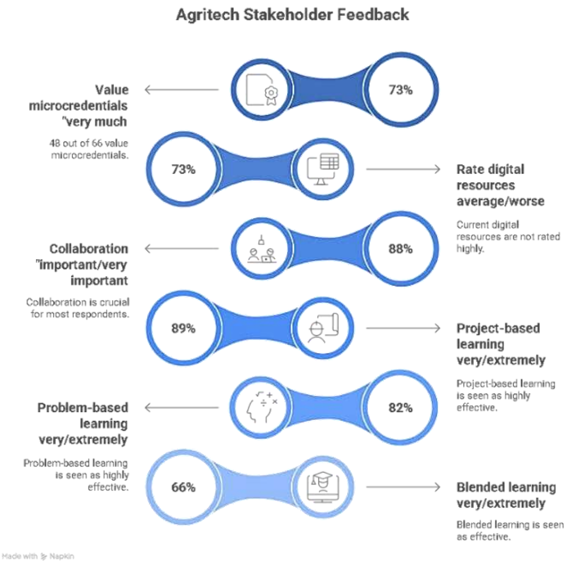

Figure 1. AGRITECH Stakeholder Feedback Questionnaire results

6. Reference to EU Frameworks & Policies and AGRITECH Objectives

The methodological choices were further aligned with EU-level strategic frameworks including the **Digital Education Action Plan (2021-2027)**, the **European Skills Agenda**, and the **Pact for Skills**. The sustainability and climate dimension is grounded in the **European Green Deal** and the **European Climate Law**, with delivery shaped through the **Fit for 55** legislative package, and in the **Commission's Vision for Agriculture and Food** (2025), which sets policy direction for 2025–2029 for a competitive, resilient and fair agri-food system. These references ensure coherence between AGRITECH outcomes and EU priorities for the digital transition, decarbonisation and climate adaptation in agriculture. The competence framework embeds ESG-related competences and climate-smart agriculture, including resource efficiency, risk management and responsible technology adoption, across learning outcomes and microcredentials.

7. Applied Design Logic

The design process was guided by a systemic model linking four interdependent dimensions:

- **Competence Development**, based on empirical data and EQF standards;
- **Pedagogical Innovation**, emphasizing digital interactivity and applied learning;
- **Technological Infrastructure**, integrating open digital platforms, analytics, and adaptive content delivery;
- **Stakeholder Collaboration**, ensuring co-ownership and long-term scalability of the ecosystem.

This integrated approach allowed D2.2 to evolve from static curriculum design into a **living framework** for cross-sector collaboration, adaptive learning, and continuous innovation in AgriTech education.

2.2 Stakeholder Mapping and Engagement

This section defines who the AGRITECH Learning Ecosystem serves, how each group contributes to its design and operation, and the mechanisms used to collect, validate, and act on their input across the project lifecycle.

2.2.1 Stakeholder groups and roles

- **Learners and professionals -** Target users across VET and HEI, including students, trainees, advisors, farm managers, and SME staff.

Role: needs identification, pilot participation, usability feedback, evidence of learning impact.

- **VET providers -** Colleges, training centres, and adult learning entities.

Role: co-design and delivery of practice-oriented modules, work-based learning, micro-credential pilots, QA input.

- **HEI providers -** Universities and applied science institutions.

Role: competence framework refinement, curriculum integration, assessment design, recognition and credit mapping.

- **Industry and SMEs -** Agri-food companies, agri-tech vendors, cooperatives, producer groups.

Role: definition of real-world tasks and datasets, challenge briefs, co-delivery, placement opportunities, endorsement of micro-credentials.

- **Research and innovation bodies -** Institutes and labs active in digital agriculture, sustainability, and edtech.

Role: technology horizon scanning, method validation, data for learning scenarios, impact studies.

- **Public authorities and intermediaries -** Ministries, agencies, chambers, associations, clusters.

Role: alignment with qualification and recognition frameworks, policy consistency, dissemination and uptake.

- **Support services -** Accessibility, inclusion, and QA specialists.

Role: inclusive design reviews, accessibility checks, ethics and data protection guidance.

2.2.2 Engagement objectives

- - capture needs and constraints of each group to inform design choices
- - validate the AGRITECH competence framework and priority pathways
- - secure recognition and portability of learning results between VET and HEI
- - embed work-based and challenge-based learning with employers
- - ensure inclusion, accessibility, and data protection are applied in practice

2.2.3 Engagement methods and cadence

- **Consultation -** Structured surveys, interviews, and national workshops to surface needs, gaps, and constraints. Evidence is logged in a feedback register and mapped to design requirements.
- **Co-design -** Multistakeholder working groups and curriculum labs to iteratively shape: competence statements, learning outcomes, assessment rubrics, and scenario specifications.
- **Validation -** Expert panels and advisory sessions to test feasibility, acceptance, and compliance. Outputs include change requests, acceptance criteria for pilots, and recognition notes.
- **Continuous feedback during pilots -** In-platform analytics, learner diaries, facilitator debriefs, and employer reviews. Findings feed into rolling updates of content, tools, and QA parameters.

Cadence by phase

- Design: monthly working groups, bimonthly advisory sessions
- Pilot: sprint reviews every 4 weeks, midpoint and end-of-pilot validations
- Scale-up: quarterly governance reviews and annual recognition refresh

2.2.4 Responsibilities and decision-making

- **Stakeholder register and RACI** (*Responsible, Accountable, Consulted, Informed*) **-** A living register identifies owners, influence, interest, and engagement channel for each stakeholder. A simple RACI model clarifies who is Responsible, Accountable, Consulted, and Informed for decisions affecting competence definitions, curriculum changes, platform configuration, and credentialing.
- **Change control -** Feedback that implies scope or standards change is logged as a change request, assessed for impact, and decided by the methodology lead with QA oversight. Accepted changes update design baselines and release notes.

2.2.5 Inclusion, accessibility, and ethics in engagement

- Representation targets ensure participation from VET and HEI, small and large providers, rural learners, and underrepresented groups.
- Materials and sessions are provided in accessible formats, with multilingual options and low-bandwidth alternatives.
- Engagement follows informed consent, GDPR-compliant data handling, and anonymized reporting.

2.2.6 Engagement outputs

- Stakeholder register and engagement plan (living documents)
- Evidence-to-design traceability entries linking inputs to specific design decisions
- Minutes and decision logs from co-design and validation events
- Pilot feedback summaries with agreed actions and timelines
- Recognition notes documenting portability agreements between VET and HEI

2.3 Data Sources and Analysis

This section documents the evidence base used to design the AGRITECH Learning Ecosystem and explains how data were processed, triangulated, and translated into requirements and design choices.

2.3.1 Primary data sources

- **Stakeholder survey (VET, HEI, industry, learners) -** The cross-country questionnaire captured availability and quality of digital resources, priority gaps, preferred pedagogies, value of microcredentials, and perceived barriers. Response profile and instrument statistics are provided in the survey export. Key items cited in this deliverable include (referenced pages are related to the Questionaire):
    - **Q7** on current digital resources quality (page 8)
    - **Q8** on major gaps in AgriTech education (page 9)
    - **Q9** on ecosystem elements and their importance (page 11)
    - **Q10-Q12** on microcredentials and effective methodologies (pages 12 and 14)
    - **Q15** on priority technical skills (page 17)
    - **Q16** on implementation barriers (page 18)

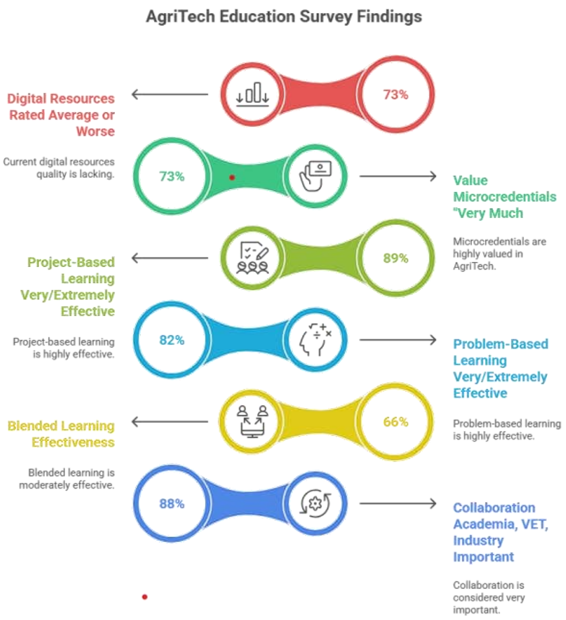

Figure 2. Education Survey Findings

Findings: **73%** rated current digital resources average or worse in their country (Q7, page 8); **73%** would "very much" value microcredentials (Q10, page 12); project-based (**89%** very or extremely effective) and problem-based learning (**82%**) ranked highest, with blended learning at **66%** (Q12, page 14);

collaboration between academia, VET, and industry was rated important or very important by **88%** (Q9, page 11).

2.3.2 Secondary data sources

- **Learning materials and platform evaluation corpus -** Structured reviews of current AgriTech learning materials, digital platforms, and interactive tools, using agreed criteria and indicators covering relevance to industry needs, technology integration, pedagogical effectiveness, accessibility and inclusivity, engagement, assessment and certification, sustainability skills, and user experience. The assessment steps and rubric are defined in the methodology note (version 1.0, March 2025).
- **Resource scan -** Consolidated references to learning materials, digital farm-management platforms, and interactive tools that informed the inventory and exemplars used in Chapter 3 and Annexes (for example Climate FieldView, Granular, OneSoil, CropX, Taranis).
- **EU policy alignment brief -** Alignment anchors with the European Skills Agenda, Pact for Skills, Digital Education Action Plan 2021-2027, and the Green Deal, used to validate recognition, portability, and dual transition requirements.

2.3.3 Analytical methods

- **Descriptive statistics** for survey items, reported with counts and percentages at item level. Interpretation is framed as indicative trends given the sample size and cross-country variation.
- **Criteria-based rating** for learning materials and platforms using the common evaluation rubric. Review outputs include relevance notes, technology-integration flags, and pedagogical fitness assessments mapped to the competence framework.
- **Thematic synthesis** of qualitative inputs from expert consultations and workshops, used to validate feasibility and refine competence statements and learning outcomes.
- **Triangulation** across survey results, material evaluations, and policy anchors to derive design requirements. Conflicts are resolved by priority to learner and employer needs, then feasibility, then policy consistency.

2.3.4 Evidence-to-design traceability

Design choices in Chapters 4-6 are linked to explicit evidence items:

- **Microcredentials and digital verification** → supported by Q10-Q11 (pages 12-13) and the policy brief's guidance on recognition and portability.
- **Scenario-based, problem- and project-based learning** → supported by Q12 effectiveness ratings (page 14) and evaluation findings on the need for immersive interactivity.
- **Academic-VET-industry collaboration mechanisms** → supported by Q9 importance ratings (page 11) and by industry-alignment criteria in the evaluation rubric.
- **Access, inclusion, and multilingual delivery** → supported by Q8 barriers and the accessibility criteria in the evaluation framework.
- **Priority competence areas** (for example AI and data analysis, precision agriculture, IoT, remote sensing, climate-smart practices) → supported by Q15 rankings (page 17) and the resources scan used to map available tools and content.

DESIGN DECISION	SURVEY EVIDENCE	KEY FINDING	EVALUATION RUBRIC ANCHOR	IMPLICATION FOR DESIGN
Adopt microcredentials as a core recognition pathway	Q10	73% "YES, very much" to microcredentials	Assessment and Certification Standards	Include short, stackable units with verifiable badges and credit options
Add digital verification for credentials	Q11	High importance of secure or Europass-aligned verification	Assessment and Certification Standards	Use standards-compliant e-credentialing and verification workflow
Prioritise project-based learning	Q12	52% extremely effective, 37% very effective	Pedagogical Effectiveness, Engagement and Interactivity	Design scenario packs and real industry briefs as default learning tasks
Prioritise problem-based learning	Q12	45% extremely, 37% very effective	Pedagogical Effectiveness	Build inquiry prompts and troubleshooting labs around real data
Use blended delivery, but not as the only format	Q12	40% very, 26% extremely effective	Technology Integration, UX	Offer modular online + facilitated workshops, keep offline alternatives
Fix quality of current digital resources	Q7	41% average, 29% poor, 3% very poor	Relevance to Industry Needs, Technology Integration, UX	Replace low-fit materials, add platform QA and style guidelines
Tackle top gaps: practice, industry alignment, tools	Q8	51% rated "limited practical experiences" extremely significant; 47% "poor industry alignment"; 43% "lack of modern tools"	Relevance to Industry Needs, Engagement and Interactivity	Embed hands-on tasks with real datasets and vendor-neutral toolchains
Make collaboration mechanisms explicit	Q9	Collaboration weighted average 4.45 with 60% very important	Industry Collaboration criterion	Set up co-delivery with employers, advisory panels, placements
Prioritise competence families	Q14	Technical and digital skills score highest; sustainability and business also high	Relevance to Industry Needs, Sustainability and Green Skills	Map competence framework focus to technical, green, and business pillars
Prioritise technical skills: sustainable practices, AI and data, remote sensing, precision ag	Q15	58% extremely for sustainable practices; 41% extremely for AI and data; 44% extremely for remote sensing; 45% very and 29% extremely for precision agriculture	Relevance to Industry Needs, Sustainability and Green Skills	Build pathways around these four clusters with capstone assessments
Address barriers in roll-out	Q16	Tech, financial, admin, engagement, and culture rated as moderate to strong barriers	Accessibility and Inclusivity, Change and QA process	Budget for onboarding, low-bandwidth options, and faculty support
Keep policy alignment explicit	Policy brief + rubric	EQF, ESCO, DEAP, Skills Agenda used as checks	Policy and Regulation Compliance	Trace outcomes to EQF levels and ESCO concepts, include recognition notes

Table 1. Evidence-to-design traceability

2.3.5 Data management and reproducibility

All instruments, rating sheets, and decision logs are archived in the project repository. Survey evidence is referenced at item level by question number and page, and evaluation notes reference the rubric criteria and indicator set. Revisions follow change-control procedures described in Section 2.5 and updates are recorded in release notes.

2.4 Sampling, Limitations, and Ethics

This section documents how participants, materials, and platforms were selected for evidence gathering, the constraints that affect interpretation, and the ethical safeguards applied across all activities. It complements the evidence listed in Section 2.3 and the traceability provided in Table 1.

2.4.1 Sampling strategy

- **Stakeholder survey -** A cross-country questionnaire targeted core stakeholder groups in the AGRITECH Learning Ecosystem: VET providers, HEIs, industry and SMEs, learners and practitioners, and policy or intermediary bodies. Recruitment used partner networks to ensure diversity of roles and national contexts. Responses were screened for completeness and role clarity before inclusion in analysis.
- **Expert consultations and focus activities -** Purposive sampling identified experts with direct experience in digital agriculture, curriculum design, and recognition systems. Each session included both education and industry representation to avoid single-perspective bias.
- **Learning materials, platforms, and tools -** A corpus was assembled from the structured evaluation and resource scan described in Section 2.3. Selection was guided by relevance to the competence areas, coverage of digital and green skills, availability within partner contexts, and representativeness across formats (curricula, e-learning modules, platforms, interactive tools). Items were logged in an inventory for reproducibility.

2.4.2 Limitations

- **Sampling and representativeness -** The survey used non-probability sampling through consortium networks. Results indicate trends across participating contexts but are not statistically generalisable to all EU countries or subsectors.
- **Heterogeneity across countries and institutions -** Differences in digital readiness, curriculum autonomy, and infrastructure create variation that can influence responses and uptake. Comparisons are therefore indicative rather than deterministic.
- **Temporal constraints -** Findings reflect conditions during the data-collection window. Given fast-moving technology and policy updates, some conclusions may require refresh during pilots and before scale-up.
- **Evaluation corpus coverage -** The learning-materials review favoured resources accessible to partners. Proprietary or commercial content behind licences may be under-represented, which can bias technology coverage toward open or widely adopted tools.
- **Self-report and desirability bias -** Survey and workshop inputs may overstate intentions or perceived effectiveness. To mitigate, analysis privileges converging signals across multiple sources, not single items.

- **Attribution limits -** Where several interventions co-exist in pilots (platform, pedagogy, credentialing), isolating the effect of any one component can be difficult. Impact interpretation will therefore rely on mixed evidence and pre-defined success criteria.

2.4.3 Ethics and data protection

All activities adhere to EU data protection requirements and standard research ethics.

- **Informed consent.** Participants received plain-language information on purpose, data use, and withdrawal rights before taking part.
- **Data minimisation.** Only role, organisation type, country, and responses essential to analysis were collected.
- **Confidentiality and anonymisation.** Individual-level data are stored in controlled project repositories; reporting uses aggregated results.
- **Right to access and erasure.** Participants can request access or deletion for any personal data captured during the study.
- **Equity and inclusion.** Engagement targeted balanced participation across roles, with accessible formats, multilingual materials where feasible, and low-bandwidth alternatives.
- **Conflict of interest.** Reviewers declared affiliations with tools or platforms prior to evaluation; potential conflicts were recorded in the evaluation log and handled through recusal if needed.

2.4.4 Mitigation and quality controls

- **Triangulation.** Conclusions are derived from converging evidence across the survey, expert inputs, learning-materials evaluation, and the policy brief.
- **Traceability.** Table 1 links major design decisions to specific evidence items to support audit and reuse.
- **Change control.** Any evidence-driven updates identified during pilots are logged as change requests and, once approved, applied to competence statements, curricula, or credentialing workflows.
- **Future refresh.** A scheduled evidence refresh precedes scale-up to capture new technologies, regulations, or recognition mechanisms.

2.5 Quality Assurance and Validation

The methodological rigor of Deliverable D2.2 was supported by a comprehensive quality assurance and validation framework, ensuring accuracy, coherence, and consistency across all phases of research, analysis, and design. The process was embedded within AGRITECH's overall project management structure and adhered to the principles of transparency, replicability, and continuous improvement.

Quality Assurance Framework

Quality assurance (QA) activities were guided by the ***AGRITECH detailed internal management plan*** prepared by PAMEA, coordinated by PAMEA (editorial coordination) and DDTG (methodology developer). QA measures were applied at three key levels:

1. Process Quality - All research and design activities followed standardized templates and methodological guidelines defined in the ***AGRITECH Methodology for Learning Materials Assessment***. These procedures included predefined evaluation criteria, scoring systems, and data validation steps to ensure comparability and traceability of findings across countries and partners.

Each analytical phase (data collection, assessment, synthesis, validation) was documented, peer-reviewed, and archived in the internal project repository to enable audit and reuse.

2. Data Quality - Data reliability was ensured through triangulation of sources:

- quantitative results from the stakeholder survey,
- qualitative evidence from expert interviews and workshops, and
- secondary data from desk research and EU policy documents.

Cross-verification between datasets minimized interpretation bias and allowed consistent validation of emerging conclusions. Outliers and inconsistencies were reviewed jointly by partner experts before inclusion in the synthesis.

3. Output Quality - Deliverable drafts were reviewed internally by all partners to ensure factual accuracy, methodological soundness, and alignment with project objectives. Each major component (competence framework, ecosystem design, curriculum mapping) underwent iterative peer review involving both educational and technical experts. Final consolidation was performed by the editorial team, ensuring linguistic, structural, and formatting consistency with AGRITECH deliverable standards.

Validation Process

Validation served as a bridge between research findings and practical application, confirming that the proposed design responds to real needs and complies with relevant frameworks. It included three complementary layers:

Figure 3. QA and validation workflow

a) Internal Validation - Conducted through partner workshops and online review sessions. Partners validated the methodological coherence, accuracy of analytical results, and the logical connection between evidence and design outcomes.

b) External Validation - Engagement of external stakeholders - including academic experts, AgriTech industry representatives, and policy advisors - ensured the practical relevance and transferability of the ecosystem. Feedback from these actors was incorporated to refine competence descriptions, learning pathways, and assessment strategies.

c) Policy and Framework Validation - The AGRITECH Learning Ecosystem was cross-checked for consistency with EU strategic frameworks:

- **European Skills Agenda** and **Pact for Skills** (upskilling and reskilling priorities);
- **Digital Education Action Plan (2021-2027)** (digital readiness and innovation in learning);
- **European Green Deal** and **Farm to Fork Strategy** (sustainability and green competences);
- **European Qualifications Framework (EQF)** and **ESCO** (transparency and recognition).
- **Continuous Improvement**

Quality assurance and validation are not one-off tasks but continuous processes throughout AGRITECH's lifecycle. The D2.2 framework includes mechanisms for ongoing feedback collection during the pilot implementation phase, enabling regular updates to competences, learning materials, and digital tools. This iterative model supports adaptability and long-term sustainability of the AGRITECH Learning Ecosystem.

Summary

The combination of rigorous QA procedures, multi-level validation, and structured partner review guarantees that the outputs of Deliverable D2.2 meet high standards of methodological soundness and policy relevance. By grounding the ecosystem design in verified evidence and stakeholder consensus, AGRITECH ensures credibility, replicability, and alignment with the evolving European context for digital and sustainable agriculture.

3. STATE OF THE ART

This chapter maps the current state of the art in AgriTech as it relates to the design of a competence-driven learning ecosystem. It synthesizes evidence from academic literature, European and international initiatives, market analyses, and practice-oriented case studies to identify the technologies, methods, standards and organisational models that are shaping digital transformation across agriculture. The goal is not an encyclopaedic inventory but a curated lens: what matters for capability building in VET and HE, for SMEs and farms, and for the emerging AGRITECH Manager profile developed in this project.

Agriculture is moving from machinery-centric productivity gains to data-centric decision making. Precision farming, remote sensing and Earth observation, farm management information systems, interoperable IoT architectures, robotics and autonomous equipment, digital twins, and AI-enabled decision support are converging into integrated production systems. Alongside yield and efficiency, sustainability metrics now drive adoption: water and nutrient use efficiency, soil health, biodiversity impact and carbon accounting. The frontier is no longer a single technology but the orchestration of many, governed by data quality, interoperability and responsible use.

At the core of this convergence lies data governance. FAIR data principles, shared vocabularies and APIs, edge-to-cloud pipelines, and privacy-preserving analytics determine whether tools can talk to each other and whether insights travel from research to field practice. Interoperability challenges persist across machinery, sensors and platforms, often compounded by proprietary ecosystems and fragmented standards. Cybersecurity, safety and reliability have become foundational, not optional, as more critical farm operations are automated or remotely managed.

The human layer is equally decisive. The literature and recent initiatives consistently flag a skills gap that spans data literacy, systems thinking, change management and cross-disciplinary collaboration. Pedagogical trends relevant to AgriTech include competence frameworks aligned with green and digital transitions, micro-credentials and modular curricula, work-based learning with authentic datasets, simulation and virtual labs, and assessment designs that capture performance in complex, software-mediated tasks. Equity and inclusion remain cross-cutting: access to infrastructure, gender gaps in AgriTech pathways, and the needs of smallholders and rural learners must be addressed in any scalable solution.

Innovation ecosystems are shifting from single-actor projects to multi-actor living labs that connect farmers, advisors, researchers, technology providers and public bodies. These arrangements shorten feedback loops, surface adoption barriers early, and create shared ownership of outcomes. Procurement models and business cases are maturing around platform subscriptions, data services and outcome-based offerings, but diffusion is uneven across regions and farm sizes. This variability underlines the need for adaptable learning pathways and support services that fit diverse contexts.

Within this frame, the chapter proceeds in four moves. First, it maps the technology landscape into functional building blocks relevant to farm and agri-food operations. Second, it reviews data standards, architectures and governance models that enable those blocks to interoperate. Third, it examines educational and training approaches that effectively translate these advances into competences for VET and HE. Finally, it identifies gaps, risks and enablers that inform the design choices for the AGRITECH Learning Ecosystem proposed in the subsequent chapters.

3.1 AgriTech Learning Ecosystem Exemplars

This section presents representative initiatives that combine technology, data, governance and pedagogy into functioning learning ecosystems for agriculture. Each exemplar is described in terms of scope, core mechanisms for knowledge exchange, and transferable design features relevant to VET and HE. The emphasis is on what learners can actually do with real tools, how knowledge travels between actors, and which design features are directly reusable in AGRITECH D2.2.

CATEGORY	EXEMPLARS (FROM ATTACHED MATERIALS)	ECOSYSTEM MECHANISMS (HOW LEARNING HAPPENS)	WHAT LEARNERS CAN DO (AUTHENTIC TASKS)	TRANSFERABLE FEATURES FOR VET/HE
Farm management & advisory platforms	Agworld; Granular; The Climate Corporation (Climate FieldView); Bushel Farm (FarmLogs); AgriWebb	Shared workspaces for planning and recording; multi-actor data capture; agronomy templates; season-long analytics	Build farm plans, log operations, reconcile costs, benchmark fields or herds, generate evidence for decisions	Role-based workflows, traceable datasets for assessment, portfolio evidence, advisor-farmer co-learning
Sensing, imagery & analytics	CropX; Arable Mark; OneSoil; Taranis AI2; CropUp AI	Sensor/EO ingestion; modelled insights; alerting; feedback loops from field verification	Configure sensors, interpret soil and microclimate data, validate imagery-derived detections, tune thresholds	Data literacy with real telemetry, model interpretation, structured field validation protocols
Integration & IoT operations	VELOS; Webbylab	Device identity and provisioning; secure telemetry; edge-cloud orchestration; update management	Onboard devices, design telemetry schemas, set up OTA updates, diagnose fleet health	Secure IoT ops, offline-first patterns, operations runbooks students can execute and defend
Trials & evidence generation	QuickTrails	Protocol libraries; KPI tracking; vendor-neutral comparisons; reporting	Design and run on-farm trials, compute KPIs, compare tools/sensors, produce decision briefs	Experimental design, KPI literacy, evidence-based procurement deliverables
Learning materials & courses	"Precision Agriculture Handbook for Beginners"; "Precision Agriculture for Sustainability" (e-book); "Introduction to Deep Learning in Agriculture"; "Deep Learning for Sustainable Agriculture"; Coursera: "Discover Best Practice Farming for a Sustainable 2050"; Coursera: "Sustainable Agricultural Land Management"	Structured curricula; micro-modular theory; case-based learning; assessed activities	Master core concepts, complete graded activities, connect theory to datasets from platforms above	Micro-credential scaffolding, cross-module reading lists, aligned rubrics for graded tasks

Table 2. Synthesis of the Observed Design Patterns

Synthesis: Design Patterns Observed

- **Multi-actor governance:** Formal coordination across advisors, researchers, networks and policymakers improves diffusion and feedback loops. *EU CAP Network*

- **Infrastructure for authentic practice:** DIHs, TEFs and pilot sites enable learning with real systems, data and safety constraints. smartagrihubs.eu+1
- **Role-specific capacity building:** Advisor, farmer and technician pathways benefit from targeted competence frameworks and peer learning. CORDIS
- **Interoperability as pedagogy:** Training embedded in integration projects accelerates both technical adoption and skills acquisition. Demeter - EMPOWERING FARMERS
- **Open and stackable credentials:** Microlearning and certification ecosystems widen access and support progression across VET and HE. elearning.fao.org+1

These studied exemplars support a single, coherent delivery model: learners work inside live platforms (management, sensing, IoT, trials), generate evidence with real data, and anchor theory through the listed courses and e-books. The design pattern is simple to implement at scale: pick one platform per category as a primary teaching rig, mirror production workflows in capstones, and grade performance on reproducible, dataset-backed tasks.

3.2 Cross-Sector Practices Transferable to AgriTech

This section consolidates the resources provided in the attached pack into a single, practice-oriented view. The aim is to identify proven mechanisms from adjacent, data-intensive or safety-critical domains and show how they translate into agricultural contexts. Selection and prioritisation are grounded in the examples, courses, platforms and vendor solutions listed in our materials. The criteria were: relevance to farm or agri-food operations, maturity of methods, interoperability potential, and direct usefulness for competence development in VET and HE.

Practice	Transferable mechanisms	Mapped resources (from attached materials)	Primary agritech applications	Competence focus (VET/HE)	Priority for AGRITECH
DevOps, DataOps, MLOps	CI/CD for data and models, experiment tracking, versioned datasets, model monitoring	Introduction to Deep Learning in Agriculture; Deep Learning for Sustainable Agriculture; Taranis AI2; CropUp AI; OneSoil	Lifecycle management of CV models for weed/disease detection; yield models; traceable imagery pipelines	CI/CD basics, pipeline design, model governance, observability	High
Digital twins & model-based engineering	Telemetry-calibrated models, co-simulation, configuration control	Arable Mark; CropX Soil Sensor System; OneSoil; Climate FieldView; Granular	Field or block-level twins for irrigation and fertigation scenarios; maintenance planning; carbon/water accounting	Systems thinking, model calibration/validation, uncertainty basics	High
Functional safety & assurance	Hazard analysis, fail-safe design, operator-in-the-loop protocols	VELOS (cellular IoT plus drones); Taranis AI2; Arable Mark; AgriWebb	Safe operation of autonomous or remote assets; risk-aware decision support in livestock and cropping	Hazard logging, SOPs, incident review skills	Medium
Cybersecurity & zero-trust operations	Device identity, least-privilege access, secure OTA, anomaly detection	VELOS; Webbylab; Climate FieldView; Granular; Bushel Farm (FarmLogs)	Protect sensor fleets and FMIS; secure data sharing with suppliers and advisors	IAM fundamentals, secure IoT operations, basic incident response	High
Interoperability by design	API-first workflows, canonical schemas, conformance testing	Agworld; Climate FieldView; Granular; Bushel Farm (FarmLogs); QuickTrails	Cross-vendor data exchange across machinery, advisory, trials and FMIS	API design, schema mapping, data quality metrics, interoperability tests	High
Edge–cloud orchestration	Edge inference, offline-first design, fleet management	VELOS; Arable Mark; CropX; Webbylab; Climate FieldView	Reliable rural deployments; energy-aware sensing; resilient telemetry	Edge deployment patterns, device lifecycle management, SRE basics	High
Human-centred design & change management	Co-design, usability in real workflows, adoption plans	Bushel Farm (FarmLogs); AgriWebb; Agworld; "Precision Agriculture for Beginners" (e-book); "Precision Agriculture for Sustainability" (e-book)	Tools aligned to farmer and advisor routines; explicit value cases by farm type	User research, service blueprinting, communication for adoption	High
Simulation-based training & assessment	Scenario libraries, virtual labs, performance analytics	QuickTrails; Coursera: Discover Best Practice Farming for a Sustainable 2050; Coursera: Sustainable Agricultural Land Management; listed case-based e-books	Trial design and analytics; simulated climate/market scenarios; machinery and incident drills	Scenario authoring, rubric-based assessment, reflective practice	Medium-High
Modular credentials & competence frameworks	Micro-modules, evidence-based assessment, portability	Coursera courses listed; selected e-books as module backbones	Short courses on data stewardship, API integration, robotics safety, irrigation analytics	Micro-assessment design, curriculum mapping, recognition of prior learning	Medium
Outcome-oriented procurement & test-before-invest	KPI-driven pilots, neutral testbeds, TCO analysis	QuickTrails; CropX; Arable Mark; Taranis AI2; Bushel Farm (FarmLogs)	Evidence-based selection of sensors and platforms via local trials and verified performance	KPI setting, pilot design, benefits tracking	High

Table 3. Cross-Sector Practices Transferable to AgriTech

The attached resources converge on a practical recipe: pair lifecycle practices (MLOps, interoperability, cybersecurity) with regionally accessible testbeds, then deliver learning through authentic tasks that use the same tools farms actually run. The "High" priorities above are both widely represented in your pack and broad enough to serve cropping and livestock contexts. For the learning ecosystem, this translates into three concrete design choices: embed hands-on integration and assurance tasks inside modules; scaffold these tasks with micro-credentials to support progression across VET and HE; and route pilot and procurement decisions through KPI-based trials so training effort and deployment outcomes reinforce each other.

3.3 Gaps and Opportunities

This concluding section synthesizes evidence from 3.1 (Exemplars) and 3.2 (Cross-sector practices) into a single view of what is missing and where the highest-leverage opportunities lie for the AGRITECH Learning Ecosystem. The analysis focuses on what matters for delivery in VET and HE, for farms and SMEs, and for the emerging AGRITECH Manager competence profile. The goal is pragmatic: identify the bottlenecks that block learning and deployment, then match each to concrete opportunities using the platforms and learning assets already catalogued (farm management and advisory tools, sensing and analytics, IoT operations, trials/evidence tools, and the course/e-book set).
The table below consolidates technical, organizational and pedagogical gaps into one action plan. It is intentionally compact to avoid inflating the table of contents while remaining implementation-ready.

Gap (what's missing)	Why it matters	Opportunity for the AGRITECH Learning Ecosystem	Near-term actions (0–6 months)	Medium-term enablers (6–24 months)
Fragmented data and vendor lock-in across platforms (FMIS, sensing, analytics)	Learners cannot practice end-to-end workflows; farms cannot reuse data across tools	Make interoperability a learning outcome and an infrastructure feature	Stand up a small "data spine" that ingests from one FMIS and one sensing/imagery source; publish a canonical field/plot schema and mapping templates	Expand connectors to two more platforms; introduce conformance checks in assessments; formalize data provenance and versioning
Limited hands-on environments for IoT and edge-cloud operations	Theory without practice produces low readiness for real deployments	Create a minimal IoT lab stack using the listed edge devices and management toolchains	Provision a sandbox with device onboarding, telemetry schemas, OTA updates and fault injection; provide runbooks students must execute and defend	Scale to a regional lab with fleet monitoring dashboards; embed SRE-style reliability targets in capstone rubrics
Weak lifecycle practice for AI/analytics (models treated as one-offs)	Models drift, are irreproducible, and cannot be audited	Embed MLOps/DataOps as the default way of working	Introduce versioned datasets, experiment tracking and model registries around one imagery/detection use case	Generalize to multiple crops or livestock tasks; add continuous evaluation with drift alerts; require model cards in assessments
Safety and assurance missing from robotics/automation learning	Automation risks are unmanaged; adoption slows	Integrate lightweight safety cases and incident reviews into practical work	Teach hazard logging and operator-in-the-loop protocols using current field tools; assess with a simple safety case dossier	Build a shared library of agritech hazard scenarios; align SOPs with lab/testfield operations
Cybersecurity maturity gaps for farm IT/OT	Real deployments fail audits or create liabilities	Treat zero-trust basics as table stakes in every technical module	Provide IAM baselines, device identity, and secure telemetry patterns in the sandbox; run one tabletop incident exercise	Add continuous logging, anomaly detection exercises and a minimal incident response playbook; require security evidence in capstones
Trial design and evidence for procurement underused	Purchases are anecdote-driven; learning is disconnected from decisions	Use the trials platform to teach "test-before-invest" with KPIs	Deliver one on-farm or simulated trial per cohort using the trials tool; grade on protocol quality and KPI literacy	Institutionalize vendor-neutral comparisons; publish anonymized trial briefs as teaching cases for future cohorts
Skills gap in data literacy and model interpretation for non-technical roles	Advisors and managers cannot translate analytics into action	Role-specific pathways with modular credentials	Create micro-modules for advisors, farm managers and technicians using the listed courses/e-books as backbones	Stack micro-modules into badges aligned to the AGRITECH Manager profile; recognize prior learning across VET/HE
Change management and adoption planning often absent	Good tools fail in practice; benefits are not realized	Bake human-centred design and adoption plans into project work	Require service blueprints and stakeholder value cases in each team project; assess usability against real workflows	Track post-deployment benefits over a season; include benefit-realization reviews in final grading
Connectivity variability and offline operation not addressed	Rural constraints break elegant cloud-only designs	Default to offline-first patterns with graceful degradation	Include edge buffering and sync strategies in the sandbox; test assignments under simulated low bandwidth	Extend to multi-site replication and conflict resolution; measure energy/bandwidth budgets in lab tasks
Assessment misaligned with authentic performance	Students overfit to quizzes; skills don't transfer	Use portfolio-grade, data-backed assessments	Replace a portion of exams with reproducible notebooks/dashboards using real platform data	Introduce external juries from partner farms/SMEs; map evidence to micro-credentials and EQF descriptors
Equity and access gaps (infrastructure, time, language)	Adoption stalls for smallholders and under-resourced learners	Provide low-barrier options and shared infrastructure	Offer cloud vouchers, shared datasets and translated task guides; rotate access to the lab stack	Establish a pooled equipment library; add asynchronous micro-modules to widen participation

Table 4. Gaps and Opportunities Findings

Priority focus areas

- **Establish the data backbone and IoT sandbox.** Implement shared data flows and a practical environment for hands-on work. Start with one FMIS integrated with a single sensing or EO source to prove the end-to-end pathway, then expand connectors incrementally.

- **Embed MLOps and interoperability in assessment.** Make lifecycle discipline examinable. Require version-controlled datasets, experiment logs, and explicit API mappings in all technical submissions.
- **Link learning outputs to decision-making.** Run one KPI-defined pilot per cohort using the trials tool so training deliverables and procurement choices reinforce each other.
- **Baseline security across modules.** Treat identity management, secure telemetry, and basic incident response as mandatory elements of every technical activity.
- **Structure progression with micro-credentials.** Offer short, stackable units that document learner progress toward the AGRITECH Manager competence profile.

Short-term indicators of success (next delivery milestone)

- One end-to-end, cross-platform workflow executed with the selected tools (plan → sense → analyse/model → advise/act → evaluate).
- An operational IoT sandbox supporting device onboarding, OTA updates, and a basic fault-injection lab, used in at least two modules.
- Portfolio-grade, reproducible learner artefacts: a versioned dataset, an experiment log, a model card, and a KPI-linked decision brief.
- A completed minimal safety case for one robotics or high-automation scenario.
- One cohort-level KPI trial completed, with anonymised results packaged as a teaching case.
- Three micro-modules delivered and stackable toward an interim badge aligned with AGRITECH Manager competences.

Risks and mitigations

- **Tool access or licensing -** to prioritise inventoried platforms; where necessary, use trial tiers and centrally managed shared accounts.
- **Data protection.** Default to de-identified datasets; store consent, provenance, and version metadata with every dataset.
- **Faculty capacity** - to provide ready-made runbooks, rubrics, and seed datasets so staff effort focuses on coaching and review.
- **Over-complexity** - to keep the starter stack lean; add integrations only after the initial cross-platform workflow is stable and assessed.

4. COMPARATIVE NEEDS ASSESSMENT

Chapter 4 provides a comparative needs assessment across the six participating countries (**Czech Republic**, **Cyprus**, **Greece**, **Hungary**, **Italy** and **Romania**) and across the two educational sub-systems, Higher Education Institutions (**HEIs**) and Vocational Education and Training (**VET**). Building on the twelve national analysis reports produced under WP2 - T2.2, the chapter synthesises the evidence on existing strengths, persistent gaps and emerging opportunities in agricultural technology education, as mapped against the AGRITECH Manager competence framework and the associated D2.1 domains. The analysis adopts a multidimensional perspective, considering not only curricular content related to digitalisation, sustainability and entrepreneurship, but also delivery models, technological and infrastructural readiness, recognition and micro-credential frameworks, as well as issues of equity, inclusiveness and territorial coverage across partner countries. Despite substantial contextual differences, the national reports converge on several structural needs, including the systematic embedding of advanced data and automation skills in both HEI and VET pathways, deeper integration of climate-smart and circular-economy competences into mainstream provision, and more explicit development of entrepreneurial and innovation capacities that can link educational offers with the ongoing transformation of agri-food systems. At the same time, the comparison reveals marked divergences in institutional capacity, regulatory maturity, digital infrastructure and labour-market dynamics, which must be carefully considered when designing a pan-European learning ecosystem that is both coherent and adaptable to national conditions. The following subsections unpack these commonalities and differences in a structured manner, providing a consolidated evidence base for prioritising AGRITECH curriculum components, support services and implementation pilots in subsequent work packages.

4.1 User Needs by Stakeholder Group

The comparative analysis of the twelve national reports confirms that the demand for AGRITECH-related learning is articulated differently across stakeholder groups, even where the underlying competence gaps are similar. Learners, teaching staff, institutional leaders, employers and policy / quality assurance bodies face distinct but interrelated challenges in engaging with digital, sustainable and entrepreneurial innovation in agriculture. This section synthesises the needs identified across these groups in the six partner countries, providing a structured basis for the subsequent design of the AGRITECH learning ecosystem and its associated curricula, services and governance arrangements.

4.1.1 Learners in HEI, VET and Continuing Education

Across all partner countries, learners at EQF levels 4 - 7 consistently signal the need for programmes that combine robust disciplinary foundations with applied digital and sustainability skills, delivered through authentic, practice-oriented learning activities. HEI students expect exposure to precision agriculture, sensing/IoT, data analytics and decision-support tools that move beyond purely theoretical coverage, with systematic access to modern equipment, real datasets and training or demonstration farms. VET learners and early-career professionals underline the importance of concrete, work-relevant competences (operation of GNSS-enabled machinery, drone-based data collection, basic automation, farm management information systems) that can be immediately transferred to farm and advisory contexts.

Learners also express a strong need for flexible, modular formats that can accommodate diverse entry profiles and constraints. In all six countries, demand is growing for short, stackable micro-credentials and continuing professional development offers that allow working farmers, advisors and SME staff to upskill in discrete AGRITECH domains without committing to full degree programmes. At the same time, baseline digital skills and confidence with advanced ICT tools remain uneven, particularly among VET cohorts and rural adult learners, which creates a need for scaffolded learning pathways and differentiated support (introductory “on-ramp” modules, blended delivery, remote and virtual lab options) rather than a one-size-fits-all offer.

Finally, learners emphasise employability and progression as core expectations. They require clear visibility of how AGRITECH modules translate into recognised credits, micro-credentials or qualifications, how they articulate between VET and HEI pathways, and how they relate to emerging job profiles in digital agronomy, advisory services, AgriTech companies and sustainability compliance. Career guidance, exposure to role models and structured work-based learning (placements, dual tracks, challenge-based projects with enterprises) are recurrently identified as necessary supports for informed study and career choices, especially for young people considering whether to remain in, or return to, the agricultural sector.

4.1.2 Teaching and Training Staff

Academic staff in HEIs and trainers in VET institutions report a pressing need for continuous professional development that keeps pace with the rapid evolution of digital and climate-smart technologies in agriculture. While many educators possess strong agronomic and engineering expertise, they frequently lack structured opportunities to deepen their skills in data analytics, AI applications, automation, remote sensing workflows and advanced sustainability assessment methods (e.g. LCA, ESG-related reporting).

Beyond subject-matter updating, teaching staff require pedagogical and instructional-design support to translate complex AGRITECH topics into coherent, project-based learning sequences that integrate digital tools, real datasets and interdisciplinary teamwork. National reports highlight limited institutional capacity in learning design, assessment of work-based and micro-credential learning, and facilitation of challenge-based or living-lab formats. Educators therefore need access to shared digital resources (case libraries, data repositories, simulation environments), communities of practice and cross-institutional mentorship that reduce duplication of effort and support the gradual mainstreaming of innovative methods.

Staff also point to incentive structures as a significant need. In several countries, teaching innovation, curriculum co-design with industry and engagement in micro-credential development are not yet fully recognised in promotion and workload models, which constrains the time and energy that academics and trainers can devote to AGRITECH-related renewal. More explicit institutional and policy-level recognition of these roles is therefore required if staff are to act as active co-creators of the learning ecosystem rather than passive implementers.

4.1.3 Educational Institutions and Programme Designers

At institutional level, HEIs and VET providers identify a cluster of strategic and operational needs that condition their ability to host and sustain AGRITECH offers. First, they require predictable investment in digital and physical infrastructure: robust connectivity; learning management systems; data storage and processing capacity; modern laboratory and field equipment; and, where possible, access to demonstration farms and living labs that can support cross-institutional use. These needs are especially acute for smaller and rural institutions, which frequently operate with outdated equipment and fragmented digital systems.

Second, programme designers require clear regulatory frameworks and operational guidance for implementing micro-credentials, recognition of prior learning and international module-level accreditation. While all partner countries are progressing towards harmonised frameworks, institutional actors report uncertainty about design parameters (credit volumes, learning outcome formulations, assessment standards), QA procedures and interoperability between national and European recognition systems. Institutions therefore need model templates, exemplars and shared criteria that reduce transaction costs and facilitate participation in transnational learning ecosystems such as AGRITECH.

Third, both HEI and VET providers stress the need for structured mechanisms to collaborate with external stakeholders (enterprises, advisory services, technology providers, regional innovation actors) in a way that is manageable within existing governance and resource constraints. This includes standardised partnership models, co-funding schemes and coordination platforms that can support shared use of equipment, co-delivery of modules and joint supervision of student projects across institutional and national boundaries.

4.1.4 Employers, Advisory Services and Technology Providers

Employers in the agri-food value chain, advisory organisations (AKIS actors) and AgriTech companies converge on the need for graduates and trainees who combine solid agronomic knowledge with operational proficiency in digital tools and an understanding of business and regulatory contexts. They emphasise not only technical competencies (e.g. setting up and maintaining sensor networks, processing spatial and temporal data, operating autonomous machinery, configuring farm management systems) but also transversal abilities such as problem-solving, communication with farmers, project management and innovation / entrepreneurship skills.

From the employer perspective, a key need is the availability of structured, co-designed learning offers that reflect real-world use cases (CAP eco-schemes, compliance reporting, resource-efficiency optimisation, traceability and quality schemes) and that can be used both for recruitment and for continuous upskilling of existing staff. Stakeholders request streamlined channels for feeding labour-market intelligence into curriculum design, participating in challenge-based assignments, providing datasets and case material, and hosting work-based learning placements that are properly integrated into assessment.

In parallel, advisory services and technology providers require enhanced pedagogical and digital capacities among their own staff in order to scale support for farmers and cooperatives. They look for micro-credentials and tailored modules that validate specific profiles (e.g. “precision agriculture advisor”, “digital farm manager”) and that are recognised both within national qualification systems and across borders, thereby increasing mobility and professionalisation within the AGRITECH ecosystem.

4.1.5 Policy, Quality Assurance and Accreditation Bodies

Finally, policy-makers, qualification authorities and QA / accreditation bodies across the six countries identify needs related to system-level coherence, evidence and governance. They require robust, comparable data on participation, outcomes and labour-market impact of AGRITECH-related offers in order to calibrate funding, regulatory measures and incentive schemes. At the same time, they seek practical models for embedding micro-credentials and innovative learning formats (dual programmes, work-based learning, living labs) into existing qualification frameworks without undermining quality or transparency.

Across countries, authorities highlight the need for alignment between AGRITECH developments and broader strategies on digitalisation, sustainability, youth employment and inclusion, so that investments in agricultural technology education reinforce, rather than duplicate, national and EU policy instruments (CAP Strategic Plans, Digital Decade roadmaps, green transition strategies). They also stress the importance of shared European reference points (competence frameworks, QA protocols, accreditation standards) to support mutual trust and portability of learning outcomes.

Taken together, these user needs delineate a complex but coherent demand landscape for the AGRITECH learning ecosystem: learners require accessible, practice-oriented pathways; staff and institutions need capacity, infrastructure and clear rules; employers and advisors seek job-ready competences and flexible upskilling tools; and public authorities need reliable frameworks and evidence to steer and recognise innovation. The subsequent subsections of Chapter 4 build on this mapping to prioritise competence domains and structural interventions across the partnership.

4.2 Institutional and Industry Requirements

The comparative analysis of the twelve national reports reveals that the effective deployment of the AGRITECH learning ecosystem is conditional on a coherent set of institutional and industry requirements that go beyond individual programme redesign. These requirements concern strategic governance, regulatory and quality-assurance frameworks, human and infrastructural capacity, and structured collaboration mechanisms between education providers and the agri-food sector. Together they define the enabling environment within which AGRITECH modules, microcredentials and digital resources can be sustainably integrated into higher education (HEI) and vocational education and training (VET) systems and translated into measurable change in practice.

From an institutional perspective, the first requirement is explicit alignment of AGRITECH activities with national and institutional strategies for digitalisation and the green transition. In all partner countries, agricultural and education policies emphasise the integration of digital skills, climate-smart agriculture and entrepreneurship, but the degree of operationalisation varies. Italy, Hungary, the Czech Republic and Romania have adopted sectoral or cross-sectoral digital and innovation strategies that provide a clear mandate for integrating data-driven agriculture and precision technologies into HE and VET, legitimising the adoption of AGRITECH modules and associated infrastructure. By contrast, Greece and Cyprus are at an earlier stage of embedding dedicated AgriTech content within institutional strategies, despite strong rhetorical commitments to regenerative agriculture, climate adaptation and digital skills, which implies a need for AGRITECH to act as a catalyst for operationalising existing policy aspirations in curriculum and programme design.

A second institutional requirement concerns governance and internal role allocation for modular, microcredential-based provision. The Romanian higher education report demonstrates a fully articulated microcredential governance model, with a vice-rectorate-level owner, a cross-functional steering group, and an operational microcredentials office embedded in the teaching and learning centre. This model provides a reference for other partners: to implement AGRITECH microcredentials credibly, universities and, in adapted form, VET centres will need clearly mandated structures responsible for outcome definition, EQF/EHEA level referencing, assessment design, badge issuance and record-keeping. In systems such as Italy, Greece and Cyprus, where microcredentials are either nascent, project-based or only partially recognised, the development of such governance arrangements will be a precondition for moving from ad-hoc short courses to recognised, portable units of learning aligned with AGRITECH.

Third, institutional participation in AGRITECH requires a regulatory and quality-assurance environment that allows for modular innovation without compromising compliance. The reports converge on the persistence of slow and often rigid accreditation procedures for new programmes and modules, particularly in Italy and the Czech Republic, where multiple bodies (ministries, national accreditation authorities, professional councils) must approve curricular changes. Romania, by contrast, has explicitly recognised “micro-certificări” in Higher Education Law 199/2023, enabling microcredentials to carry ECTS credits and to be stacked and recognised within degree structures, and has anchored the AGRITECH modules in an international accreditation pathway with ACQUIN, aligned with EQF and ESG. Greece and Cyprus report an absence of formal microcredential recognition and only emerging pilot frameworks, implying that AGRITECH implementation will initially rely on institutional or project-based certificates, with subsequent work required to embed these into national qualifications frameworks. At VET level, Czech, Hungarian and Romanian systems emphasise alignment with national qualifications frameworks and sectoral skills councils, creating both an opportunity and a constraint: AGRITECH units must be carefully mapped to existing standards to be recognised, but this mapping also provides a route to system-level scaling.

Human-resource and pedagogical capacity constitute a further critical requirement. Across the countries, there is a shared need for teaching staff who can operate across agronomy, data analytics, IoT/automation and sustainability, and who are able to use modern digital pedagogy (remote labs, simulations, challenge-based learning). Hungary and the Czech Republic benefit from strong academic centres (MATE, ČZU, MENDELU) and extensive training-farm networks, but both highlight insufficient teaching capacity in advanced AgriTech topics and a lack of systematic staff upskilling. Italy and Greece show similar patterns: pioneering programmes and individual laboratories coexist with institutions where staff expertise and teaching practices remain largely oriented towards traditional agronomy and analog practices, and where innovation depends on a small number of motivated individuals. Romania and Cyprus, with more concentrated AgriTech provision in a limited number of universities, face risks of over-reliance on a few hubs and therefore must plan for deliberate diffusion of expertise to regional institutions and VET providers. In all contexts, AGRITECH requires structured staff-development pathways and incentives for educators to engage with new digital tools, data-rich assignments and co-teaching with industry experts.

On the infrastructural side, institutional requirements are pronounced and highly convergent. The national reports consistently point to gaps in access to contemporary equipment (GNSS-enabled machinery, sensor networks, drones), up-to-date software stacks, and robust digital learning environments. Italian, Greek and Hungarian analyses underline the prevalence of fragmented or outdated learning management systems and limited interactive content, with many programmes still dominated by text-based or lecture-centric delivery and only isolated use of simulations or virtual labs. Romania and the Czech Republic report equipment and access constraints, particularly in peripheral institutions and rural regions, as well as a scarcity of remote or virtual laboratories that would allow scale and inclusion of working learners. In Cyprus, the concentration of AgriTech provision in a single main HEI (CUT) and limited VET-level digital agriculture provision similarly implies the need to invest in shared platforms, datasets and possibly national or regional "sandboxes" that AGRITECH can populate. Across all systems, the rural - urban digital divide (in broadband coverage and connectivity) represents a structural constraint that institutions must address through offline-capable resources, blended formats, and careful scheduling of field-based components.

Industry and sectoral stakeholders bring a complementary set of requirements that condition their willingness and ability to participate in the AGRITECH ecosystem. The labour-market analyses from Hungary, Italy, the Czech Republic and Romania all indicate a strong and growing demand for graduates and trainees with competencies in precision agriculture, digital advisory services, data-driven farm management and climate-smart practices, but also express dissatisfaction with the current depth and integration of such skills in HEI and VET outputs. Employers expect education providers to deliver not only technical familiarity with drones, FMIS and sensors, but also the capacity to interpret data, manage projects, communicate with clients and navigate regulatory frameworks. This implies that AGRITECH modules must incorporate authentic assignments based on real datasets, field trials and advisory scenarios, and that institutions must have mechanisms to systematically capture, and respond to, employer feedback.

At the same time, industry actors require clear, low-friction modalities for collaboration. The reports highlight a range of existing models: Hungarian and Czech training farms and smart-farm estates; Italian and Greek academies and private digital-farming platforms; Romanian and Cypriot Digital Innovation Hubs and civil-society organisations providing field demonstrations and digital literacy training. For AGRITECH to leverage these assets, institutions must provide standardised partnership frameworks covering co-design of modules, guest lecturing, hosting of placements, access to anonymised data, joint supervision of applied projects and, where relevant, shared use of testing facilities. Industry partners, for their part, require clarity on intellectual-property arrangements, time commitments, and the recognition they receive (e.g. visibility in accredited modules, access to upskilling for their own staff).

Finally, there are differentiated requirements around recognition and signalling of AGRITECH learning outcomes to the labour market. In Romania and, prospectively, in Cyprus, the development of microcredential frameworks aligned with EU recommendations allows AGRITECH badges to be transparently documented, quality-assured and stacked within formal qualification systems. In Greece and Italy, where microcredentials are emerging but not yet fully recognised in national qualifications frameworks, industry stakeholders emphasise the need for short, targeted certifications that clearly denote expertise in niche domains such as smart irrigation, digital farm management tools, drone operation or climate-smart metrics, even if these initially function as complementary rather than core qualifications. Across the partnership, therefore, AGRITECH will need to operate with a dual logic: aligning with formal QA and accreditation where possible, while simultaneously ensuring that the content, assessment and communication of its microcredentials meet employers' expectations for rigour, transparency and immediate workplace relevance.

In summary, the institutional and industry requirements identified in the national analyses point to a set of common design principles for AGRITECH: alignment with national digital and green strategies; clear internal governance for modular and microcredential-based provision; investment in staff capacity and digital/physical infrastructure; regulatory pathways that permit innovation while ensuring quality; and partnership frameworks that make collaboration with the agri-food sector both feasible and attractive. Meeting these requirements is not a merely technical exercise but a systemic task, and the degree to which they can be satisfied will shape both the feasibility and the impact of the AGRITECH learning ecosystem across the participating countries.

4.3 Technological and Infrastructural Readiness

The comparative review of the twelve national reports indicates that the technological and infrastructural baseline for AGRITECH implementation is characterised by a combination of strong, often project-driven centres of excellence and structurally weaker peripheral provision, particularly in rural VET institutions and small HEIs. While most partner countries benefit from solid basic connectivity and at least one or two well-equipped academic hubs, the availability of modern teaching laboratories, demonstration farms, digital platforms and remote-access environments remains uneven, which has direct implications for the scalability, inclusiveness and realism of AGRITECH learning activities.

4.3.1 Digital Connectivity, Platforms and Data Infrastructures

At system level, all six partner countries report that basic internet connectivity in higher education is largely adequate for data-intensive teaching and research, supported where relevant by national research and education networks or university-managed high-capacity links. Romania and Hungary, for example, combine strong fixed broadband or academic network coverage with national digital-education or digital-agriculture strategies, which create favourable conditions for hosting shared platforms, data repositories and remote labs envisaged in the AGRITECH ecosystem. Cyprus and the Czech Republic similarly benefit from Digital Decade roadmaps and recovery-plan investments that target school and campus connectivity, even if specialised AgriTech platforms are still at an early stage. By contrast, digital access remains more fragile in parts of the VET sector and in rural training centres, where connectivity is less reliable and internal networks are often outdated. Romanian, Hungarian and Cypriot VET reports underline persistent gaps in digital infrastructure for agricultural schools and adult-training centres, including limited Wi-Fi coverage in workshops and fields, insufficient device availability and fragmented use of learning management systems. Greek and Italian analyses likewise note that many VET providers and smaller institutions still rely on basic e-class systems or generic platforms, with few dedicated tools for managing AgriTech datasets, simulations or blended delivery at scale.

Across countries, there is also a clear distinction between general-purpose digital platforms and those explicitly oriented towards AGRITECH-relevant data and workflows. Italy and Hungary, for instance, host national or institutional platforms and observatories (e.g. digital agriculture academies, smart-farming observatories) that provide repositories of learning objects, videos and case material, but these are not yet systematically integrated into mainstream HEI or VET curricula. Cyprus and the Czech Republic present emerging examples of e-learning hubs, project-based platforms and micro-course repositories in sustainability and digital agriculture, though usage remains limited and often confined to project cohorts. This suggests that while the technical preconditions for a shared AGRITECH digital environment are present, significant work is required on integration, standardisation and institutional adoption.

4.3.2 Physical Infrastructure: Laboratories, Training Farms and Demonstration Sites

With respect to physical infrastructure, the national reports identify a dense but heterogeneous landscape. At HEI level, most partner countries possess at least one strong agricultural university or faculty with access to experimental farms, specialised laboratories and pilot facilities that can support AGRITECH-type learning. Romania's agricultural universities rely on field stations and farms such as

Moara Domnească to anchor precision-agriculture teaching and data-driven experimentation, although access to state-of-the-art machinery and sensor networks is still uneven across institutions. Hungary showcases a network of training and demonstration farms associated with universities such as MATE, Szeged and Debrecen, with substantial areas dedicated to precision agriculture trials, drone operations and digital advisory services. In the Czech Republic, universities like ČZU and MENDELU host precision-agriculture centres and smart-farming hubs equipped with robotics, sensor systems and GIS/RS laboratories.

Italy, Greece and Cyprus also report significant physical assets in specific institutions: Italian universities maintain advanced laboratories and experimental farms, while the Greek and Cypriot academic sectors benefit from well-equipped university farms, competence centres and laboratories in areas such as smart greenhouses, plant stress physiology and post-harvest technology. These hubs offer a solid platform for implementing practice-oriented AGRITECH modules at EQF levels 6 - 7 and for generating authentic datasets for shared use within the ecosystem.

However, the VET landscape presents a more fragmented picture. Hungarian and Romanian VET systems are undergoing substantial infrastructure investment, including modernisation of agricultural high schools and regional VET centres, yet many institutions still lack contemporary precision machinery, calibrated sensor networks or access to commercial farm-management systems. Czech VET schools and tertiary professional institutions benefit from some modernised training farms and EU-funded demonstration projects, but student surveys indicate that hands-on experience with GPS guidance, robotics or advanced equipment remains limited for the majority. Greek, Italian and Cypriot VET providers report similar challenges, with advanced technology often concentrated in a small number of pilot schools, private training centres or project-based demonstrators rather than embedded across the mainstream system.

Overall, the comparative picture is one of “islands of excellence” surrounded by wide areas of partial or outdated provision. For AGRITECH, this implies a need to design curriculum and delivery models that leverage high-capacity hubs for intensive, equipment-dependent activities while also supporting lower-infrastructure contexts through shared datasets, portable instrumentation and collaborative access arrangements.

4.3.3 Remote, Virtual and Blended Learning Capacity

A third dimension of readiness concerns the capacity to deliver AGRITECH learning through remote, virtual and blended formats, which is essential for reaching working professionals, rural learners and cross-border cohorts. Across the partnership, the national reports converge on the finding that such capacity is emerging but not yet mainstream. Romanian HEI and VET analyses explicitly identify the scarcity of remote or virtual laboratories as a major bottleneck: most practical activities remain tied to physical presence, which constrains scale and limits participation by professionals and learners in remote areas. Italian and Czech HEI reports likewise note that, although some online platforms and MOOCs exist, simulation environments and virtual access to equipment are rarely used within core degree programmes.

Hungary, by contrast, has begun to experiment with hybrid models that combine digital agriculture academies, online knowledge platforms and demonstration-farm access, but even here the integration of these tools into structured, credit-bearing curricula remains partial. Greece and Cyprus present a similar pattern: general-purpose e-learning platforms and project-based hubs (including micro-credential pilots) are available, yet they are not systematically leveraged to provide virtual labs, remote sensor access or data-rich casework at scale in either HEI or VET provision.

In all six countries, therefore, the underlying technical potential for blended and online AGRITECH delivery exists, but there is a clear need to develop common architectures, reusable digital assets (datasets, simulations, remote experiments) and staff competences in online pedagogy. Without these, the learning ecosystem risks remaining dependent on geographically bound, equipment-intensive formats that are difficult to scale and replicate.

4.3.4 Comparative Readiness Patterns and Implications for AGRITECH

Synthesising the evidence, three broad readiness patterns emerge. First, countries such as Hungary and the Czech Republic possess relatively advanced, sector-specific infrastructures in higher education and selected VET centres (training farms, precision-agriculture hubs, digital academies), supported by strong policy mandates for digitalisation and sustainability, but face challenges in diffusing these capacities across the wider school and training network. Second, Italy and Romania combine well-developed academic centres and growing project-based initiatives with pronounced disparities between leading universities and smaller or rural institutions, particularly in terms of access to modern equipment, integrated data pipelines and remote-learning solutions. Third, Greece and Cyprus show emerging but still partial technological infrastructures for AgriTech in both HEI and VET, with significant reliance on individual institutional initiatives, external projects and research institutes rather than system-wide, dedicated digital-agriculture facilities.

For the AGRITECH learning ecosystem, these patterns imply that technological and infrastructural readiness cannot be treated as a uniform baseline. Instead, curriculum design, digital platform development and pilot implementation must be explicitly sensitive to the heterogeneous starting points of partner systems. This includes: prioritising interoperable, cloud-hosted solutions that can function across varying levels of local infrastructure; structuring modules so that high-end hardware is an enabler rather than a precondition; and leveraging the most advanced institutions as shared resource hubs and training providers for the wider network. In this sense, the needs identified in previous sections (user, institutional and industry) can only be met if technological and infrastructural investments are coordinated, inclusive and deliberately aligned with the AGRITECH competence framework and delivery model.

4.4 Barriers and Enablers

The cross-country synthesis of HEI and VET analyses shows that the implementation of the AGRITECH learning ecosystem will not occur on a neutral terrain. It will be shaped by a combination of structural and institutional barriers that constrain innovation, and a parallel set of enabling conditions that can be leveraged to accelerate change. Many of these factors are mirrored across the six partner countries: slow and centralised curriculum governance alongside ambitious digital and green transition agendas; strong centres of excellence coexisting with under-resourced rural institutions; and a labour market that signals growing demand for advanced AGRITECH skills while parts of the education and training system remain anchored in traditional practices.

4.4.1 System-level and regulatory conditions

At system level, a first group of barriers concerns regulatory rigidity and fragmented governance. Italy, the Czech Republic, Greece and Cyprus all report slow and complex accreditation procedures for new programmes and modules, often involving multiple national bodies and lengthy approval cycles that make rapid curricular adaptation difficult. In Greece, curriculum approval in both HEI and VET can take one to two years, limiting the responsiveness of providers to emerging AgriTech trends. In Romania and Cyprus, formal frameworks for microcredential recognition are still consolidating, with many short learning experiences operating on a project basis rather than within stable, nationally recognised structures.

At the same time, there are strong system-level enablers. All six countries have adopted national strategies that explicitly promote digital transformation and sustainability in both education and agriculture (e.g. SMART.Edu and the national digitalisation of agriculture strategy in Romania; the Digital Agriculture Strategy and Digital Welfare Programme in Hungary; Italy's PNRR and Agritech National Centre; Greece's Digital Transformation Bible and Digital Transformation of Agriculture plan; the Czech "Strategy 2030+" and CAP Strategic Plan; and Cyprus's National Digital Strategy and Digital Decade Roadmap). These frameworks provide explicit mandates and funding windows for integrating precision agriculture, data-driven decision-making and green skills into HEI and VET provision, creating a favourable policy context for AGRITECH.

In addition, several systems are advancing microcredential policies that can function as enablers for AGRITECH. Romania has already embedded "***micro-certificări***" in higher education law, with open-badge pilots and alignment to the national qualifications framework; the Czech Republic is developing a harmonised microcredential framework with verification systems; and Hungary links sectoral skills councils to qualification design in ways that can accommodate short, stackable learning units.

4.4.2 Institutional organisation and human capacity

Across all partner countries, institutional and human-resource constraints constitute a second major barrier cluster. A recurring finding is the limited number of staff who combine expertise in agronomy, data analytics, IoT/automation and sustainability with competence in modern digital pedagogy. Italy, Greece and Cyprus report that advanced AGRITECH teaching is often concentrated in a small number of motivated individuals or specialised labs, leaving many programmes reliant on traditional lecture-based approaches and analog practices. Hungary, the Czech Republic and Romania likewise highlight gaps in teaching capacity for advanced AgriTech topics and note that systematic staff-development pathways for digital agriculture are still emerging.

Fragmentation between HEIs, VET providers, research institutes and private training actors also acts as a barrier. In Greece, Cyprus and Romania, the analyses underscore weak coordination across institutional types, which results in duplicated efforts, inconsistent curricula and missed opportunities to share datasets, equipment and expertise. Similar, though less pronounced, coordination gaps are reported in the Czech Republic and Italy, particularly between mainstream HE/VET provision and non-formal or private AgriTech training.

Set against these barriers, institutional enablers are significant. All countries possess one or more strong universities or research institutes that function as de facto AGRITECH hubs: the network of Romanian agricultural universities with associated farms and laboratories; MATE and partner universities in Hungary with their training estates and drone laboratories; ČZU, MENDELU and associated centres in the Czech Republic; Agricultural University of Athens, Aristotle University of Thessaloniki and other Greek universities with dense laboratory networks; CUT and the Agricultural Research Institute in Cyprus; and multiple Italian universities and research bodies with advanced AgriTech infrastructure. These institutions already participate in European projects, host precision-agriculture or digital-farming programmes and can serve as anchor organisations for staff development, module co-delivery and shared resource generation within the AGRITECH ecosystem.

In VET, reforms in Hungary (VET 4.0, IKK coordination of 56 agricultural secondary schools), the Czech Republic (modernisation programmes for agricultural schools and training centres) and Romania (PNRR funding for at least 57 agricultural high schools) provide governance structures and investment platforms that can act as strong enablers when aligned with AGRITECH design.

4.4.3 Technological and infrastructural factors

The technological and infrastructural picture, detailed in Section 4.3, translates into a mixed set of barriers and enablers. Common barriers include:

- **Uneven access to modern equipment and software,** particularly in VET institutions and smaller or rural HEIs. Greece, Italy, Cyprus, Romania and the Czech Republic report that many schools and colleges still rely on conventional machinery and minimal digital tools, leaving most students with little or no hands-on experience of GNSS guidance, sensor networks, drones, farm-management systems or robotics.
- **Limited availability of remote and virtual laboratories**, which keeps practical teaching tied to specific sites and constrains scale, flexibility and inclusion of working learners. This issue is explicitly highlighted in Romania, Italy and the Czech Republic, and implicitly present in the other systems.
- **Rural - urban digital divides**, especially affecting agricultural VET and adult-training centres. Greece, Cyprus, Romania and Hungary emphasise deficiencies in rural connectivity and in local network infrastructure for workshops, farms and training centres, which complicate the use of data-intensive tools and blended learning formats.

Conversely, the analyses identify several strong infrastructural enablers. National research and education networks (e.g. RoEduNet in Romania), university-managed high-capacity links, and national broadband / 5G strategies (Cyprus, Greece, Italy, Hungary, Czech Republic) mean that baseline connectivity in higher education is largely sufficient for AGRITECH's digital platform and remote-access ambitions. In addition, existing AgriTech-relevant platforms and services - such as Hungary's Digital Agriculture Academy and AEDIH, Italy's Agritech and Smart AgriFood observatories, Romanian and Cypriot digital-advisory and farm-management tools, and EU-funded platforms like RELIEF and DG-VET - provide reusable components and datasets that can be integrated into the AGRITECH learning environment rather than built from scratch.

4.4.4 Socio-economic and cultural dynamics

Several barriers are socio-economic rather than purely technical. In Greece, Cyprus, Italy and Romania, agriculture is frequently perceived by young people as a low-status or low-prospect career compared with urban or "office-based" jobs, contributing to modest enrolment in agri-technology programmes relative to labour-market needs. The Czech VET analysis reports that a significant share of students choose agricultural pathways for pragmatic reasons (e.g. perceived accessibility or acquisition of driving licences) rather than a clear commitment to careers in a modernised agricultural sector. Low wages in agriculture, noted in Czech and Romanian sources, further dampen the attractiveness of the sector.

Low baseline digital skills among the general population and among farmers act as an additional cultural and capacity barrier, particularly in Romania and parts of Italy and Cyprus, where large numbers of potential learners require substantial scaffolding before they can confidently engage with advanced AgriTech tools. Surveys in Italy and the Czech Republic also reveal cultural resistance or hesitancy toward new technologies among some farmers and VET learners, especially when perceived as complex, risky or misaligned with existing practices.

At the same time, there are strong socio-economic enablers. All national reports highlight rising employer demand for precision-agriculture, digital advisory and sustainability skills, often backed by explicit incentives. In Hungary, for instance, CAP measures and national programmes award additional points to farmers possessing or committing to acquire digital-agriculture qualifications, while precision advisors are required to undertake regular professional training. Italy, the Czech Republic and Romania similarly document growing employer interest in graduates who can operate sensors, drones, data platforms and sustainability reporting tools. Youth-employment and young-farmer schemes across the partnership further reinforce the potential of AGRITECH microcredentials as recognised routes into subsidised start-up support and early-career opportunities.

4.4.5 Pedagogical and curricular practices

A final set of barriers relates to pedagogy and curriculum. Despite clear progress, the national analyses converge on the finding that many HEI and VET programmes remain content-heavy and theory-led, with limited use of project-based, interdisciplinary and data-intensive learning aligned with the AGRITECH competence framework. Italy, Hungary and the Czech Republic report that, although precision agriculture, GIS/remote sensing and basic digital topics are increasingly present, advanced themes such as AI, digital twins, blockchain, data governance and integrated sustainability metrics (e.g. LCA, ESG reporting) are rare or only superficially covered. Greece, Cyprus and Romania highlight that, particularly in VET, curricula often lag behind practice, with slow update cycles and limited incorporation of digital and entrepreneurial skills into mainstream qualifications.

Work-based learning and structured engagement with real datasets are also underdeveloped. While placements and practical exercises exist, assessment of workplace learning is inconsistent, and few programmes offer multi-week "end-to-end" data pipelines from sensor or UAV capture through analysis and decision-support to documented environmental and economic outcomes.

Conversely, there are emerging pedagogical enablers. Across the partnership, providers have begun experimenting with MOOCs, blended courses, micro-modules and challenge-based formats in AgriTech-related domains. Examples include EU-CONEXUS microcredentials with Greek participation; Hungarian and Italian online academies and short courses; Romanian and Cypriot continuing-education offers; and EU-funded platforms such as RELIEF and DG-VET designed specifically for Agriculture 4.0 and digital-green skills. These initiatives provide concrete prototypes for short, stackable, practice-oriented modules that AGRITECH can adapt, integrate and scale.

4.4.6 Synthesis and implications for AGRITECH design

Taken together, the barriers and enablers identified across the twelve national reports suggest that AGRITECH will operate in a context characterised by:

- strong **policy mandates** and **centres of excellence**, but uneven diffusion of technology, skills and innovative pedagogy;
- **regulatory and curricular inertia**, but also emerging frameworks for microcredentials and substantial investment windows in digital and green transitions;
- persistent **capacity gaps and cultural reservations**, alongside pronounced and growing labour-market demand for the precise competences that AGRITECH seeks to develop.

For the design of the AGRITECH learning ecosystem, these findings imply that success will depend not only on the intrinsic quality of the modules and digital platform, but also on deliberate strategies to:

- align with and use existing **policy and funding frameworks** as levers rather than constraints;

- mobilise leading HEIs, research institutes and VET centres as **national and regional hubs** for staff development, resource sharing and joint delivery;
- design curriculum, assessment and digital infrastructure that are robust enough for advanced contexts yet **scalable to low-resource settings** via shared datasets, remote labs and blended formats; and
- link microcredentials explicitly to **labour-market incentives** and youth-employment measures so that learners and employers perceive clear value in engagement.

Addressing the identified barriers while systematically exploiting the enablers will be central to ensuring that AGRITECH evolves from a project-based innovation into a sustainable, widely adopted learning ecosystem across the participating countries.

4.5 Design Implications Summary

The comparative needs assessment across the six participating countries and twelve national reports provides a coherent foundation for the design of the AGRITECH learning ecosystem. Despite national specificities, the analyses converge on a shared pattern: strong policy mandates for digitalisation and sustainability; a limited but growing set of institutional centres of excellence; uneven technological and pedagogical capacity across HEI and VET systems; and a labour market that increasingly demands integrated digital, green and entrepreneurial competences. These findings translate into a set of design imperatives that shape the architecture, delivery model and governance of AGRITECH.

4.5.1 Core design principles for the AGRITECH ecosystem

First, the ecosystem must be **competence-driven and role-anchored**. The AGRITECH Manager profile and associated competence framework require integration of digital agriculture, data analytics, sustainability and entrepreneurship, not as separate themes but as an applied, cross-disciplinary capability set. National reports consistently show that existing provision is fragmented along disciplinary lines, with digital, green and business skills often taught separately or superficially. AGRITECH therefore needs to prioritise modules and learning pathways that explicitly operationalise this integration in authentic agricultural contexts.

Second, the ecosystem must be **modular, stackable and recognisable**. All partner countries operate EQF-referenced qualification frameworks, and several are developing or refining national approaches to microcredentials (Romania, Czech Republic, Hungary, Italy), while others signal interest and emerging pilots (Greece, Cyprus). AGRITECH modules should therefore be designed from the outset as microcredentials with clear learning outcomes, credit values and assessment standards, enabling both stand-alone use for professionals and stacking into degree programmes in HEI and VET.

Third, the ecosystem must be **context-aware but cross-nationally portable**. The national analyses document distinct agrarian structures, climatic conditions, institutional configurations and regulatory environments, yet the underlying competence needs are remarkably similar. AGRITECH content and digital infrastructure should therefore separate a common “core” (e.g. data pipelines, generic precision-agriculture workflows, transversal innovation skills) from flexible contextual layers (e.g. country-specific CAP measures, local cropping systems, national advisory structures).

4.5.2 Curriculum architecture and learner pathways

The comparative analysis of user needs and institutional requirements implies a **multi-tier curriculum architecture**:

- **Foundational modules** that provide accessible entry points for learners with low or uneven digital skills, including many VET students and practitioners in Romania, Greece, Cyprus and parts of Italy, where both population-level digital indicators and stakeholder feedback emphasise the need for substantial scaffolding.
- **Intermediate, role-specific modules** aligned with typical profiles identified in the reports (e.g. digital agronomist, precision-agriculture technician, farm advisor, data-savvy farm manager), responding directly to documented labour-market demands in all partner countries.
- **Advanced and specialisation modules** that extend into AI, advanced analytics, robotics, digital twins, traceability and ESG-aligned sustainability assessment, addressing gaps repeatedly observed in HEI and VET offers, particularly in Italy, Czech Republic and Hungary.

This structure should support **vertical progression** (from VET to HEI and from basic to advanced levels) and **horizontal mobility** across domains (e.g. agronomy graduates acquiring data skills; ICT graduates entering AgriTech; advisors upskilling in climate-smart agriculture), with recognition of prior learning and microcredential stacking used to minimise duplication.

Furthermore, the strong presence of national and EU youth-employment and young-farmer schemes (e.g. Hungary, Italy, Romania, Greece) suggests that AGRITECH pathways should be explicitly **mapped to such incentives**, so that completion of specific microcredentials can be recognised as evidence of competence in funding applications or advisory accreditation.

4.5.3 Pedagogical model and assessment

The gap analyses converge on the diagnosis that much existing provision is **theory-heavy, equipment-dependent and weakly connected to real data and workplace practice**, especially in VET and in non-elite HEIs. In response, the AGRITECH ecosystem should institutionalise a distinct pedagogical model characterised by:

- **Project- and problem-based learning**, organised around multi-week challenges that use real or realistic datasets (e.g. yield maps, sensor streams, UAV imagery, FMIS exports) and require learners to pass through full decision cycles from data acquisition to agronomic or managerial recommendations.
- **Integrated work-based and field-based learning**, leveraging training farms, living labs and partner enterprises that already exist in all six countries (e.g. university farms in Romania and Hungary; demonstration farms and centres in the Czech Republic; smart greenhouse and competence centres in Greece; CUT and ARI infrastructure in Cyprus; VET farms in Italy and Hungary).
- **Formative and summative assessment frameworks** that explicitly evaluate the integrated competence profile (digital, agronomic, sustainability and innovation/entrepreneurship) rather than isolated knowledge fragments, in line with the AGRITECH Manager role.

To address staff-capacity constraints and uneven experience with digital pedagogy, the ecosystem will also need **embedded "train-the-trainer" mechanisms**, including reusable teaching packs, assessment rubrics and exemplar project briefs that can be adopted or adapted by instructors with varying levels of AgriTech expertise. This responds directly to the recurrent concern across all reports regarding limited human capacity for advanced digital agriculture teaching.

4.5.4 Digital infrastructure and resource strategy

The analysis of technological and infrastructural readiness highlights an asymmetric landscape: strong connectivity and advanced labs in leading HEIs and some VET centres, alongside pronounced equipment gaps and rural digital divides. AGRITECH's digital design must therefore:

- Use a **cloud-based platform** with low entry requirements, compatible with standard institutional LMS solutions and accessible over moderate bandwidth, while allowing integration of more demanding tools (e.g. high-resolution imagery, simulation services) where local infrastructure permits.
- Provide a **shared repository of datasets, case studies and virtual/remote labs**, enabling institutions without sophisticated hardware to deliver authentic, data-intensive learning experiences through remote access to partner facilities or curated open resources. This directly addresses barriers identified in Romania, Italy, the Czech Republic and Cyprus regarding limited access to equipment and datasets.
- Build on and, where possible, **integrate existing platforms and initiatives** (e.g. Digital Agriculture Academy and AEDIH in Hungary; RELIEF and DG-VET platforms; Italian and Cypriot digital-farming tools; Smart Agro Hub in Greece), avoiding duplication and instead positioning AGRITECH as an orchestrating layer.

Given uneven language competencies and the dominance of English in advanced AgriTech materials, multilingual interface and content strategies (including localisation of key modules and glossaries) will be essential to inclusion, as highlighted particularly in the Romanian and Cypriot analyses.

4.5.5 Partnership, governance and scalability

The system-level and institutional analyses show that **collaboration gaps and fragmented governance** are major obstacles to coherent AgriTech education, even in countries with strong individual institutions. At the same time, all countries exhibit active networks of universities, VET centres, research institutes, advisory bodies, DIHs and private providers. AGRITECH should therefore be designed as a **multi-actor, multi-level partnership framework**, with:

- **National and regional hubs** anchored in leading HEIs and VET centres (e.g. USAMV network, MATE, ČZU/MENDELU, AUA, CUT/ARI, key Italian universities and VET consortia), mandated to support surrounding institutions through staff development, shared delivery and resource pooling.
- **Formalised interfaces with policy and funding instruments**, aligning module portfolios and pilots with CAP Strategic Plans, digital-education strategies, recovery and resilience investments and youth-employment schemes, thereby embedding AGRITECH within existing implementation channels rather than operating as a parallel system.
- **Iterative, evidence-based scaling**, starting with pilot deployments in high-capacity hubs and progressively extending to lower-resource institutions and regions, with monitoring indicators that track not only participation but also changes in teaching practice, learner competences and labour-market outcomes.

In governance terms, the weight of accreditation and quality-assurance procedures, repeatedly noted as a barrier to agility, argues for a design in which AGRITECH maintains **robust internal QA and documentation** to facilitate national and international module-level accreditation processes and to ease local adoption.

4.5.6 Overall implications

In summary, the comparative needs assessment indicates that AGRITECH cannot be conceived merely as a catalogue of innovative modules or a standalone digital platform. It must function as a **structured, competence-based ecosystem** that:

- responds directly to clearly articulated user and labour-market needs across multiple stakeholder groups;
- leverages and connects existing institutional and technological assets while compensating for documented gaps;
- aligns with emerging microcredential and accreditation frameworks; and
- embeds distinctive pedagogical model centred on authentic, data-driven, sustainability-oriented learning.

Designing the AGRITECH ecosystem in this way will position it not only to address current deficits in digital and green skills, but also to act as a durable lever for systemic transformation in agricultural education across the participating countries.

5. LEARNING ECOSYSTEM DESIGN

The analyses conducted in previous chapters have shown that agricultural education and training across the six participating countries is confronted with a structurally similar set of challenges: persistent skills gaps in digital and data-driven agriculture, uneven integration of sustainability and entrepreneurship into curricula, fragmented provision across HEI, VET and non-formal sectors, and highly variable technological and infrastructural readiness. At the same time, all systems present strong enabling conditions, including national strategies for digital and green transition, established centres of excellence and living labs, and emerging microcredential initiatives. Within this context, the AGRITECH learning ecosystem is conceived not merely as a collection of innovative modules or digital tools, but as an integrated architecture that connects competences, curricula, delivery formats, institutions and recognition mechanisms into a coherent, scalable whole.

This chapter translates the **comparative needs and readiness assessment** into a concrete design for such an ecosystem. Building on the AGRITECH Manager competence framework (D1.2) and the cross-country findings summarised in Chapter 4, the proposed design adopts a **competence-driven, modular and microcredential-ready** approach. It specifies how advanced digital, sustainability-related and entrepreneurial competences will be operationalised into module clusters at different EQF levels; how these modules will be organised into flexible learner pathways for diverse target groups (students, young professionals, farmers, advisors, institutional staff); and how they will be supported by a shared digital platform, a network of physical and virtual learning environments, and a structured governance model.

The AGRITECH ecosystem is explicitly designed to function **across educational sectors and national borders**. On the one hand, it must be sufficiently robust and academically sound to be embedded into existing HEI and VET programmes, contributing to degrees and formal qualifications in agriculture and related disciplines. On the other hand, it must remain flexible enough to serve as a stand-alone offer for adult learners, professionals and farmers who require targeted upskilling and reskilling outside traditional programmes. To achieve this, the design is organised around three interlocking layers:

- a **core layer** of shared competences, module templates, datasets and assessment standards that are common across countries and institutions;
- a **contextual layer** that allows adaptation to national regulatory frameworks, agricultural systems, CAP implementations and language requirements; and
- an **implementation layer** that specifies delivery models, institutional roles and partnership arrangements at local and regional level.

The ecosystem must also respond directly to the **barriers and enablers** identified in Chapter 4. Regulatory rigidity and lengthy accreditation cycles require a design in which microcredentials and short learning units can be recognised incrementally, while still aligning with national qualification frameworks and quality-assurance procedures. Uneven technological readiness and rural - urban divides imply that high-end equipment should be treated as an asset, not a precondition: modules must be deliverable through a combination of remote labs, shared datasets, simulations and low-threshold digital tools, while still exploiting the full capacity of advanced hubs where these exist. Fragmentation between HEIs, VET providers, research institutes and private actors calls for a hub-and-spoke governance model in which leading institutions support the wider network through co-delivery, staff development and resource sharing.

At pedagogical level, the design is guided by the need to move beyond **theory-heavy and equipment-dependent provision** towards authentic, data-rich and practice-oriented learning. The AGRITECH ecosystem therefore embeds project-based learning, field and workplace experiences, and exposure to real datasets and decision-making contexts as non-negotiable design features rather than optional enhancements. This entails systematic use of training farms, living labs, advisory networks and industry partners as sites for learning, as well as the development of remote or virtual laboratories that can be accessed across institutions and countries. In parallel, the ecosystem incorporates explicit “train-the-trainer” components, recognising that staff capacity in digital agriculture and innovative pedagogy is a critical bottleneck across all partner systems.

Finally, the chapter positions the AGRITECH learning ecosystem as a **catalyst for systemic change**, rather than as a project-bound pilot. By articulating clear roles for universities, VET centres, research institutes, advisory services, digital-innovation hubs and employers, it aims to create durable structures for co-design, co-delivery and continuous updating of content in line with technological and policy developments. The ecosystem is designed to interface with existing funding and policy instruments (e.g. CAP Strategic Plans, national digital-education strategies, recovery and resilience plans), thereby increasing the likelihood that successful pilots can be mainstreamed and scaled..

5.1 Framework and Architecture Overview

The AGRITECH Learning Ecosystem is conceived as a socio-technical architecture that organises actors, processes and digital infrastructures into a coherent environment for competence development in digital and sustainable agriculture. It responds directly to the design implications identified in Chapter 4, which highlighted the need for integrated, modular, context-aware and recognisable learning arrangements across VET and HEI systems. The framework provides a common reference model that can be instantiated in diverse national and institutional contexts without sacrificing interoperability, quality or alignment with European recognition mechanisms.

At its core, the ecosystem is structured around four interdependent layers: **Engagement**, **Learning**, **Recognition** and **Operations**. Each layer groups functions and services that are conceptually distinct but practically intertwined. The Engagement layer organises how stakeholders enter and interact with the ecosystem; the Learning layer structures the provision of curricula, resources and pedagogical models; the Recognition layer ensures that learning outcomes are validated and made portable through micro-credentials and formal qualifications; and the Operations layer provides the governance, data, analytics and quality-assurance backbone that sustains the system over time.

This layered model is deliberately **competence-driven and role-anchored**, reflecting the AGRITECH Manager profile and associated competence framework described in Chapter 4. It translates the required integration of digital agriculture, data analytics, sustainability and entrepreneurship into a set of architectural commitments: each layer, and the interfaces between layers, is specified in terms of the competences it enables, the stakeholder roles it mobilises, and the evidence it generates for monitoring and improvement.

5.1.1 Architectural logic and design principles

The architecture operationalises the design principles formulated in Chapter 1: competence-based structure, modularity and flexibility, digital and interactive learning, integration of green and digital competences, collaboration and ecosystem logic, and continuous quality and adaptability. Concretely, this implies that:

- **Competence-based structure**: All components in the ecosystem (modules, learning paths, engagement formats, micro-credentials) are defined through explicit learning outcomes mapped to the AGRITECH competence framework and referenced to EQF/EHEA levels. This ensures that activities in different countries and institutions contribute to a common competence baseline.
- **Modularity and flexibility**: The architecture is organised as a set of loosely coupled services rather than a monolithic system. Engagement hubs, digital learning environments, work-based learning arrangements and assessment services can be combined into different configurations, allowing each partner to implement a minimum viable ecosystem and to scale toward more complex arrangements as capacity grows.
- **Digital and interactive learning by design**: The framework assumes that core learning processes will be mediated by digital platforms, remote or virtual labs, and scenario-based resources, complemented by place-based practice on farms, in laboratories and in living labs. The architecture therefore separates content, data and delivery channels so that interactive resources and datasets can be reused across platforms and countries.
- **Integration of green and digital competences**: Sustainability and digitalisation are not defined as separate layers but embedded across all four. Engagement processes explicitly connect learners to green transition agendas; learning components systematically combine digital tools with climate-smart practices; recognition instruments document both technical and sustainability competences; and operations functions track performance against both digital and green indicators.
- **Collaboration and ecosystem logic**: The architecture is explicitly multi-actor. VET providers, HEIs, advisory services, farms, agri-businesses, technology vendors and public authorities are treated as nodes in the ecosystem with defined roles, responsibilities and interfaces. Stakeholder engagement and co-creation are therefore structural features of the architecture rather than optional additions.
- **Quality and adaptability**: Feedback loops, analytics and change-control mechanisms are built into the Operations layer so that evidence from pilots and routine delivery can be used to adjust competences, curricula, digital tools and micro-credential designs over time.

5.1.2 The four ecosystem layers

a) Engagement layer

The Engagement layer structures how stakeholders discover, enter and interact within the ecosystem. It includes physical and virtual **Engagement Hubs** and **Communities of Practice** that bring together learners, educators, researchers, employers, advisory services and policymakers around AGRITECH themes. These hubs may take the form of regional centres, digital communities, thematic working groups or living labs, but all fulfil three core functions:

- articulating and updating demand for competences (through needs analyses, challenge briefs, innovation projects);
- brokering opportunities for work-based learning, mentoring and co-supervised projects;
- hosting communities of practice that sustain peer learning, exchange of resources and continuous professional development.

Section 5.2.1 specifies the services and governance models associated with these hubs, including minimum requirements for participation, inclusion and cross-border collaboration.

b) Learning layer

The Learning layer organises the actual provision of competence-development opportunities. It comprises:

- modular curricula and learning units aligned with the AGRITECH competence framework;
- digital learning platforms, tools and remote labs that deliver interactive, scenario-based learning experiences;
- work-based and practice-based learning arrangements connecting learners to farms, agri-businesses and research sites;
- support services such as tutoring, coaching and technical assistance.

In architectural terms, the Learning layer is the main consumer and producer of data within the ecosystem, generating learning analytics, assessment evidence and artefacts that are then used by the Recognition and Operations layers. Section 5.2.2 details the typology of learning platforms and tools, while Chapter 6 elaborates the underlying digital platform specification.

c) Recognition layer

The Recognition layer ensures that learning outcomes achieved within the ecosystem are **validated, documented and made portable** across institutions, countries and labour-market contexts. It connects AGRITECH modules to:

- micro-credentials and digital badges with explicit learning outcomes, workload and EQF/EHEA level references;
- national qualification frameworks and institutional credit systems (ECTS, ECVET or equivalent);
- recognition of prior learning and validation mechanisms in VET and HEI systems.

Although specific design rules for micro-credentials are developed in Section 5.7, the architectural role of the Recognition layer is broader: it acts as the interface between learning processes and formal systems of qualification, accreditation and labour-market signalling. It also provides the metadata and verification services (for example through European Digital Credentials for Learning) that allow AGRITECH achievements to be trusted across borders.

d) Operations layer

The Operations layer provides the **governance, infrastructural and data backbone** of the ecosystem. It includes:

- multi-level governance structures (project-level steering, institutional boards, national coordinators) that oversee strategy, compliance and resource allocation;
- quality-assurance processes aligned with internal project standards and external frameworks (EQF, ESG, national QA regimes);
- data management, interoperability and analytics services that collect, store and process usage, learning and outcome data across platforms and institutions;
- operational support functions such as user management, helpdesk, documentation, and capacity-building for staff.

Sections 5.2.3 and 5.2.4 translate these functions into concrete data, interoperability, analytics and governance components, while Chapters 6 and 7 specify the technical and procedural requirements for platform implementation and road-mapping.

5.1.3 Levels of instantiation and scalability

The framework is designed to be instantiated at three interrelated levels:

- **Ecosystem level (cross-country)**, where common design principles, competence frameworks, micro-credential templates and interoperability standards are defined. At this level, AGRITECH functions as a reference model and coordination mechanism, ensuring coherence and portability across partner countries.
- **National and regional level**, where policy frameworks, funding instruments and existing centres of excellence (for example national AgriTech hubs, agricultural universities, regional VET centres) are mobilised as anchor institutions. Chapter 4 has shown that countries differ significantly in infrastructural readiness and regulatory maturity; the architecture therefore allows each national consortium to select an appropriate combination of hubs, platforms and recognition routes, while maintaining alignment with the core model.
- **Institutional and local level**, where individual VET providers, HEIs and work-based learning sites configure their engagement formats, learning offers and internal governance arrangements within the common framework. Here, the architecture supports a **minimum viable ecosystem** configuration (for example one engagement hub, a shared digital platform instance, a limited set of pilot modules and micro-credentials, and basic analytics) that can be expanded into more complex structures as experience and resources grow.

Scalability is achieved not by imposing identical structures across all contexts, but by specifying **stable interfaces** between layers and levels: common competence descriptors, shared data models, interoperable credential formats and agreed quality criteria. As a result, new modules, institutions or countries can be added to the ecosystem without redesigning the architecture, provided that they adopt the agreed interfaces and principles.

5.1.4 Relationship with subsequent chapters

Chapter 5 as a whole operationalises this architectural framework. Section 5.2 unpacks the components and services within each layer; Section 5.3 maps stakeholder roles and interaction patterns onto the architecture; Section 5.4 translates the framework into concrete VET - HEI learning pathways; Sections 5.5 and 5.6 embed accessibility, inclusion and quality-assurance mechanisms; and Section 5.7 defines the micro-credential design rules that give the Recognition layer its concrete form. Chapter 6 then specifies the digital platform requirements needed to support the architecture, while Chapter 7 outlines the implementation roadmap and Chapter 8 addresses long-term sustainability and governance.

In this way, the Framework and Architecture Overview provides the structural bridge between the comparative needs assessment of Chapter 4 and the concrete ecosystem components, digital infrastructure and implementation plans developed in the remainder of the deliverable.

5.2 Components and Services

The AGRITECH Learning Ecosystem is operationalised through a set of components and services that materialise the four layers of the architecture introduced in Section 5.1: Engagement, Learning, Recognition and Operations. These components translate high-level design principles into concrete arrangements that institutions can deploy, adapt and scale in line with their respective capacities and regulatory environments. They provide the minimum configuration required to initiate pilots, while also outlining the extended configuration needed for consortium-wide adoption and long-term sustainability.

Rather than prescribing a single technology stack or organisational template, the ecosystem defines functional building blocks that can be implemented through different institutional forms and digital solutions. This is essential given the heterogeneous readiness patterns identified across partner countries, where advanced hubs with specialised infrastructure coexist with rural VET schools and smaller HEIs operating under significant resource constraints. The components and services described below are therefore specified in a way that distinguishes between core services, which are mandatory for any AGRITECH pilot site, and optional enhancements, which can be added progressively as institutional capacity and funding permit.

Section 5.2.1 focuses on engagement hubs and communities of practice that structure how stakeholders meet, co-design and deliver learning. Section 5.2.2 outlines the learning platforms and tools that support the delivery of modular, practice-oriented curricula. Section 5.2.3 specifies data, interoperability and analytics services that allow tools, institutions and recognition systems to work together. Section 5.2.4 addresses governance and operational support functions that keep the ecosystem coherent, compliant and improvable over time. Taken together, these components ensure that the AGRITECH Learning Ecosystem is not an abstract model but a concrete, service-based configuration that institutions can implement and maintain.

5.2.1 Engagement Hubs and Communities of Practice

Engagement hubs constitute the primary interface between the AGRITECH Learning Ecosystem and its external environment. They are conceived as hybrid (physical and virtual) structures that convene learners, teaching staff, employers, advisory services, technology providers and policymakers around shared agendas in digital and sustainable agriculture. These hubs respond directly to the identified needs for structured collaboration mechanisms, living-lab arrangements and systematic involvement of external stakeholders in programme design and delivery.

At regional or national level, engagement hubs are typically anchored in existing centres of excellence, such as agricultural universities, leading VET colleges or research and innovation institutes, which already host training farms, experimentation facilities or sectoral networks. Each hub provides a coordinated envelope for:

- **Co-designed challenge briefs and projects**, through which employers, advisory organisations and technology providers formulate authentic tasks (for example, implementation of a precision irrigation strategy, deployment of a sensor network, or development of a carbon-smart farm plan) that are integrated into AGRITECH modules and microcredentials.
- **Work-based and practice-based learning opportunities**, including placements, dual education arrangements, supervised mini-projects and field trials that are aligned with assessment requirements and clearly documented for recognition purposes.
- **Stakeholder consultations and policy dialogue**, enabling systematic feedback from sector actors and regulatory bodies on competence needs, curriculum relevance and recognition mechanisms.

These functions can be implemented through a combination of scheduled engagement events (workshops, advisory panels, joint curriculum design sessions) and ongoing collaboration channels (shared repositories, mailing lists, communication platforms).

Complementing the hubs, **communities of practice (CoP)** provide continuous, topic-specific collaboration spaces within and across countries. CoPs may form around competence clusters (for example, precision agriculture technicians, remote sensing and AI, sustainability and ESG reporting, agricultural entrepreneurship) and include both educators and practitioners. Their roles include: sharing

teaching materials and datasets; co-developing and peer-reviewing scenarios and assessment rubrics; exchanging implementation experiences; and mentoring less experienced staff or institutions.
In less resourced contexts, where physical infrastructure is limited, the engagement function can rely predominantly on virtual hubs, using consortium-level platforms and remote access to leading institutions. In such cases, a minimal configuration would include: at least one institutional anchor per country, a formally designated hub coordinator, an annual engagement plan with clear targets (number of briefs, placements, CoP meetings), and documented outputs feeding directly into curriculum and platform updates.

5.2.2 Learning Platforms and Tools

Learning platforms and tools operationalise the **Learning layer** of the ecosystem by providing the environments in which AGRITECH modules are delivered, practised and assessed. Their configuration is guided by the project's design principles of competence-based, modular, digitally enriched and practice-oriented learning, as well as by the strong stakeholder preference for project- and problem-based approaches supported by blended and online modalities.
A core learning configuration comprises the following elements:

- **Learning Management System (LMS)** providing enrolment, sequencing of modules, delivery of digital content, assignment submission and feedback. The LMS must support multilingual interfaces, blended and asynchronous learning, and basic tracking of learner progression required for microcredential issuance.
- **Digital content and scenario repository**, hosting structured learning materials (for example, Articulate-based objects, videos, datasets, readings, case descriptions) mapped to the AGRITECH competence framework and tagged with common metadata (EQF level, workload, language, accessibility attributes).
- **Project and collaboration spaces**, enabling group work, documentation of decisions and sharing of artefacts (for example, farm plans, analytics notebooks, policy briefs) associated with scenario-based and challenge-based assignments.
- **E-portfolio functionality**, allowing learners to curate evidence of competences across modules and contexts, including outputs from work-based learning, which can be linked to microcredentials and used in dialogue with employers and advisory bodies.

To bridge the persistent gap between theory-heavy provision and the need for authentic, data-driven practice, the learning configuration is complemented by **remote and virtual laboratories**. These may include remote desktops connected to farm management information systems (FMIS), simulated IoT sandboxes, UAV operation environments or geospatial analytics workspaces pre-loaded with representative datasets. Such labs enable learners in institutions without advanced local equipment to complete end-to-end workflows from data acquisition to decision support, in line with the ecosystem's pedagogical model.
Where feasible, physical **training farms, sensor kits and UAV packages** are integrated into the learning environment through structured protocols that connect field activities with digital analysis and reflection tasks. National reports indicate that such facilities already exist in several partner contexts (for example, university farms, agricultural high schools with modernised infrastructure, national research institutes), and can serve as shared resources within regional engagement hubs.
Given the uneven connectivity and digital literacy profiles observed across partner systems, all learning platforms and tools must adhere to **accessibility and inclusion requirements** defined in Chapter 5 and the platform specification in Chapter 6. These include mobile-friendly interfaces, low-bandwidth

content options, bilingual or multilingual support, and compatibility with assistive technologies, thereby ensuring that rural learners, adults and underrepresented groups can participate effectively.

5.2.3 Data, Interoperability, and Analytics

The AGRITECH Learning Ecosystem depends on a coherent **data and interoperability layer** that connects engagement hubs, learning platforms and recognition mechanisms into a functioning whole. This layer operationalises the **Recognition** and **Operations** dimensions of the architecture by ensuring that learning activities, assessment outcomes and microcredentials are machine-readable, portable and analysable across tools and institutions.

At its core, the ecosystem defines a **common data model** covering:

- learner identity and profile attributes consistent with privacy and data protection requirements;
- module, microcredential and programme descriptors aligned with EQF, ESCO and national qualification frameworks;
- competence statements derived from the AGRITECH framework;
- activity, assessment and attainment records, including links to artefacts stored in e-portfolios;
- credential metadata necessary for digital badge issuance and verification.

This model is implemented across platforms through interoperable standards such as SSO, LTI 1.3 and xAPI, which are further specified in Chapter 6. Interoperability services ensure that learners can move seamlessly between institutional platforms, that external tools (for example, simulation environments, FMIS instances, IoT sandboxes) can be integrated into courses, and that microcredential records can be exchanged with institutional student information systems and national registries as these become available.

On top of the data model, the ecosystem deploys a **learning analytics service** that aggregates and visualises key indicators across pilots and partner institutions. At minimum, this service must support:

- monitoring of access, participation and completion patterns, with disaggregation by stakeholder group and equity variables;
- tracking of engagement with practice-oriented tasks (for example, use of remote labs, completion of end-to-end data projects);
- quality indicators such as assessment consistency, moderation coverage and feedback timeliness;
- recognition metrics, including the volume and portability of microcredentials issued and accepted across institutions.

These analytics functions respond to the explicit needs of institutional leaders, employers and policymakers for robust evidence on the effects of AGRITECH interventions and support continuous improvement of curricula, engagement practices and platform configuration.

Given the variability in national infrastructures and regulatory conditions, the analytics service is designed to be federated: partner institutions retain control over their local data stores, while contributing selected, anonymised indicators to consortium-level dashboards. This arrangement both respects data protection obligations and facilitates cross-country comparison and policy learning.

5.2.4 Governance and Operations

Governance and operations components ensure that the AGRITECH Learning Ecosystem remains coherent, compliant and sustainable as it moves from design to pilot and scale-up phases. They provide the organisational backbone required to coordinate multi-actor collaboration, manage change and align ecosystem activities with institutional and national strategies.

At consortium level, governance is structured around:

- a **Learning Ecosystem Steering Committee**, responsible for strategic decisions on architecture evolution, recognition agreements, pilot portfolio and quality thresholds;
- thematic **working groups** corresponding to the four layers of the architecture (Engagement, Learning, Recognition, Operations), each tasked with maintaining component specifications, resolving implementation issues and proposing updates;
- an **evidence and QA lead function**, ensuring traceability between evidence, design decisions and revisions, in line with the QA and validation procedures set out in Chapter 2.

At institutional level, each participating HEI or VET provider designates a **local ecosystem coordination unit** that may build on existing structures such as teaching and learning centres, microcredential offices or international relations units. Its responsibilities include; contextualising AGRITECH modules within local programmes; managing learner recruitment and support; liaising with engagement hubs and external partners; and ensuring compliance with institutional QA and accreditation procedures. In systems where microcredentials have already acquired a formal legal status, this unit also manages alignment with national qualification registers and external accreditation bodies.

Operational support services cut across all layers and include:

- **Onboarding and helpdesk services** for learners and staff, addressing platform use, access issues and basic troubleshooting, with particular attention to users with low digital literacy.
- **Capacity-building and CPD programmes** for teaching and training staff, focusing on digital pedagogy, scenario-based assessment, data governance and the use of AGRITECH-relevant tools, in response to the documented demand for structured upskilling opportunities.
- **Change management processes**, incorporating feedback loops from pilots, stakeholder consultations and analytics into systematic updates of curricula, platform configurations and governance arrangements.
- **Risk management and compliance monitoring**, ensuring that issues related to data protection, ethical use of learner data, platform reliability and equity of access are identified and addressed, in consistency with the implementation roadmap described in Chapter 7.

By explicitly defining these governance and operations components as part of the ecosystem, AGRITECH reduces the transaction costs associated with innovation in individual institutions and creates a shared reference model that can be progressively embedded into national systems. This, in turn, increases the likelihood that the ecosystem will outlive the project lifecycle and contribute to lasting transformation in agricultural education across the participating countries.

5.3 Roles and Interactions of Stakeholders

The **AGRITECH Learning Ecosystem** is conceived as a multi-actor environment in which no single stakeholder group can, on its own, guarantee relevance, quality or sustainability. Instead, value is created through structured and recurrent interactions between learners and professionals, VET and HEI providers, employers and advisory services, technology vendors, research bodies, and public authorities, supported by specialised services for accessibility, inclusion and quality assurance. Building on the stakeholder mapping presented in Chapter 2 and the comparative needs identified in Chapter 4, this section clarifies how these actors share responsibilities and collaborate across the four ecosystem layers (Engagement, Learning, Recognition, Operations).

The description that follows does not duplicate the stakeholder register, but specifies how each group contributes to the design, delivery and continuous improvement of AGRITECH pathways, and how interaction patterns are embedded "by design" into the ecosystem architecture rather than left to ad-hoc arrangements.

5.3.1 Core Stakeholder Groups and Role Profiles

Learners and professionals

Learners in VET, HEI and continuing education, including farmers, advisors, SME staff and early-career professionals, are the primary beneficiaries and ultimate validators of the ecosystem. Their roles extend beyond participation in courses to include: articulating needs and constraints during consultation phases; contributing to the co-design of scenarios and use cases; providing usability and satisfaction feedback during pilots; and supplying evidence of impact on practice (e.g. adoption of digital tools, changes in farm management decisions).

VET providers

VET schools, colleges and adult training centres act as first-line implementers of practice-oriented AGRITECH modules. They are responsible for integrating ecosystem components into existing programmes, coordinating work-based learning with local employers, hosting engagement hubs, and supporting initial micro-credential pilots at EQF levels 3 - 5. VET institutions also contribute systematically to the refinement of competence descriptions and assessment rubrics, drawing on their proximity to regional labour markets and to learners with diverse entry profiles.

HEI providers

Universities and applied science institutions provide advanced expertise in digital agriculture, data analytics, sustainability assessment and innovation management. Within the ecosystem they act as anchors for: higher-level competences (EQF 6 - 7), curriculum integration and recognition of AGRITECH modules into degree programmes; design and validation of assessment strategies, especially for capstone tasks; research-driven updating of content; and the issuance of micro-credentials that can be stacked towards formal qualifications.

Employers, advisory services and technology providers

Enterprises in the agri-food value chain, farm advisory organisations (AKIS actors) and AgriTech companies constitute the core "practice partners" of the ecosystem. They define authentic tasks and challenge briefs grounded in real operational needs; contribute data, case material and access to equipment; host placements and dual-learning arrangements; co-deliver selected learning activities; and endorse micro-credentials as meaningful signals in recruitment and staff development. Their involvement ensures that AGRITECH modules remain tightly coupled to evolving job profiles and regulatory contexts, including CAP eco-schemes and sustainability reporting obligations.

Research and innovation bodies

Research institutes and laboratories active in digital agriculture, sustainability and educational technology provide the innovation "pipeline" of the ecosystem. Their role is to scan emerging technologies and methods, curate tools and datasets suitable for teaching, evaluate pedagogical effectiveness of new formats (e.g. remote labs, AI-assisted tutoring), and document impact through targeted studies. They support experimentation while helping to maintain scientific and methodological rigour.

Public authorities and intermediary organisations

Line ministries, qualification and accreditation agencies, chambers of agriculture and commerce, professional associations, and regional clusters act as system-level enablers. They align AGRITECH developments with national qualification frameworks, quality assurance regulations and funding instruments; provide guidance on the formal recognition of micro-credentials and work-based learning; and support dissemination and scale-up through policy briefs, strategic partnerships and incentive schemes.

Support and transversal services

Specialised units or partners in accessibility, inclusion, digital pedagogy, data protection and quality assurance operate transversally across the ecosystem. They ensure that content and platforms comply with accessibility standards; that engagement processes and data handling respect ethical and legal requirements; and that continuous improvement cycles are based on reliable evidence and structured QA protocols.

5.3.2 Interaction Patterns Across Ecosystem Layers

The four-layer architecture presented in Sections 5.1 and 5.2 is explicitly designed to organise these stakeholder roles into coherent interaction patterns.

Engagement layer

At the Engagement layer, stakeholders interact primarily through multi-actor hubs and communities of practice. Learners, educators, employers and advisors participate in thematic groups (e.g. Precision Agriculture, Sustainable Practices, AI and Data, Remote Sensing) that:

- identify priority competences and scenarios at regional or sectoral level;
- formulate challenge briefs linked to real farm and agri-business contexts;
- maintain shared calendars of co-delivery events, workshops and demonstration activities; and
- broker partnerships for placements, field trials and joint projects.

These interactions are structured through regular working groups, advisory sessions and co-design labs with predefined cadences for design, pilot and scale-up phases.

Learning layer

Within the Learning layer, VET and HEI providers orchestrate formal and non-formal learning activities using the common digital platforms and resources defined in Section 5.2. Learners engage with scenarios and datasets supplied by employers and research partners; instructors from VET, HEI and industry co-facilitate project-based and problem-based sessions; and advisory services contribute their field experience to connect classroom learning with advisory workflows and farm decision-making.

This layer relies on continuous interaction between pedagogy and technology: educators adapt learning designs based on analytics and learner feedback; technology providers refine tools based on classroom and field use; and support services monitor accessibility and inclusion, triggering adjustments where necessary.

Recognition layer

At the Recognition layer, HEIs, VET institutions and qualification bodies collaborate to translate learning outcomes into formally recognised micro-credentials and credit-bearing units. HEI and VET curriculum committees negotiate mapping of AGRITECH modules to national frameworks and to institutional programmes; employers and advisory bodies validate that assessment rubrics and performance standards reflect workplace expectations; and public authorities provide guidance on portability across borders and systems.

Interactions here are mediated by shared templates for learning outcomes, workload and assessment descriptions, as well as by recognition notes documenting bilateral or multilateral agreements between institutions, as specified in the stakeholder engagement plan.

Operations layer

In the Operations layer, governance, data and quality assurance processes align stakeholder actions with the overall ecosystem logic. A core governance group (involving project leads, institutional coordinators and policy representatives) defines standards for platform configuration, data flows, analytics, and change control. VET and HEI IT teams, platform providers and QA specialists collaborate to implement interoperability standards (e.g. SSO, LTI, xAPI), protect personal data, and generate dashboards for monitoring participation and outcomes.

This layer ensures that interactions in the Engagement, Learning and Recognition layers are technically feasible, traceable and auditable, and that adjustments triggered by evidence or policy changes can be propagated consistently across the ecosystem.

5.3.3 Governance and Decision-Making

To prevent stakeholder collaboration from remaining purely consultative, the AGRITECH ecosystem embeds clear responsibilities and decision pathways. A living stakeholder register and a RACI (Responsible, Accountable, Consulted, Informed) model are used to clarify who can decide on, or must be consulted about, changes affecting competence frameworks, curricula, platform configurations and credentialing rules.

At operational level, decision-making is distributed across:

- **Design governance**, where multi-actor working groups propose and iteratively refine competences, learning outcomes and assessment strategies, subject to validation by institutional and policy stakeholders;
- **Pilot governance**, where sprint-style reviews involving educators, learners and employers assess feasibility, workload, user experience and impact, leading to documented change requests; and
- **Recognition governance**, where HEI/VET committees and qualification authorities formalise micro-credential structures, credit mappings and recognition agreements.

This governance model maintains a balance between inclusiveness (broad consultation and co-creation) and manageability (clear accountability and controlled change). It also ensures that decisions at one level (e.g. curriculum changes) are coherent with constraints and opportunities at others (e.g. platform capabilities, regulatory requirements, employer expectations).

5.3.4 Feedback, Learning and Continuous Improvement

Stakeholder interactions are designed not as one-off events, but as iterative feedback loops that support continuous improvement of the ecosystem. Evidence from the stakeholder survey and national analyses is translated into design requirements; pilot feedback from learners, instructors and employers is captured through analytics, debriefs and structured questionnaires; and QA processes synthesise this information into concrete updates of competences, learning materials, platform configurations and recognition rules.

Key mechanisms include:

- **Evidence-to-design traceability**, which links specific stakeholder inputs to corresponding design decisions, making it possible to justify and audit changes over time;
- **Regular validation cycles**, combining internal partner review with external expert and policy feedback to test the acceptability and transferability of proposed evolutions; and

- **Scheduled refresh points**, aligned with implementation phases, during which accumulated evidence is reviewed and used to update baseline competence statements, curricula and credentialing workflows.

Through these interconnected roles and interaction patterns, the AGRITECH Learning Ecosystem functions as a living system rather than a static framework. Stakeholders become co-owners of the architecture, jointly responsible for its relevance, quality and resilience as digital and sustainable agriculture continue to evolve across the participating countries.

5.4 Learning Pathways (VET and HEI Integration)

The **AGRITECH Learning Ecosystem** is designed to make progression between vocational education and training (VET), higher education institutions (HEIs) and continuous professional development both systematic and transparent. Learners across EQF levels 4 - 7 have clearly expressed the need for pathways that combine robust disciplinary foundations with applied digital and sustainability competences, delivered through flexible, modular formats and leading to recognisable qualifications and micro-credentials. At the same time, the comparative analysis of national reports underlines that AGRITECH provision must respond to heterogeneous institutional capacities, "islands of excellence" in both HEI and VET, and diverse regulatory environments for modular learning and micro-credentials.

In this context, learning pathways are not conceived as linear sequences confined within a single subsystem, but as interoperable trajectories across VET and HEI that support vertical progression (from **EQF 4 - 5** to **EQF 6 - 7**), horizontal mobility between specialisations, and recurrent upskilling and reskilling for professionals. Pathways are built from modular AGRITECH units designed as micro-credentials by default, with clearly defined learning outcomes, workload (ECTS / notional hours), EQF/EHEA level referencing and assessment standards, and are underpinned by recognition rules agreed among participating institutions and aligned with national frameworks.

To operationalise this approach, the AGRITECH ecosystem distinguishes four interrelated pathway types: (i) initial **VET-to-HEI** progression, (ii) **HEI-to-VET**/practice-oriented deepening, (iii) continuous professional development and specialisation, and (iv) cross-disciplinary entry into AgriTech from adjacent fields. Each pathway type is mapped to specific competence clusters within the AGRITECH framework and supported by common services in the Engagement, Learning, Recognition and Operations layers defined earlier in this chapter.

5.4.1 Objectives and design logic of integrated pathways

The design of integrated VET - HEI pathways serves four main objectives:

1. **Ensure permeability between subsystems.** AGRITECH pathways are intended to make transitions between VET and HEI routine rather than exceptional. This is achieved by using shared competence descriptors, common workload conventions (ECTS / notional hours) and explicit articulation agreements that define how micro-credentials and modules completed in one subsystem are recognised in another.
2. **Support cumulative competence development.** Pathways are structured so that learners can progress from basic operational skills (e.g. GNSS use, UAV data capture, FMIS operation) to more advanced analytical, managerial and innovation competences associated with the AGRITECH Manager profile, without unnecessary duplication of content.

3. **Embed work-based and authentic learning throughout.** Pathways systematically integrate work-based learning, challenge-based assignments and the use of real datasets and platforms, reflecting stakeholder preferences for project and problem-based learning and the need to link training to real agrifood use cases.
4. **Align with policy and incentive structures.** Pathways are mapped, where feasible, to national and EU instruments such as CAP eco-schemes, young farmer and youth employment measures, digitalisation and green transition strategies, so that completion of specific stacks of AGRITECH micro-credentials can be used as evidence of competence in funding applications, advisory accreditation or professional registration.

The logic of pathway design follows directly from the evidence base summarised in Chapter 4: learners require visible progression routes and recognised outcomes; institutions need templates and governance models that reduce the transaction costs of recognition; and employers call for role-anchored, practice-oriented profiles that can be coherently developed across VET and HEI.

5.4.2 Pathway types and learner trajectories

The AGRITECH ecosystem defines four archetypal learning pathways, which can be adapted and instantiated in different national contexts. These archetypes provide a common design template rather than rigid sequences; they can be combined, shortened or extended depending on learner profile, institutional capacity and regulatory framework.

a) VET-to-HEI progression pathways (EQF 4 - 5 to EQF 6 - 7)

This pathway targets learners who begin in upper-secondary or post-secondary VET programmes (EQF 4 - 5) and wish to progress to bachelor-level or equivalent studies in AGRITECH-related fields (EQF 6 - 7). National reports highlight both the demand for such progression and the obstacles created by fragmented curricula and weak recognition of non-formal learning and micro-credentials.

Within AGRITECH, VET-to-HEI pathways are structured as follows:

- **Foundation modules (VET context, EQF 4 - 5):** Learners complete micro-credentials focused on basic digital agriculture operations (e.g. “Introduction to GNSS-enabled machinery”, “Digital farm administration”, “Basics of remote sensing for crop monitoring”), aligned with national VET standards and delivered primarily through VET providers and regional hubs.
- **Bridging micro-credentials (joint VET - HEI context, EQF 5 - 6):** Selected units address gaps typically identified at the VET - HEI interface, such as applied statistics, data management, systems thinking and academic communication. These are co-designed and co-delivered by HEIs and advanced VET centres, using blended formats and shared digital resources (remote labs, datasets, simulations).
- **Articulated entry into HEI programmes (EQF 6 - 7):** HEIs formally recognise specified stacks of VET and bridging micro-credentials as partial fulfilment of admission or study requirements (e.g. exemption from introductory modules, advanced standing in specific course sequences). In systems such as Romania, this is facilitated by Higher Education Law 199/2023 and emerging micro-credential governance models; in others, it can be anchored in institutional regulations and Erasmus+ mobility templates pending national framework development.

This pathway is particularly relevant where VET reforms (e.g. Hungary’s VET 4.0, modernisation of agricultural schools in Romania and the Czech Republic) are already creating governance structures and investment platforms that can support joint design and delivery.

b) HEI-to-VET/practice-oriented deepening pathways

The second pathway archetype addresses HEI students and graduates who possess strong theoretical or analytical competences but require more operational proficiency with equipment, farm management systems and advisory practices. National analyses repeatedly underline that many HEI programmes remain theory-heavy and provide limited exposure to real equipment, data pipelines and farm operations.

In this pathway:

- HEI learners enrol in short, practice-intensive AGRITECH micro-credentials delivered in collaboration with VET centres, training farms, demonstration sites and advisory services.
- Modules focus on “learning by doing” in authentic environments: execution of UAV missions, configuration of sensor networks, operation of FMIS, implementation of CAP eco-scheme compliance workflows, measurement of environmental and economic KPIs.
- Credits obtained through these micro-credentials are recognised within HEI degree structures (e.g. as electives or practice modules), thereby enhancing employability while maintaining academic coherence.

This pathway exploits the complementary strengths of HEIs (analytical depth, research infrastructure) and VET institutions (operational practice, work-based learning traditions), and provides a mechanism to use the “islands of excellence” in VET as shared practice hubs for HEI cohorts.

c) Continuous professional development and specialisation pathways

A third pathway type is aimed at farmers, advisors, SME staff and other professionals who require targeted upskilling in AGRITECH domains without enrolling in full programmes. Across all partner countries, demand for short, stackable micro-credentials and continuing education offers is high, especially among working adults and rural learners.

In this pathway:

- Professionals select micro-credentials aligned with their roles (e.g. “Precision agriculture advisor”, “Digital farm manager”, “Sustainable livestock data management”), combining units offered by both HEIs and VET providers.
- Learning is delivered primarily online or in blended formats, with strong reliance on remote labs, datasets and scenario-based activities to accommodate time and geographical constraints.
- Stacks of micro-credentials can be mapped to partial qualifications, advisory accreditation schemes or eligibility requirements for CAP and young farmer measures, subject to national regulations.

This pathway is crucial for diffusing AGRITECH competences beyond initial education and for leveraging national digital transformation and sustainability strategies as enablers of lifelong learning.

d) Cross-disciplinary entry into AgriTech

Finally, the ecosystem supports learners entering from adjacent domains (e.g. ICT, environmental sciences, business) who wish to specialise in agricultural technology. National reports point to growing interest from such profiles, particularly in AI, data analytics, robotics and sustainability assessment applied to agri-food systems.

For these learners:

- Tailored “on-ramp” micro-credentials introduce core agronomic concepts, agricultural systems and policy frameworks, while simultaneously connecting to their existing disciplinary expertise (e.g. “Data pipelines in precision agriculture” for ICT graduates, “ESG metrics in agri-food chains” for business or environmental graduates).

- Subsequent modules integrate them into the same advanced AGRITECH pathways as other learners, ensuring convergence toward the AGRITECH Manager competence profile.

5.4.3 Mechanisms for recognition, credit transfer and progression

To make the above pathways operational, the AGRITECH ecosystem embeds a set of common mechanisms in the Recognition and Operations layers:

1. **Common metadata model for all modules and micro-credentials.** Each learning unit is described using a shared schema that includes: learning outcomes mapped to the AGRITECH competence framework; EQF/EHEA level; workload (ECTS / hours); assessment methods; prerequisite competences; and tags for domain, technology and sustainability focus. This enables transparent mapping across VET and HEI curricula and supports automatic pathway construction in the digital platform.
2. **Articulation agreements and country annexes.** For each participating country, a concise annex specifies how AGRITECH micro-credentials articulate with national qualification frameworks, VET standards and HEI regulations (e.g. maximum share of external credits, rules for recognising non-formal learning, links to NSK in the Czech Republic or micro-credential provisions in Romanian HE law).
3. **Recognition of prior learning (RPL).** The ecosystem incorporates RPL procedures that allow experienced professionals and graduates of existing programmes to have their competences validated against AGRITECH modules, using portfolios, workplace evidence and challenge assessments. This reduces duplication, shortens pathways and increases attractiveness for adult learners.
4. **Stacking rules and progression thresholds.** Clear rules define how micro-credentials stack into larger awards (e.g. certificates, diplomas, specialisation tracks) and what combinations are required to evidence specific roles (e.g. “AGRITECH field technician”, “digital agronomist”, “AGRITECH Manager”). These rules are aligned with emerging national and European guidance on micro-credential volumes, levels and QA requirements.
5. **Advisory and guidance services.** Within the Engagement layer, AGRITECH hubs provide structured guidance to learners and institutions on pathway options, including digital “pathway planners” embedded in the platform and human advisory support through career services, VET coordinators and academic tutors.
6. **Analytics-supported progression monitoring.** The Operations layer uses learning analytics to track learner movement across modules, providers and subsystems, enabling early identification of drop-off points, under-used pathways and equity gaps (e.g. rural learners, women, low-income groups). This information feeds back into pathway design and policy reporting.

5.4.4 Implementation considerations and national adaptation

Given the diversity of regulatory, infrastructural and institutional conditions across the six partner countries, pathway implementation will proceed in a staged and context-sensitive manner. Comparative analyses show that while all systems have strong policy mandates and centres of excellence, they differ significantly in micro-credential regulation, accreditation procedures, VET reform trajectories and digital readiness.

Key implications for implementation include:

- **Leveraging national and regional hubs.** Leading HEIs and VET centres (e.g. USAMV network, MATE, ČZU/MENDELU, AUA, CUT/ARI and key Italian universities and consortia) will act as pathway anchors, piloting VET - HEI articulation, hosting shared remote labs and providing staff development for surrounding institutions.
- **Aligning with ongoing VET reforms and investments.** In Hungary, the Czech Republic and Romania, AGRITECH pathways will be embedded within VET 4.0 strategies, modernisation programmes and PNRR investments in agricultural schools, using these frameworks to scale successful pilots.
- **Using HEI micro-credential frameworks as initial carriers.** Where VET-specific micro-credential instruments are not yet formally recognised (e.g. Romania, Cyprus, Greece), early AGRITECH micro-credentials can be issued via partner HEIs and opened to VET learners, with articulation into VET qualifications negotiated through national qualifications authorities.
- **Ensuring inclusion and territorial balance.** Pathway pilots will deliberately include lower-resource institutions and rural regions, using cloud-hosted platforms, remote/virtual labs, portable instrumentation and blended formats to avoid reinforcing existing "islands of excellence" and territorial disparities.

Through these mechanisms, Section 5.4 provides the operational bridge between the AGRITECH competence framework, the layered ecosystem architecture and national education and training systems. Integrated VET - HEI pathways become the primary vehicle through which learners can accumulate, combine and deploy AGRITECH competences over time, while institutions and employers gain a coherent, evidence-based structure for collaboration, recognition and workforce development.

5.5 Accessibility and Inclusion by Design

Accessibility and inclusion are not treated in AGRITECH as optional enhancements, but as structural design requirements for the Learning Ecosystem. Across the six partner countries, the national analyses highlight recurring barriers related to rural connectivity, uneven digital skills, language limitations, gender imbalances and the absence of systematically inclusive practices in agricultural education. Learners in rural and remote areas often face lower quality internet access and limited exposure to digital tools; VET and HEI programmes remain predominantly monolingual; and underrepresented groups, including women, migrants and learners with disabilities, are rarely targeted explicitly in programme design. The AGRITECH Learning Ecosystem therefore embeds accessibility and inclusion by design across its engagement, learning, recognition and operational layers, in order to reduce structural barriers and widen participation in digital and sustainable agriculture.

5.5.1 Conceptual framing and scope

In this deliverable, accessibility is understood in a broad, systemic sense. It covers compliance with recognised accessibility standards for digital platforms and learning materials, the availability of low-bandwidth and offline alternatives, and the removal of practical obstacles that prevent learners from participating in training (such as incompatible schedules, rigid attendance requirements or lack of equipment). Inclusion extends beyond formal non-discrimination to the proactive design of learning opportunities that acknowledge different starting points, languages, socioeconomic backgrounds, gendered patterns of participation and disability-related needs.

This framing is consistent with the methodological choices described in Chapter 2, where inclusive stakeholder engagement required accessible formats, multilingual materials and low-bandwidth options for consultations and surveys. It also follows the evidence consolidated in Chapter 4, which indicates that baseline digital skills are uneven, particularly among VET learners and adults in rural areas, and that language and cost barriers compound existing inequalities in access to advanced AgriTech learning. By treating accessibility and inclusion as cross-cutting design constraints, the ecosystem aims to avoid reproducing these disparities in its own operation.

5.5.2 Cross-country accessibility and inclusion challenges

The national VET and HEI reports converge on several structural challenges that inform the design of this section:

- **Digital divide and infrastructure gaps.** Rural learners in several partner countries face lower connectivity and less reliable access to devices, which restricts participation in data-intensive or synchronous online activities.
- **Language and cultural barriers.** Many existing resources are available only in the national language or English, with limited multilingual support. Technical materials for advanced topics (AI, remote sensing, robotics) are often accessible only in English, which limits uptake among VET learners and adult farmers with lower language proficiency.
- **Digital literacy and user experience.** Platforms and tools frequently assume a level of digital confidence that is not yet universal, especially among older workers, returning adults and some VET cohorts. Learners report difficulties in navigating LMS interfaces and using administrative portals, even before engaging with specialised AgriTech platforms.
- **Socioeconomic and territorial inequality.** Equipment costs, travel requirements and time constraints disproportionately affect learners from low-income or remote communities. National reports highlight cases where modern equipment and demonstration facilities are concentrated in a few high-capacity institutions, while many agricultural schools operate with outdated infrastructure.
- **Gender and diversity gaps.** Despite policy attention to gender equality and inclusion, women remain under-represented in some technology-intensive agricultural domains, while data on learners with disabilities and minority groups are often missing or fragmented.

These patterns confirm that accessibility and inclusion need to be operationalised as concrete design decisions in the ecosystem, rather than addressed through generic statements or ad-hoc support.

5.5.3 Design principles for an inclusive ecosystem

In response to these challenges, AGRITECH adopts a set of accessibility and inclusion principles that apply across all layers and components of the Learning Ecosystem:

1. **Universal design and standards compliance.** All digital touchpoints (LMS, content library, e-portfolio, analytics dashboards and supporting websites) are configured to meet at least WCAG 2.2 AA accessibility standards, including keyboard navigation, alternative text, captions and transcripts for multimedia, sufficient colour contrast and screen-reader compatibility. Learning materials are designed following universal design for learning (UDL) principles, offering multiple means of representation, engagement and assessment.
2. **Low-bandwidth and offline-capable provision.** Core learning units, guidance documents and assessment tasks are made available in formats that can be accessed under constrained connectivity (compressed files, static HTML versions, downloadable datasets, printable

worksheets). Where remote or virtual labs are used, a "tiered" model distinguishes between high-fidelity experiences for well-connected hubs and lower-bandwidth simulations or recorded walkthroughs for constrained contexts.

3. **Multilingual and plain-language communication.** Key ecosystem artefacts (competence descriptors, module briefs, microcredential specifications, learner guidance) are provided at minimum in English and the partner languages, using consistent terminology and glossaries. Where full translation is not feasible, executive summaries, learning outcomes and assessment criteria are localised to support understanding and recognition at national level.
4. **Progressive scaffolding of digital skills.** The ecosystem incorporates "on-ramp" modules that build basic digital and data literacy before introducing specialised AgriTech tools. These include orientation to LMS use, safe device practices, navigation of national agricultural portals and simple data manipulation tasks. The design of higher-level modules assumes successful completion of these foundational elements and provides alternative pathways for learners with heterogeneous starting points.
5. **Targeted support for underrepresented groups.** Engagement hubs and learning pathways are configured to explicitly reach women, rural youth, migrants and other groups that are currently under-represented in AgriTech programmes. Measures include outreach in collaboration with local schools and NGOs, role-model visibility (e.g. female AgriTech professionals as mentors), flexible scheduling for working adults and, where feasible, financial or in-kind support (loan equipment, travel cost coverage) linked to pilots.
6. **Accessibility as a quality criterion.** Accessibility and inclusion are integrated into the quality assurance logic of the ecosystem, including design reviews, acceptance criteria for digital tools and continuous monitoring in pilots (e.g. participation patterns, completion rates, feedback stratified by group). This links directly to the quality assurance mechanisms specified in Section 5.6 and the monitoring framework in Chapter 7.

5.5.4 Operationalisation across ecosystem layers

To ensure that these principles translate into practice, accessibility and inclusion requirements are embedded in each of the four layers of the AGRITECH Learning Ecosystem described in Section 5.1.

- **Engagement layer.** Communities of practice, challenge calls and stakeholder consultations are organised in formats that accommodate different time zones, work schedules and connectivity profiles. This includes combining in-person meetings with asynchronous online forums, providing pre-reading and recordings, and offering low-bandwidth participation options. Information about opportunities, calls and events is disseminated in multiple languages and channels (institutional websites, social media, local intermediaries) to reach learners beyond the usual institutional audiences.
- **Learning layer.** Within the LMS and content library, inclusive design patterns are applied consistently: templates for course pages include mandatory accessibility checks; all multimedia items carry captions and transcripts; and assessments are designed to allow a degree of choice in modality (written report, oral presentation, annotated dataset, etc.) while still aligning with common rubrics. Remote and virtual labs are sequenced so that learners with weaker digital infrastructure can still achieve learning outcomes through alternative activities (e.g. working with pre-collected datasets instead of live sensor feeds).
- **Recognition layer.** Microcredentials and other forms of recognition are described in clear, non-technical language, with transparent workload, entry requirements and progression

options. The same recognition rules apply regardless of whether learning has been acquired through VET or HEI pathways, or via continuing training, thereby supporting mobility between subsystems for learners who may have had limited opportunities in formal education. Recognition of prior learning processes are designed to be accessible, with guidance, exemplars and, where relevant, support sessions for learners unfamiliar with portfolio-based assessment.

- **Operations and data layer.** Platform configuration, analytics and governance processes include specific parameters for monitoring accessibility and inclusion. Examples include tracking usage by device type and bandwidth proxy, monitoring participation and completion rates by institution type, region and gender (where lawful and proportionate), and flagging persistent disparities for attention by governance bodies. Support services (e.g. helpdesks, technical assistance) are delivered in multiple languages and through multiple channels (email, messaging, phone) to accommodate different user preferences and constraints.

5.5.5 Interfaces with quality assurance and implementation

Accessibility and inclusion by design are not static commitments; they require continuous verification and adjustment. The AGRITECH Learning Ecosystem therefore links this section explicitly to the quality assurance mechanisms presented in Section 5.6 and the implementation roadmap in Chapter 7. Accessibility requirements are incorporated into:

- **design checklists and acceptance criteria** for modules, digital tools and pilot configurations;
- **training and guidance for educators, instructional designers and platform administrators**, with specific attention to inclusive digital pedagogy; and
- **monitoring and evaluation frameworks**, which include indicators on participation, progression and learner experience for different groups.

Where pilots reveal persistent barriers (for example, systematically lower completion rates among rural learners or low uptake by women in specific technical modules), these findings trigger a structured change-management process to adjust content, delivery formats or support mechanisms. In this way, accessibility and inclusion remain active design parameters throughout the lifecycle of the AGRITECH Learning Ecosystem, rather than a one-off compliance exercise.

5.6 Quality Assurance in the Ecosystem

The AGRITECH learning ecosystem is conceived as a high-stakes environment: it supports multi-country provision of advanced agricultural education, it interfaces with national VET and HE quality regimes, and it feeds into emergent recognition models such as micro-credentials and digital badges. Quality assurance (QA) is therefore not an auxiliary function, but a structural property of the ecosystem's design. This section operationalises the principles, indicators and procedures established in the AGRITECH Quality Plan (D1.2) at the level of the learning ecosystem, ensuring that the ecosystem's architecture, services and learning experiences are demonstrably robust, transparent and improvable over time.

The approach builds directly on the QA framework, principles and indicators already defined for the project as a whole, including the Triple C model (Communication, Cooperation, Coordination), the PDCA cycle (Plan–Do–Check–Act), the structured KPI set and the governance roles of GA, PMB, WP leaders and the International Expert Panel (IEP). Within this deliverable, these elements are translated into ecosystem-level quality domains, procedures and responsibilities that apply to: (a) learning content and programmes, (b) delivery and learner support, (c) digital platforms and data, and (d) governance, stakeholder engagement and impact.

5.6.1 Objectives and principles for ecosystem-level QA

The overarching objective of QA in the AGRITECH ecosystem is to guarantee that all learning experiences, digital services and governance processes are:

- **Relevant**, in the sense of addressing clearly identified user needs and labour-market requirements across the VET–HE continuum, and being aligned with the AGRITECH Manager Competency Framework and national standards.
- **Complete**, by covering the expected learning outcomes, competences and methodological elements defined in the curriculum and ecosystem design, without critical omissions.
- **Accurate and valid**, by relying on sound evidence, updated sectoral intelligence and recognised pedagogical practices, and by avoiding bias or unsupported claims, especially in technology-rich and data-driven components.
- **Timely**, by ensuring that content, services and platforms are updated in line with project milestones and evolving Deep Tech Agriculture (DTA) practices, and that feedback cycles lead to concrete revisions within defined timeframes.
- **Understandable and usable**, by applying agreed standards for language, structure, layout and accessibility, and by providing user-centred navigation and support across the digital platform and associated resources.
- **Sustainable and reproducible**, by documenting design decisions, licensing and data management in ways that allow other providers to reuse, adapt and maintain ecosystem components beyond the project's lifetime.

These principles are deliberately consistent with the quality principles already established for AGRITECH deliverables (relevance, completeness, information accuracy, timeliness, readability, visual quality and sustainability), which are here extended from "project outputs" to "ecosystem services" (e.g. hubs, platforms, micro-credentials).

5.6.2 Quality domains and indicators

Drawing on the Quality Plan's distinction between quality of activities, resource use, collaboration, information management and deliverables, ecosystem QA is organised into four mutually reinforcing domains, each associated with a set of indicators and evidence sources.

(a) Learning design and content

This domain covers the design of curricula, modules, micro-credentials, learning pathways and associated resources (e.g. cases, datasets, simulations). The deliverables' quality indicators defined in D1.2 (relevance, completeness, validity/accuracy, understandability, layout/format, timeliness, sustainability) are adopted as the baseline rubric for all ecosystem learning objects, not only formal deliverables.

Indicative ecosystem-level indicators include:

- Explicit mapping of each module/micro-credential to the AGRITECH competence framework and to EQF levels and national standards where applicable.
- Evidence that content integrates both digital and sustainability dimensions, in line with national analyses highlighting persistent gaps in advanced digital and climate-smart skills.

- Peer-review outcomes for key ecosystem artefacts (D2.2, curricula, platform content, certification framework), using the peer-review matrix and external IEP evaluations defined in the QA Plan.

(b) Learning delivery and support

This domain focuses on the pedagogical and organisational quality of delivery, including blended and work-based learning arrangements, communities of practice and learner support services. Building on the Quality Plan's emphasis on monitoring the quality of activities, collaboration and stakeholder engagement, indicators include:

- Proportion of learning activities using problem- and project-based methodologies, as recommended by stakeholders across national reports.
- Learner and teacher satisfaction with the flexibility, inclusiveness and workload of learning pathways, captured through standardised evaluation forms and impact assessment templates.
- Evidence of participation and progression for under-represented groups (e.g. women in AgriTech, rural learners), reflecting the inclusion and accessibility requirements formulated in Section 5.5 and in national gender-equality strategies.

(c) Digital platform and data services

For the AGRITECH platform and associated digital services, the quality indicators defined in D1.2 for online platforms (design, content, delivery, technical aspects, information management) are directly adopted as non-functional requirements in Chapter 6. This includes, inter alia:

- Design quality (alignment with user needs and national legal frameworks, clarity of flows and functions);
- Content quality (pedagogical coherence, multilingual availability, sectoral relevance);
- Delivery quality (user satisfaction, flexibility, mobile operability, cultural sensitivity, assessment forms);
- Technical quality (stability, performance, accessibility, security, data-protection compliance);
- Information management (traceability of participation, analytics on enrolment, completion and drop-out).

Platform analytics are explicitly integrated into the Monitoring and Evaluation Framework (Chapter 7) to enable continuous tracking of usage patterns and outcome indicators.

(d) Governance, recognition and impact

Finally, QA extends to ecosystem governance, external recognition and impact, in line with the Quality Plan's treatment of KPIs, impact assessment and external evaluation. This involves indicators such as:

- Establishment and functioning of the International Expert Panel (IEP) with a mandate that explicitly covers ecosystem design, not only project management.
- Degree of alignment between ecosystem micro-credentials and emerging national frameworks for micro-credentials and QA (e.g. ESG and EQAVET references, use of national or sectoral QA bodies where available).
- Evidence of policy and institutional uptake of the ecosystem model (e.g. integration into institutional QA systems of VET providers and HEIs, recognition of micro-credentials, inclusion in national registries).

5.6.3 Processes, roles and tools for quality assurance

Ecosystem QA follows the same PDCA logic that underpins AGRITECH's overall Quality Plan, but with instruments adapted to educational design and platform operation.

- **Plan**: Key ecosystem artefacts (competency framework, curricula, ecosystem architecture, platform specification) are designed using common templates and checklists derived from D1.2 (e.g. deliverable template, platform quality rubric, ethics and AI guidance, data-management requirements).
- **Do**: Components are implemented in pilots (learning hubs, modules, platform releases, micro-credentials), with WP leaders and task leaders responsible for embedding QA requirements into their work plans and for ensuring that partner contributions meet agreed standards.
- **Check**: Outputs are subjected to multi-level review: internal peer review according to Table 10, IEP review of key public deliverables, user evaluations via standardised questionnaires, and periodic QA reports (five interim plus final) that synthesise findings and recommend corrective actions.
- **Act**: The PMB, together with WP leaders and the Quality Coordinator, uses QA evidence to approve, revise or suspend ecosystem components, and to prioritise design changes in subsequent iterations of the curriculum, platform and governance model.

Roles and responsibilities are distributed as follows:

- The **Quality Coordinator** and QA team (WP1) ensure that QA principles, indicators and instruments are consistently applied across all ecosystem components and that QA data flow into project-level monitoring.
- **WP2–WP4 leaders and task leaders** are responsible for the first line of QA of learning design, ecosystem architecture, platform implementation and pilot operation, using the deliverable and platform quality indicators.
- The **International Expert Panel** provides independent external scrutiny of key ecosystem artefacts (D2.1–D2.5, D3.1–D3.2, D4.1–D4.2, D5.1), including methodological soundness, sector relevance and alignment with European QA and research-ethics standards (e.g. European Code of Conduct for Research Integrity).
- **National and institutional QA bodies and accreditation agencies**, identified in Chapter 4 as key stakeholders, are engaged to review the compatibility of the ecosystem model with existing accreditation, evaluation and audit procedures in VET and HE, thus facilitating future mainstreaming.

5.6.4 Integration with monitoring, evaluation and continuous improvement

Quality assurance in the AGRITECH ecosystem is explicitly integrated with the broader monitoring and evaluation (M&E) architecture detailed in the Quality Plan and in the Implementation Roadmap (Chapter 7).

First, the **QA KPIs** defined in D1.2 (formation of the IEP, implementation of a QA system with templates, delivery of five interim QA reports and one final report, development and approval of an evaluation framework, and six impact assessments of educational incubators) provide a quantitative backbone for assessing whether QA mechanisms are actually in place and functioning.

Second, **ecosystem usage and performance data** collected through the platform (enrolments, completions, drop-outs, engagement metrics, assessment results) are integrated into the project's central monitoring templates and inform both internal quality reports and external evaluations.

Third, **impact assessment instruments** (for both consortium partners and external stakeholders) capture qualitative evidence on the usefulness, added value and sustainability of the ecosystem, including its contribution to reducing skills gaps, enhancing employability and improving institutional capacity.

Finally, continuous improvement is formalised through:

- Scheduled **QA review points** aligned with major design and implementation milestones (e.g. completion of curriculum package, platform beta, pilot phases);
- Documented **change-log procedures** for ecosystem artefacts (curricula, platform features, QA tools), ensuring that revisions are traceable and justified;
- Explicit **feedback loops** between QA findings and design decisions in subsequent work packages (e.g. refinement of micro-credential design rules in Section 5.7 and of the Monitoring and Evaluation Framework in Chapter 7).

In this way, quality assurance in AGRITECH is not confined to a project-administrative layer, but is embedded as a systemic feature of the learning ecosystem itself: shaping the way content is produced and validated, how platforms are designed and operated, how learning is recognised, and how stakeholders collaborate to sustain a trustworthy, effective and inclusive environment for advanced agricultural education.

5.7 Micro-credentials: Design and Integration

Micro-credentials constitute a central instrument in the AGRITECH Learning Ecosystem, providing a flexible and transparent mechanism to certify discrete competence units in digital and sustainable agriculture. They are designed to respond simultaneously to three structural challenges identified in the comparative needs assessment: rapidly evolving technology, heterogeneous regulatory environments, and the need to connect VET, HEI and workplace learning through modular pathways rather than exclusively through long, linear programmes.

In line with the Council Recommendation on micro-credentials (2022), AGRITECH defines a micro-credential as a short, competence-based learning experience that is explicitly assessed, quality assured and documented in a standardized format, and that can be stacked and combined with other learning to support progression within and across VET and HEI systems. Micro-credentials in AGRITECH are therefore not an add-on but a structural element of the ecosystem: they are the basic “currency” through which learning is recognized, exchanged and accumulated across institutions and borders.

5.7.1 Comparative starting point in partner countries

The six AGRITECH countries display markedly different levels of policy and implementation maturity with regard to micro-credentials, which the ecosystem must accommodate rather than ignore. The design therefore starts from a comparative reading of national landscapes, focusing on the degree of formal recognition, institutional capacity and existing practice in agricultural and AgriTech-related fields.

- **Greece** has no formal, legally binding definition of micro-credentials. Short courses and continuing training offered by HEIs, ELGO-DIMITRA and private providers function de facto as micro-credentials, but they are not systematically aligned with the Hellenic Qualifications Framework and carry limited portability beyond the issuing institution or specific schemes (e.g. CAP advisory services). Stakeholders nonetheless express strong interest in short, targeted certifications in precision irrigation, digital farm management and remote sensing, and national reports explicitly recommend their integration into an overarching framework in line with EU guidance.

- **Italy** is more advanced conceptually and institutionally. Under the *Microcreds Plan* within the National Recovery and Resilience Plan (PNRR), micro-credentials are defined as certified, stackable learning outcomes aligned with EQF and supported by Europass Digital Credentials and, in some cases, blockchain-based verification. ITS Academies and universities already offer microcredential-type modules, including in agri-food and climate-smart agriculture, although a fully operational national registry and uniform quality standards are still in development.
- **Czech Republic** has developed one of the most coherent national approaches among the partners. All 26 public HEIs have adopted a common micro-credential format, standardised learning outcomes with ECTS, and a joint verification system. A two-year harmonisation project, supported by the Ministry of Education and OECD, is extending this framework towards VET and non-formal learning, building on the National Register of Vocational Qualifications (NSK) as a legal basis for recognising outcomes acquired outside formal programmes. Micro-credentials of 2–15 ECTS are already being issued, and AgriTech-relevant pilots (e.g. hydroponics, digital farm administration) are planned or underway.
- **Cyprus** is at an early conceptual stage. There is no national framework or legal category for micro-credentials, and existing practice is largely project-based. HEIs and VET-oriented EU projects (e.g. RELIEF, DG-VET, STEM4Agri) issue certificates for short modules in climate-smart agriculture and Agriculture 4.0, but these remain non-formal and are not yet integrated into the Cyprus National Qualifications Framework. National strategies on digital transformation and sustainable development, however, explicitly support modular, competence-based learning and provide a favourable policy backdrop for formalisation.
- **Hungary** is in the process of transposing the EU micro-credential framework within the broader VET 4.0 reform. The Hungarian Qualifications Framework is being adapted to accommodate smaller learning units, and a network of accredited examination centres is scheduled to become operational by 2025. Pilot micro-credentials in precision agriculture and digital farm management at EQF levels 4–5 have already been designed, with practical, portfolio-based assessment and emerging employer recognition. These developments are supported by substantial investments in VET digitalisation and green skills through the national recovery and REPowerEU programmes.
- **Romania** currently lacks a formal micro-credential category. Recent education laws favour modularisation and dual pathways, yet the National Qualifications Framework (CNC) and National Register of Qualifications (RNC) remain geared towards full qualifications. Adult training providers under OG 129/2000 and agricultural universities (USAMV network) deliver short courses in smart farming, drone operations and digital farm management, but their certificates are treated as non-formal. National analysis reports explicitly propose using HEIs as early issuers of EQF 6–7 micro-credentials, open to VET learners, as a pragmatic route until CNC and RNC are updated to accommodate short, stackable awards.

In summary, the consortium operates across a spectrum from relatively mature and standardised systems (Czech Republic, to some extent Italy and Hungary) to contexts where micro-credentials exist primarily as project-based or institutional practices without formal national anchoring (Greece, Cyprus, Romania). The AGRITECH micro-credential design must therefore be **European by default and**

nationally adaptable by construction, allowing credible implementation even where regulatory frameworks are incomplete.

5.7.2 AGRITECH micro-credential model

To provide coherence across these heterogeneous contexts, AGRITECH adopts a single, project-wide micro-credential model, aligned with the EU Recommendation and embedded in the competence framework and pedagogical model defined in previous chapters.

Each AGRITECH micro-credential will:

- be **explicitly competence-based**, with 3–6 clearly formulated learning outcomes mapped to the AGRITECH competence domains (digital & data skills, sustainability and climate-smart practices, entrepreneurial and innovation skills, and transversal/managerial competences);
- specify a **workload between approximately 50 and 175 hours** of total learning time (2–7 ECTS equivalents), including guided learning, practical work, and assessment activities;
- be assigned a **target EQF level** (typically 4–7) and, where feasible, a corresponding national level in the partner country's qualifications framework;
- include a concise description of **pre-requisites**, with parallel versions suitable for initial VET learners, HEI students and professionals in continuing education;
- follow a **blended and practice-rich design**, integrating scenario-based digital learning, work-based assignments, and, where relevant, use of real datasets and equipment (e.g. FMIS, remote sensing platforms, IoT sensors);
- be subject to **formal assessment** through rubrics aligned with the stated learning outcomes, including at least one applied or project-based component;
- be covered by the AGRITECH **quality assurance framework** (Section 5.6), including peer review of assessment design and periodic moderation of grading;
- result in a **digitally verifiable credential**, issued as a badge compatible with Europass Digital Credentials and the European Learning Model, containing standard metadata (issuer, workload, EQF level, learning outcomes, assessment mode, date, and link to evidence).

At ecosystem level, the initial AGRITECH micro-credential portfolio will be organised around the core competence clusters identified earlier in the report: *Sustainable Practices*, *Precision Agriculture & Operations*, *Remote Sensing & Data Analytics*, and *Innovation & Entrepreneurship in Agri-food*. Each cluster will comprise several micro-credentials that can be combined into "stacks" leading to larger recognisable units (e.g. a short specialisation or a full module within a VET or HEI programme).

5.7.3 Integration with VET and HEI pathways

A key design requirement is that micro-credentials must not create a parallel, disconnected certification universe. Instead, they must integrate into, and add flexibility to, existing VET and HEI pathways in each country.

At **VET level**, AGRITECH micro-credentials will primarily serve three functions:

1. **Enrichment and modernization of existing programmes**, by embedding micro-credential units as optional or mandatory components within upper-secondary and post-secondary agricultural VET curricula (e.g. as distinct modules on precision irrigation, GNSS-guided machinery or farm data management). Given the slow pace of formal curriculum revision in several systems (e.g. Greece, Romania), this enrichment can initially be implemented via non-formal or extra-curricular offerings that are, however, internally quality assured and externally visible.

2. **Continuing VET and upskilling**, by offering standalone micro-credentials to farmers, technicians and advisors through national VET centres, agricultural organisations and adult training providers. In Hungary and the Czech Republic, these micro-credentials can be explicitly linked to the emerging validation and recognition systems (accredited exam centres, NSK-based qualifications), while in Cyprus and Greece they will provide structured yet flexible CPD opportunities that anticipate future regulatory developments.
3. **Bridging between VET and HEI**, enabling VET graduates to gain HEI-recognised credit for specific AGRITECH micro-credentials, thus lowering the barrier to entering bachelor-level study in agri-related fields. In Italy and Romania, where HEIs already operate continuing education and micro-course formats, this bridging function can be implemented relatively quickly through bilateral agreements between VET providers and universities.

At **HEI level**, micro-credentials will:

- provide **flexible entry points** into advanced AgriTech topics (e.g. AI for yield prediction, blockchain for traceability), accessible to both degree students and external professionals;
- support **stackable progression** within degree structures, by allowing specific micro-credentials to be recognised as elective or compulsory components of bachelor or master programmes, subject to institutional regulations;
- function as **shared assets** across institutions and borders, where one partner may deliver a specialised micro-credential that others choose to recognise and integrate into their local curricula via ECTS transfer and digital credential verification (particularly relevant for Czechia's and Italy's more advanced micro-credential systems).

This dual integration logic makes micro-credentials the operational link between the ecosystem's learning pathways (Section 5.4) and its recognition layer, supporting permeability between VET, HEI and work-based learning in line with EU lifelong learning objectives.

5.7.4 Country-specific implementation pathways

Given the diversity of regulatory contexts, AGRITECH distinguishes three broad implementation pathways for its micro-credentials, which will be followed in parallel across the six countries:

1. **Alignment with existing or emerging national frameworks**
    - In the **Czech Republic**, AGRITECH micro-credentials will be designed to comply with the common HEI format and verification system (ECTS-based workload, ELM-compatible metadata), allowing participating universities and, at a later stage, VET institutions to issue fully recognised national micro-credentials.
    - In **Hungary**, pilots will be aligned with the VET 4.0 validation system and the network of accredited vocational examination centres, enabling AGRITECH micro-credentials (e.g. "Precision Agriculture Technician", "Digital Farm Management") to be recognised within the Hungarian Qualifications Framework once national procedures are finalised.
    - In **Italy**, micro-credentials will be linked to the PNRR Microcreds Plan and related initiatives (e.g. AGRIFOODSKILLS) by adhering to Italian guidelines on EQF levels, ESCO alignment and EDC issuance, thereby facilitating their stackability into ITS and university programmes.
2. **Institution-led recognition with future national anchoring**
    - In **Greece**, **Cyprus** and **Romania**, where no comprehensive national recognition frameworks are yet in place, AGRITECH micro-credentials will initially be recognised through institutional policies (e.g. HEI Senate decisions, VET provider regulations) and

through memoranda of understanding between project partners and sector organisations. At the same time, they will be explicitly designed to be ready for future integration into national frameworks, using EQF-referencing, clear workload specifications and ESCO-compatible competence descriptors.

3. **Sectoral and employer-driven endorsement**
    - Across all six countries, the project will seek explicit endorsement from sector bodies (e.g. Chambers of Agriculture, producer organisations, advisory services) for selected micro-credentials, using them as hiring or upskilling benchmarks in domains such as drone operations, farm data analytics and climate-smart planning. This approach is particularly important where formal legal recognition is still evolving, but labour-market signalling can create de facto value and accelerate acceptance.

5.7.5 Quality assurance and continuous improvement

Micro-credentials will be fully embedded in the AGRITECH quality assurance architecture outlined in Section 5.6 and the project-level Quality Plan. This implies that each micro-credential is subject to:

- **ex ante design review**, verifying alignment with the competence framework, clarity of learning outcomes, appropriateness of assessment and feasibility within the specified workload;
- **pilot testing** in at least one VET and/or HEI setting in the consortium, including collection of learner, teacher and employer feedback;
- **evidence-based refinement** after the pilot, adjusting content, delivery mode or assessment where necessary;
- **external moderation** of assessment artefacts for selected "high-stakes" micro-credentials, particularly those that may be recognised for credit transfer or used as gateways to higher-level programmes;
- **data-informed monitoring**, using platform analytics (completion rates, time-on-task, progression patterns) and learner surveys to identify equity issues (e.g. by gender or geography) and to ensure accessibility and inclusion targets are met.

A consolidated **Micro-credential Specification and Design Guide** will be produced as an internal reference, capturing templates, examples, QA checklists and national recognition notes for all six countries. This guide will serve as the bridge between the ecosystem-level design presented in this chapter and the more technical credentialing and verification standards defined in Chapter 6.

6. DIGITAL PLATFORM SPECIFICATION

Chapter 6 specifies the AGRITECH digital platform as the core technological infrastructure that operationalises the learning ecosystem design presented in Chapter 5 and translates the AGRITECH Manager competence framework into a concrete online environment for VET and HE learners, trainers and stakeholders. It consolidates the functional, non-functional and interoperability requirements that must be met in order to deliver accessible, secure and scalable training provision across partner countries, and to support evidence-based quality assurance, credentialing and recognition processes consistent with the project's competence, curriculum and QA frameworks.

The chapter is explicitly grounded in the ***AGRITECH eLearning Platform Structure*** – *Version 1* developed by **CARDET**, which defines the layered architecture, user roles and core services of the AGRITECH E-Learning Platform. Building on that blueprint, the present specification adapts and systematises the platform's foundation (user and access management), core learning layer (multilingual course delivery, interactive and gamified activities), motivation and recognition layer (assessment, certification and digital credentials), and management layer (analytics, reporting and communication), ensuring full alignment with the learning ecosystem design, the competence and micro-credential framework, and the project's quality standards.

The platform is conceived as a dynamically evolving system rather than a static product. During the project lifecycle, it will be progressively refined through structured feedback and usage data collected during the pilot implementation (conducted at two levels: **VET** and **Master**'s) and subsequently during the first official training cycles. In this way, user experience, accessibility, performance and data-integration features can be iteratively optimised while preserving compliance with security, privacy and QA requirements. Section 6.1 defines the functional requirements that enable the platform to support the AGRITECH learning pathways and services. Section 6.2 specifies non-functional requirements, including security, privacy, accessibility and usability constraints. Section 6.3 sets out interoperability requirements (e.g. SSO, LTI 1.3, xAPI) to ensure integration with institutional systems and external tools. Section 6.4 details credentialing and verification standards for certificates and micro-credentials. Section 6.5 describes analytics and reporting capabilities needed for monitoring and evaluation. Section 6.6 concludes with a platform readiness checklist that links these specifications to pilot and full-scale deployment milestones.

6.1 Functional Requirements

This section specifies the core functional requirements of the AGRITECH digital platform. They translate the learning ecosystem architecture defined in Chapter 5 and the detailed platform blueprint developed by CARDET into concrete capabilities that the technical solution must provide for all user groups (learners, trainers, institutional administrators, quality assurance actors and external stakeholders).

The requirements are structured around the main functional domains of the AGRITECH Learning Ecosystem: user and identity management, learning catalogue and pathways, learning experience and content delivery, assessment and gamification, credentialing, analytics and quality monitoring, communication and support, and platform administration and governance.

6.1.1 User and identity management

The platform shall support a role-based, multi-institutional user model aligned with the ecosystem governance model (VET providers, HEIs, industry partners and project-level coordination).
At minimum, the system must:

- **Support distinct user roles and permissions**, including:
  - Learners (VET students, HEI students, professionals, farmers and other practitioners);
  - Trainers / tutors;
  - Course authors and instructional designers;
  - Institutional administrators (per organisation);
  - Project-level administrators (consortium-wide);
  - Quality assurance, evaluation and research users with read-only analytic access.
- **Provide user registration and authentication** through:
  - A standard credential-based login mechanism;
  - Compatibility with institutional single sign-on (SSO) and federated identity providers, as further detailed in Section 6.3.
- **Offer personalised dashboards for each role**, including at least:
  - For learners: overview of enrolled modules, progress at module, level and programme (ATM) level, upcoming activities, and issued certificates;
  - For trainers: enrolment lists, progress and performance views per cohort, access to grading interfaces and feedback tools;
  - For institutional and project-level administrators: high-level indicators of usage, completion and certificate issuance, with drill-down by course and institution (see Section 6.5).
- **Allow representation of multiple affiliations**, so that users from several institutions or organisations (for example, a trainer working both in VET and HEI) can operate under a single account with institution-specific permissions.

6.1.2 Learning catalogue and pathways

The platform functions as the primary delivery environment for the AgriTech Manager (ATM) curriculum and related deep-tech agricultural learning paths, across both VET and HEI contexts.
The system must therefore:

- **Host the full AGRITECH course catalogue**, structured into three progressive course levels (Level 1: Foundations, Level 2: Applied AgriTech Systems and Data, Level 3: Integration and Innovation Management), each comprising seven thematic modules plus one capstone project.
- **Provide a searchable, filterable catalogue interface**, enabling users to discover modules and courses by:
  - Level, topic, competence area, language, difficulty, and intended audience (VET, HEI, continuing professional development);
  - Cross-cutting tags aligned with the AGRITECH Manager competence framework (e.g. data & analytics, digital operations/IoT, sustainability, entrepreneurship).
- **Implement flexible enrolment logic**, allowing:
  - Full-programme navigation (sequential completion of all modules within a level, followed by the capstone);
  - Stand-alone access to individual modules for targeted upskilling, while preserving coherence of the learning pathway;

  - Parallel cohorts (e.g. VET pilot groups and Master-level HEI groups) using the same modules but different scheduling and support arrangements.
- **Support prerequisite and progression rules**, so that capstones and higher-level modules can be conditionally unlocked based on completion and/or competence demonstration in earlier modules, as defined in the curriculum.
- **Expose structured metadata for each module and capstone**, including title, description, learning outcomes, estimated workload, prerequisite knowledge, competence mapping, and indicative EQF alignment, to facilitate recognition and micro-credentialing (see Section 6.4).

6.1.3 Learning experience and content delivery

The AGRITECH platform is required to deliver an interactive, multimodal learning experience consistent with the pedagogical model defined in WP2 and operationalised in the CARDET platform blueprint.
For each module and capstone, the system must:

- **Support a standardised module structure**, comprising at minimum:
  1. Welcome & orientation (introductory video and infographic);
  2. Core learning materials (texts, infographics, slides, interactive content, and downloadable manual);
  3. Interactive/gamified knowledge checks (scenario-based challenges and quiz items);
  4. Completion and certification trigger.
- **Deliver diverse media types**, including:
  - Short introductory videos (module-level and level-level orientation clips);
  - Interactive training objects created in tools such as Genially/RISE and embedded in the LMS;
  - Downloadable module manuals in accessible formats (e.g. PDF) with extended readings and resources;
  - Infographics and navigation maps explaining learning pathways and platform use.
- **Enable both self-paced and facilitated learning**, through:
  - Asynchronous access to all materials;
  - Optional scheduling features (start/end dates, suggested pace);
  - Integration points for synchronous activities (webinars, live sessions) via external tools, as specified in Section 6.3.
- **Provide mobile-responsive access and offline-friendly content options**, such as low-bandwidth variants and downloadable resource packs, to mitigate rural connectivity constraints and support inclusive participation.
- **Allow trainers to adapt and contextualise content** (e.g. adding local examples, additional readings, or custom activities) while preserving version control and core learning outcomes.

6.1.4 Assessment, feedback and gamification

Assessment and gamification are integral elements of the AGRITECH pedagogical model, not optional add-ons. The platform must support continuous, criterion-referenced assessment and rich feedback loops, integrated with an overarching gamification framework.
Key functional requirements include:

- **Item and assessment management**
  - Creation and management of question banks (multiple-choice, matching, short answer, scenario-based items, etc.);

- Configuration of formative and summative assessments at module and capstone level;
- Support for time limits, attempt rules and randomisation where pedagogically appropriate.

- **Scoring, feedback and progression**
  - Automatic scoring for objective items and calculation of module scores;
  - Interfaces for trainers to grade open-ended tasks, upload rubric-based evaluations and provide narrative feedback;
  - Configurable mastery thresholds (e.g. 70 % success) as triggers for completion, unlocks and certificate issuance.
- **Gamification features**, aligned with the CARDET framework:
  - Visual progress bars at module, level and programme level;
  - Optional points system rewarding engagement (video viewing, quiz completion, peer interaction);
  - Automatic awarding of digital badges linked to specific achievements;
  - Optional leaderboards at course or partner-country level, with privacy-respecting configurations;
  - Embedded feedback mechanisms (e.g. course rating widgets, short satisfaction polls) to inform continuous improvement.
- **Support for capstone assessment**, including:
  - Submission of project outputs (files, links, media artefacts);
  - Group work options where several learners submit jointly;
  - Structured marking interfaces for supervisors, including rubrics and space for summative comments;
  - Recording of capstone outcomes for later use in micro-credential stacks and ATM certification.

6.1.5 Credentialing and learning records

Given the centrality of micro-credentials to the AGRITECH ecosystem (Chapter 5.7), the platform must provide end-to-end support for issuing, managing and displaying digital credentials, in alignment with the certification model described in the platform blueprint.

The system shall:

- **Automatically generate digital certificates** upon fulfilment of defined criteria, at three levels:
  - Module Completion Certificate;
  - Level Completion Certificate (per course level);
  - AGRITECH Certified AgriTech Manager (ATM) for completion of all three levels and capstones.
- **Embed rich metadata in each credential**, including learner identity, module/level identifier, completion date, mapped competences and workload, and a unique verification link, in at least English and the learner's interface language.
- **Provide learners with a persistent credential wallet/profile**, where they can view, download and share certificates and badges (e.g. as PDF and interoperable digital badges), including export options to Europass or professional networking platforms.
- **Maintain a secure learning record store**, capturing completion and credential data in a manner compatible with the AGRITECH competence framework, national recognition procedures and the verification standards elaborated in Section 6.4.

6.1.6 Analytics and quality monitoring support

Although analytics and reporting are detailed in Section 6.5, certain core functional capabilities are a prerequisite at platform level. The AGRITECH platform is conceived as an integrated monitoring and quality management system that transforms learning activity into structured data for WP4 and project governance.

The system must:

- **Capture fine-grained learning events** (logins, content views, assessment attempts, completion, credential issuance) in a format suitable for xAPI and dedicated Learning Record Store (LRS) processing.
- **Provide role-specific dashboards**, at minimum:
  - Learner views of own progress and achievements;
  - Trainer views of class-level engagement and performance;
  - Administrator and QA views aggregating indicators by country, institution, course and cohort.
- **Enable export of anonymised datasets** (e.g. CSV/XLSX) for evaluation, research and reporting purposes, in line with the quality plan and WP4 requirements.

6.1.7 Communication, support and communities of practice

To sustain engagement and operational efficiency, the platform must embed basic communication and support functions and provide hooks for the wider communities of practice described in Chapter 5.2.1.

The minimum functional set includes:

- **Announcements and news channels**, configurable per course, level, institution and consortium-wide.
- **Internal messaging or notification mechanisms**, enabling trainers and administrators to contact learners, and notifying users of key events (enrolment, completion, certificate availability, upcoming deadlines).
- **Integrated helpdesk and knowledge base**, including:
  - A support contact channel (ticket or email routing);
  - Frequently asked questions, user guides and short “how-to” resources;
  - Links to accessibility support and data-protection information.
- **Basic social and collaborative features**, such as discussion fora or comment threads attached to modules, to support peer-to-peer learning and cross-country exchange, with moderation tools for trainers and administrators.

6.1.8 Administration, configuration and governance

Finally, the platform must provide robust administrative and configuration tools that allow CARDET (as technical lead) and partner institutions to manage the system throughout and beyond the project lifecycle.

Core administrative requirements are:

- **Course and catalogue management**
  - Creation, duplication and archiving of courses and modules;
  - Management of language versions and local adaptations;
  - Configuration of enrolment rules, cohorts and visibility.
- **User and role management**
  - Assignment and revocation of roles;

    - Institution-scoped administration;
    - Management of access for external evaluators and observers.
- **Configuration of integrations and plugins**, including:
    - Activation/deactivation of LTI tools, webinar connectors, analytics plugins and credentialing extensions;
    - Management of API keys and endpoints in line with Section 6.3.
- **Support for quality assurance workflows**, such as:
    - Versioning of courses and content;
    - Sandbox/test environments for pilots;
    - Logging and audit trails of key administrative actions.
- **Sustainability and post-project use**, including the ability for partners to continue adding courses, updating manuals and translations, and using analytics after the official project end, as foreseen in the platform sustainability model.

Collectively, these functional requirements define the minimum feature set that any candidate platform solution must provide in order to be considered compliant with the AGRITECH Learning Ecosystem design and to pass the platform readiness checklist presented in Section 6.6.

6.2 Non-functional Requirements (Security, Privacy, Accessibility)

The non-functional requirements of the AGRITECH digital platform define the cross-cutting quality attributes that ensure the environment is secure, trustworthy, and accessible to all intended users. They translate the principles outlined in the AGRITECH Platform Structure developed by CARDET and the Quality Plan (D1.2) into concrete design and implementation obligations. Together with the functional specifications in Section 6.1, these requirements form the basis for the platform readiness checklist and the acceptance criteria for Deliverable D4.1.

The requirements are grouped into three main clusters: (a) security and reliability, (b) privacy and data protection, and (c) accessibility, usability and inclusion. Each cluster applies to all components of the platform architecture and is binding for both the initial deployment and subsequent enhancements.

6.2.1 Security and Reliability

Security and reliability requirements ensure that AGRITECH operates as a resilient and trustworthy infrastructure for learning, certification and analytics, capable of supporting pilots and long-term use by partner institutions.

At infrastructure level, the platform shall be hosted on cloud-based servers located within the European Union, with an availability target of at least 99.9% uptime, daily automated backups and clearly documented disaster-recovery procedures. The underlying technology stack (open-source LMS with extensible plugins) must be maintained following secure development practices, including regular patching and controlled release management.

Identity and access management is based on a role-based model aligned with the governance matrix defined in the platform structure (learner, trainer, administrator, and external stakeholder profiles). Minimum requirements include:

- Encrypted transport (HTTPS with modern TLS) for all user interactions and API endpoints.
- Encrypted storage of authentication credentials and sensitive tokens, following current best practices.

- Strong authentication for privileged accounts (e.g. two-step verification / multi-factor authentication for administrators and system managers).
- Role-based permissions that enforce the "least privilege" principle; learners, trainers and administrators see only those functions and data necessary for their tasks.

Operational security requirements further include:

- Network-level protection through firewalls and hardening of exposed services, supplemented by periodic vulnerability assessments and, where feasible, penetration testing.
- Comprehensive logging and audit trails for key events (authentication, role changes, course publishing, certificate generation, data exports), stored in a secure, tamper-evident manner and accessible to authorised administrators for incident investigation.
- A documented incident-response procedure specifying responsibilities, notification timelines, and corrective actions in case of suspected data breach or significant service disruption, coordinated with the project's overall risk management and QA framework.

Reliability is also assessed through the online platform quality indicators defined in the Quality Plan (quality of delivery, technical aspects, information management). Platform monitoring must therefore provide, at minimum, metrics on system performance, error rates, enrolment and completion statistics, and access patterns, enabling evidence-based corrective measures during pilots and subsequent operation.

6.2.2 Privacy and Data Protection

Privacy and data protection requirements operationalise the project's commitment to GDPR compliance and "privacy-by-design" principles, which are explicitly identified as non-negotiable in the platform blueprint.

First, all personal data processing within the platform must be documented and assessed through a Data Protection Impact Assessment (DPIA), covering user registration, learning analytics, certification, helpdesk interactions and any integrations with external systems. The DPIA outcomes inform the configuration of data flows, storage locations and retention schedules.

Lawfulness, fairness and transparency are ensured by:

- Presenting clear privacy notices at registration and during key processing steps (e.g. enrolment, survey completion, issuance of digital badges), in all consortium languages.
- Recording explicit, informed consent for optional processing (e.g. inclusion in research datasets, subscription to newsletters), with equally simple mechanisms for withdrawal.
- Providing concise documentation for users on how their data are used to support learning, evaluation (WP4) and dissemination (WP6).

Data minimisation and purpose limitation are addressed through:

- Restricting mandatory registration fields to the minimum necessary for platform operation and reporting (e.g. name, email, organisation, country), as already foreseen in the platform structure.
- Configuring analytics dashboards to operate primarily on pseudonymised or aggregated data, with disaggregation by country, gender or organisation type used solely for evaluation and inclusion monitoring purposes.
- Implementing retention policies that distinguish between operational data (needed for active users), certification records (retained for verification) and research/evaluation datasets, with clear timelines for anonymisation or deletion.

Data subject rights must be fully supported through platform and organisational procedures, including:

- Mechanisms for users to access and update their profile data.

- Processes for requesting erasure (“right to be forgotten”), restriction of processing, and export of personal data in a commonly used format.
- Contact points for data protection enquiries and complaints, aligned with the consortium’s data management and ethics arrangements in WP1.

Any transfer of personal data to third-party processors (e.g. hosting providers, email services, webinar tools, credential wallets) shall be governed by written agreements that specify purposes, security measures and responsibilities, and shall remain within the EU/EEA or in jurisdictions providing adequate protection under EU law.

6.2.3 Accessibility, Usability and Inclusion

Accessibility and inclusion are defined as baseline requirements rather than optional enhancements, reflecting the user-centred design principles of the AGRITECH platform and the cross-cutting needs identified in the ecosystem analysis.

Conformance with web accessibility standards is central. The platform must comply with the EU Web Accessibility Directive, achieving at least WCAG 2.1 Level AA at launch, with the explicit target of full WCAG 2.2 AA conformance as specified in the CARDET blueprint. This includes:

- Keyboard-only navigation and logical focus order across all key workflows (registration, course navigation, assessment, certificate download).
- Screen-reader compatibility, correct use of landmarks and headings, and descriptive alternative text for non-text content.
- Sufficient colour contrast, resizable text, and avoidance of colour-only communication of meaning.
- Captions and, where appropriate, transcripts for 100% of audio-visual learning materials.

Usability requirements align with the online platform quality indicators defined in D1.2, which emphasise user friendliness, mobile operability and cultural sensitivity. Concretely, this implies:

- A responsive, mobile-first interface that remains fully functional on smartphones and tablets, including access to core learning activities and assessments over low-bandwidth connections.
- Simple and consistent navigation based on a “three-click” logic, personalised dashboards, and clear progress indicators, as already embedded in the platform’s UX design.
- Availability of offline or low-connectivity options where feasible (e.g. downloadable resources, progressive web app / offline packs) to reduce barriers for rural users and those with unstable internet connections.

Inclusion is further supported through multilingual and culturally sensitive design. All core interface elements and training materials are required to be available, at minimum, in English and the consortium partner languages (GR, IT, HU, RO, CZ, CY), as specified in the platform’s Multilingual and Accessibility Strategy. Where external tools or embedded content are used, partners must verify that language options and accessibility features are consistent with AGRITECH standards.

Finally, the platform’s feedback and analytics mechanisms must be used to monitor accessibility and inclusion over time. This includes collecting user satisfaction data on usability and accessibility, disaggregating participation and completion rates by country, gender and (where possible) other relevant characteristics, and feeding these insights into continuous improvement cycles under WP4 and the QA framework.

Taken together, these non-functional requirements ensure that the AGRITECH platform is not only functionally adequate, but also secure, privacy-preserving and genuinely accessible, in line with

European regulatory expectations and the project's commitment to a human-centred learning ecosystem.

6.3 Interoperability (SSO, LTI 1.3, xAPI)

Interoperability is a foundational design principle of the AGRITECH digital platform and underpins its role as the operational layer of the wider learning ecosystem. It ensures that VET providers, higher education institutions, industry partners and learners can access shared resources, tools and services without duplicating infrastructure or fragmenting data. In practical terms, interoperability enables seamless user access across institutions, integration of external learning tools, and reliable collection of learning analytics in support of quality assurance and impact evaluation.

The AGRITECH platform implements interoperability along three tightly coupled dimensions: (a) user identity and access via Single Sign-On (SSO), (b) tool and content integration via the Learning Tools Interoperability (LTI) 1.3 standard, and (c) learning data interoperability via the Experience API (xAPI) and an integrated Learning Record Store (LRS). These elements are complemented by support for established content and assessment formats (e.g. read-only SCORM, QTI/CSV import/export) and by well-defined APIs for controlled integration with external systems.

Single Sign-On (SSO)

Single Sign-On is the primary mechanism for user authentication and identity federation between the AGRITECH platform and partner systems. The objective is to allow learners and staff to use their existing institutional credentials (from VET schools, universities or large training providers) to access AGRITECH resources, thereby reducing friction, avoiding parallel account management and strengthening security.

In line with good practice and the security requirements defined for the platform, SSO will rely on standards-based identity protocols (e.g. SAML 2.0 and/or OpenID Connect) provided by institutional Identity Providers (IdPs) and, where appropriate, by national academic federations. Multi-factor authentication (MFA) remains under the control of the home institution but is fully supported by the platform's security model.

Key design features include:

- **Federated identity and role mapping.** User attributes received from the IdP (e.g. affiliation, role, organisational unit) are mapped to platform roles such as learner, trainer, course designer, and administrator. This allows AGRITECH to respect institutional authorisation policies while enabling cross-institutional participation in common courses.
- **Support for non-institutional users.** For learners who are not affiliated with a VET/HEI institution (e.g. farmers, SME staff, advisors), the platform offers a controlled local registration pathway with email-based verification. Where justified and compliant with the DPIA outcomes, selected external identity providers may be added, but institutional SSO remains the preferred option.
- **Data minimisation.** The SSO integration is configured to exchange only the minimum attributes required for identification, role mapping and audit, in line with GDPR and the platform's privacy-by-design principles.

Through this SSO architecture, AGRITECH can be embedded into existing digital environments of partners without forcing organisational change, while maintaining a coherent and secure identity model across the consortium.

Tool and Content Integration via LTI 1.3

The Learning Tools Interoperability (LTI) 1.3 standard constitutes the main mechanism for connecting the AGRITECH platform to external learning tools and services. It enables deep integration of third-party applications (e.g. virtual or remote laboratories, webinar systems, e-assessment engines, simulation platforms, proctoring tools) into AGRITECH courses, without replicating user accounts or content.

The platform is specified to support LTI 1.3 and Advantage services, including:

- **Secure launch and context transfer.** Users launch external tools from within AGRITECH using signed LTI messages that transmit only contextual information (course, role, activity) necessary for the tool to function.
- **Deep linking and content selection.** Course designers can insert external activities into AGRITECH courses using deep linking, ensuring that learners encounter external tools as seamless components of their learning pathway rather than as separate websites.
- **Grade and progress return.** Where pedagogically appropriate, assessment results generated in external tools are returned to the AGRITECH gradebook, supporting coherent tracking of progression and reducing manual data entry.
- **Multi-tenant configuration.** The same external tool can be configured with differentiated access for specific partner institutions, allowing national or institutional services (e.g. HEI webinar platforms) to interoperate with AGRITECH without losing local control.

LTI 1.3 thereby enables AGRITECH to function both as a “hub” for heterogeneous tools and, where desired, as an LTI-exposed provider of its own modules towards institutional LMSs, facilitating reuse of AGRITECH courses within partner platforms.

Learning Data Interoperability via xAPI and LRS

Beyond access and tools, AGRITECH requires an interoperable data layer capable of capturing rich evidence of learning for pedagogical improvement, evaluation and recognition. The platform therefore adopts the Experience API (xAPI) standard, backed by an integrated Learning Record Store (LRS).

The xAPI design will:

- **Capture fine-grained learning events.** Statements (in actor–verb–object form) record meaningful activities such as completion of simulations, participation in challenges, performance in quizzes, engagement with remote labs, or attainment of specific competence-aligned milestones.
- **Align with the AGRITECH competence framework.** Verbs, activities and context fields are mapped to the AgriTech Manager competence areas to support analytics that can be interpreted in terms of skills development rather than only platform usage.
- **Support pilot evaluation and QA.** Aggregated xAPI data feed dashboards that track participation, engagement, completion, assessment reliability and micro-credential uptake, in line with the monitoring and evaluation needs of WP4 and the project’s quality plan.

All learning records are stored in an EU-hosted LRS that is logically separated yet tightly integrated with the LMS. Retention periods, data subject rights and access controls are defined through the DPIA and the project’s governance framework, ensuring that analytics capabilities do not compromise privacy or data protection obligations.

Content and Data Exchange with External Systems

To complement SSO, LTI and xAPI, the AGRITECH platform supports additional interoperability mechanisms for content and data exchange:

- **Standards-based content handling.** The platform offers read-only support for SCORM packages and import/export of items and results using interoperable formats (e.g. QTI, CSV). This allows existing resources from partner systems to be re-used without extensive re-authoring, and facilitates migration or backup of assessment banks where needed.
- **API-based integration.** Carefully scoped API endpoints expose selected data (e.g. enrolment lists, completion status, credential verification information) for integration with institutional portals, digital credential wallets or EU-level open-badge directories, while explicitly excluding deep modifications to external SIS/HRIS/CRM systems beyond agreed SSO/LTI and API use.
- **Credential interoperability.** Micro-credentials and certificates issued by AGRITECH are represented in machine-readable formats compliant with European digital credential standards, ensuring that they can be validated by external systems and, where relevant, mapped to national qualification or recognition frameworks.

Typical Interoperability Scenarios

Within this specification, several recurrent scenarios are foreseen:

- A VET learner authenticates via their school's identity provider using SSO, accesses AGRITECH modules embedded in the institutional portal, and completes activities that launch external simulations via LTI; all interactions generate xAPI statements in the AGRITECH LRS for later analysis.
- A university integrates AGRITECH modules into its own LMS, consuming them via LTI as externally hosted courses while still using local SSO; grades and completion data flow back into the university's LMS, whereas detailed engagement data are retained within AGRITECH's LRS for cross-country comparison.
- An industry partner offers a domain-specific tool (e.g. farm management software demo environment) that is connected to AGRITECH through LTI 1.3; learners access it transparently from their course, and selected performance indicators are returned to AGRITECH for assessment and credentialing.

Through these combined mechanisms, the AGRITECH platform becomes an interoperable node within the wider European learning ecosystem rather than an isolated system. Interoperability is thus not treated as a purely technical add-on but as a structural condition for portability of learning, efficient use of resources, and sustainable collaboration between VET, HEI and industry actors.

6.4 Credentialing and Verification Standards

Credentialing in AGRITECH provides the formal interface between the digital learning environment and national / European systems of recognition. It translates the competence-based, modular design of the AGRITECH curriculum and micro-credential framework (Chapter 5.7) into verifiable digital artefacts that can be trusted by learners, institutions, employers and public authorities.

The **AGRITECH E-Learning Platform**, as specified in the CARDET Platform Structure, incorporates a dedicated certification mechanism that generates digital certificates and badges upon completion of defined learning units and stores verifiable links in the user profile. This mechanism is explicitly designed to ensure authenticity, traceability and portability of credentials across educational systems and labour markets.

The present section sets out the standards governing (a) credential types and structure, (b) metadata and alignment with European frameworks, (c) credential lifecycle and workflows, (d) verification and integrity mechanisms, and (e) governance and national adaptation.

6.4.1 Credential types and structure

AGRITECH adopts a layered approach to credentialing that reflects the architecture of the learning ecosystem and the three-level AGRITECH Manager (ATM) curriculum. Four main credential types are defined:

1. **Module Completion Certificate -** Issued automatically upon satisfaction of the completion criteria for a single AGRITECH module (e.g. "Remote Sensing for Smart Irrigation"). It documents successful achievement of the module-specific learning outcomes and workload, and can be stacked towards higher-order credentials (level and programme-level awards, micro-credentials).
2. **Level Completion Certificate -** Issued when a learner completes all modules and the associated capstone project within one of the three ATM levels (Foundations, Applied Systems & Data, Integration & Innovation). It certifies coherent achievement of a competence cluster and typically corresponds to a specified ECTS volume and indicative EQF range (for example, EQF 5–6 for Level 2 in HEI contexts).
3. **AGRITECH Certified AgriTech Manager (ATM)** - Awarded upon full completion of all three levels and capstone projects, this credential signifies that the holder has demonstrated the integrated competence profile of the AGRITECH Manager, combining advanced digital, sustainability, and innovation competences as defined in the AGRITECH competence framework.
4. **AGRITECH Micro-credentials** - In line with the EU Council Recommendation on micro-credentials (2022), AGRITECH issues shorter, focused credentials that correspond to discrete, assessed learning units (typically 2–7 ECTS equivalents). These micro-credentials are aligned with the AGRITECH competence framework and EQF, and can be embedded into or recognised within national VET and HEI structures in the six partner countries.

All credential types share a common structural template and are implemented as **digitally verifiable certificates** or **badges** within the platform.

6.4.2 Metadata and alignment with European frameworks

To ensure transparency and portability, all AGRITECH credentials follow a standard metadata schema consistent with the European Learning Model (ELM) and European Digital Credentials for Learning (EDC) conventions. Each credential includes, at minimum:

- **Credential identifier**: unique, persistent ID generated by the platform.
- **Title and type**: e.g. "Module Completion Certificate – UAV Data Capture to Field Prescription"; "Micro-credential – FMIS for Field Technicians"; "AGRITECH Certified AgriTech Manager".
- **Issuer information**: name of issuing institution(s), country, and role (e.g. HEI, VET provider, consortium-level for ATM).
- **Learner information**: name and, where appropriate, learner ID (stored in compliance with privacy requirements).
- **Learning outcomes**: 3–8 clearly formulated outcomes, mapped to the AGRITECH competence framework domains (digital & data, sustainability, entrepreneurship, transversal competences).
- **Workload and credit**: standardised workload (in hours) and, where applicable, ECTS or national credit; indicative EQF level and, where possible, national NQF level.

- **Assessment methods**: brief description (e.g. "scenario-based quiz + rubric-assessed project", "practical lab + portfolio + viva").
- **Quality assurance reference**: link to the AGRITECH QA framework (D1.2) and, where relevant, to institutional or national QA/accreditation arrangements.
- **Issue and validity dates**: date of issue and, where applicable, review or expiry date (for example, for credentials tied to rapidly evolving technologies or regulatory requirements).
- **Verification data**: URL and/or machine-readable verification payload enabling third-party verification (see 6.4.4).

This metadata schema allows AGRITECH credentials to be exported or mapped to EDC, Open Badges-compliant wallets and national micro-credential registries as they emerge in Greece, Romania, Hungary, Italy, Czech Republic and Cyprus.

6.4.3 Credential lifecycle and workflows

Credentialing workflows are tightly integrated with the learning and assessment processes described in Sections 6.1 and 6.2, and follow the learn–apply–validate loop set out in the CARDET Gamification, Assessment & Certification Framework.

The credential lifecycle comprises the following stages:

1. **Eligibility and completion**
    - Completion rules (minimum activities, mastery thresholds, capstone requirements) are defined at course design stage and configured in the LMS.
    - When a learner satisfies these rules, the platform marks the module, level or programme as "completed" in the learning record store.
2. **Credential generation**
    - The platform automatically generates the corresponding credential using the standard metadata schema.
    - Credential artefacts (PDF certificate and/or digital badge) are created and stored in the learner's profile, together with the unique verification link.
3. **Notification and delivery**
    - The learner receives an automated notification (email and in-platform message) confirming successful completion and providing direct access to download and share options.
    - Where institutions choose to mirror AGRITECH credentials in their own systems (e.g. HEI student information systems), exports can be triggered via APIs described in Section 6.3.
4. **Use and stacking**
    - Learners may present AGRITECH credentials to VET providers, HEIs or employers, or use them as evidence in recognition of prior learning procedures.
    - Within the platform, completion of specified credential "stacks" unlocks further modules or recognition events (e.g. awarding of ATM certification).
5. **Review, renewal and revocation**
    - Where content becomes obsolete (for instance, due to rapid technological change) or where a credential is found to have been issued erroneously, administrators can mark a credential as superseded or revoked.
    - Revocation or supersession is reflected in the verification endpoint, ensuring that third parties always see the current validity status.

This lifecycle ensures that credentialing is both automated (to reduce administrative burden) and controlled (to ensure QA and traceability).

6.4.4 Verification and integrity mechanisms

Verification is essential for ensuring that AGRITECH credentials are trusted beyond the platform itself. The CARDET platform structure already specifies that certificates are issued through a mechanism that ensures authenticity and portability, with verification links stored centrally.

AGRITECH adopts the following verification standards:

- **Unique verification URLs** - Each credential carries a unique verification URL (printed as text and optionally encoded as a QR code on PDF certificates). When accessed, this endpoint displays a minimal verification record (issuer, learner name, credential title, date, status) and, where appropriate, the mapped competences and EQF level.
- **Digitally signed payloads** - Verification responses and badge payloads are digitally signed using platform-level keys, enabling consuming systems (e.g. institutional registries, employer HR systems or external wallets) to validate integrity and provenance. The design is compatible with EDC and Open Badges 3.0 conventions, which several partner countries (notably Czech Republic, Italy and Hungary) are already aligning with in their national micro-credential strategies.
- **Audit trails** - The platform maintains full logs of credential issuance, modification and revocation actions, linked to administrator identities and timestamps, as part of the broader audit and logging framework described in Section 6.2.
- **Interoperability hooks** - APIs and export functions enable credentials to be shared with or consumed by external systems (e.g. institutional LMS, national registries or EU-level services), in line with the integration capabilities outlined in the platform structure (API endpoints for external systems, digital credential wallets and EU open-badge directories).

These mechanisms ensure that any stakeholder can independently verify the authenticity and current status of an AGRITECH credential, without needing direct access to the internal LMS.

6.4.5 Governance, QA and national adaptation

Credentialing is embedded within the AGRITECH quality assurance and governance framework rather than treated as a purely technical layer. The Quality Plan (D1.2) defines quality indicators for online platforms, including learning assessment forms, information management and stakeholder involvement, all of which apply directly to credential issuance.

Key governance provisions include:

Role of CARDET and QA partners
CARDET, as WP4 and platform lead, is responsible for implementing and maintaining the certification mechanism, while QA partners (OECON, ACQUIN) and the International Expert Panel validate that credential designs and workflows meet agreed methodological and quality standards.

Institutional roles
Partner HEIs and VET providers act as co-issuers for micro-credentials and, where relevant, for module and level certificates. In countries with emerging or established micro-credential legislation (Czech Republic, Italy, Hungary, Romania for HEIs), these institutions anchor AGRITECH credentials in national QA and accreditation systems.

National adaptation

Given the heterogeneous starting points of the six training countries (GR, RO, HU, IT, CZ, CY) regarding micro-credentials and digital credentials, AGRITECH credentials are designed to be **European-standard by default and nationally adaptable by construction**. Where national frameworks already exist or are emerging (CZ, HU, IT, RO-HE), AGRITECH metadata are aligned with national requirements and can be registered or recognised accordingly. Where frameworks are not yet in place (GR, CY, parts of RO VET), AGRITECH credentials function as institutionally recognised, QA-backed micro-credentials that are ready for future incorporation into national systems.

Continuous improvement

Feedback collected through pilot and official training cycles (VET and Master levels) on the clarity, usability and perceived value of credentials feeds into iterative refinements of descriptors, formats and workflows, in line with the continuous improvement loop defined in the Platform Structure and QA Plan.

Through these standards, AGRITECH ensures that digital certificates and micro-credentials issued via the platform are not only technically sound, but also educationally meaningful, quality-assured and progressively embedded in national and European recognition ecosystems.

6.5 Analytics and Reporting

Analytics and reporting functions convert platform activity into actionable intelligence for learners, educators, institutions, and the consortium. They underpin performance monitoring, quality assurance, evaluation and, ultimately, the adaptation of the AGRITECH ecosystem over time.
The analytics design must leverage the xAPI and LRS architecture described in Section 6.3, while respecting privacy and data-protection requirements and the evaluation framework defined in the Quality Plan.

6.5.1 Objectives and scope

Analytics and reporting serve several interconnected objectives:

- **Pedagogical support**: providing learners and trainers with timely, meaningful insight into progress, engagement and performance.
- **Quality assurance and improvement**: supplying evidence to assess the effectiveness, usability and inclusiveness of modules, tools and pathways.
- **Management and policy**: enabling institutional leaders and project governance to track uptake, completion and impact across countries and institutions.
- **Evaluation and research**: generating well-structured datasets for WP4 evaluation activities and, where relevant, research on digital and sustainable agriculture education.

These objectives apply across both pilot phases (VET and Master-level) and subsequent full training cycles.

6.5.2 Data sources and event model

Analytics will draw on:

- **Platform event data**, captured via xAPI statements and LMS logs (enrolments, logins, resource views, quiz attempts, completions, credential issuance);
- **Assessment data**, including scores, rubric ratings and capstone evaluations;

- **User-generated feedback**, such as course ratings, brief surveys and structured evaluation forms;
- **Contextual data**, including country, institution type, user role, and (where lawful and proportionate) optional demographic or background variables relevant to inclusion monitoring.

The platform must ensure that key events are consistently captured and mapped to a documented event taxonomy, so that indicators can be calculated comparably across modules, cohorts and countries.

6.5.3 Dashboards and user-specific views

Analytics output must be tailored to different user groups:

Learners

1. Visualisations of individual progress within modules, levels and the overall programme;
2. Indicators of mastery against learning outcomes or competence clusters;
3. Simple comparative feedback (e.g. personal progress against recommended pace) without exposing other learners' personal data.

Trainers and tutors

4. Cohort-level dashboards showing engagement (logins, activity completion), performance (scores, completion rates) and risk indicators (inactivity, repeated failures);
5. Tools for drilling down to individual learner trajectories where intervention is needed;
6. Summary reports after each module or cohort, supporting reflective practice and course refinement.

Institutional administrators

7. Aggregated views by course, programme and institution, including enrolment, completion, drop-out and credential issuance;
8. Comparisons across departments, programmes or sites (where relevant) to inform resource allocation and strategic decisions.

Project-level governance and WP4

9. Cross-country dashboards aggregating key indicators by country, partner type and pilot phase;
10. Time-series views to track changes across iterations (e.g. between VET pilot, Master-level pilot and first official training);
11. Exportable summary reports aligned with the project's KPI and impact reporting requirements.

Dashboards should be configurable, allowing filtering by relevant dimensions (country, institution, course, time window) and export in common formats.

6.5.4 Key indicators

While the exact indicator set will be refined under WP4, the platform must support calculation and reporting of at least the following categories:

Access and participation

12. Number of registered users by role, country and institution;
13. Enrolments per module, level and programme;
14. Active users over defined periods.

Engagement

15. Frequency and duration of logins;

16. Completion of core learning activities (e.g. viewing required resources, attempting quizzes);
17. Participation in interactive or collaborative elements (where available).

Achievement and progression

18. Assessment completion and success rates;
19. Module, level and programme completion rates;
20. Time-to-completion and patterns of interruption or drop-out.

Credentialing

21. Number and distribution of module, level and programme-level certificates issued;
22. Stacking patterns (e.g. typical combinations of micro-credentials per learner);
23. Cross-institutional recognition where it can be tracked.

Inclusion and equity

24. Where feasible and lawful, disaggregation of key indicators by country, institution type, and selected equity variables (e.g. urban/rural, gender), in order to detect and address participation or achievement gaps.

These indicators directly support the quality assurance and accessibility/inclusion requirements described in Sections 5.5 and 5.6.

6.5.5 Reporting, exports and governance

The platform must provide:

- **Scheduled reports** (e.g. monthly, per cohort) that can be automatically generated and delivered to designated roles (institutional coordinators, WP leaders, project management).
- **On-demand exports** of anonymised or pseudonymised datasets for evaluation and research, with configurable fields and filters.
- **Compliance-aware reporting**, ensuring that reports do not expose personal data beyond what is necessary and authorised, and that aggregation thresholds are applied to prevent re-identification in small groups.

Analytics governance is handled through:

- Clear definition of roles authorised to access different levels of data (individual, cohort, aggregated);
- Alignment of analytics use with the Data Protection Impact Assessment and the project's ethics framework;
- Documentation of indicators, calculation methods and any changes over time, to support reproducibility and comparability across pilots and training cycles.

Through this analytics and reporting architecture, the AGRITECH platform becomes not only a delivery channel for learning, but also a strategic instrument for understanding and improving digital and sustainable agriculture education across the six training organizing countries.

6.6 Platform Readiness Checklist

The Platform Readiness Checklist provides a practical instrument to verify whether the AGRITECH platform is sufficiently configured and tested to support each major implementation phase: (i) internal testing, (ii) pilots (VET and Master levels), and (iii) first official training cycles. It translates the functional and non-functional requirements of Sections 6.1–6.5 into a concise set of verifiable conditions.

The checklist is organised into five domains: (a) core functionality, (b) security and privacy, (c) accessibility and usability, (d) interoperability and credentialing, and (e) analytics and operational preparedness.

6.6.1 Core functionality

Before each phase, the following items must be confirmed:

- All relevant **user roles** (learner, trainer, institutional admin, project admin, QA/evaluator) are configured and tested.
- The **AGRITECH course catalogue** (modules, levels, capstones) is visible and correctly structured for the phase in question (e.g. only pilot modules visible during pilot).
- Enrolment workflows (self-enrolment, bulk enrolment, institutional enrolment) are operational for **VET** and **HEI** cohorts.
- Module pages contain the full set of required elements (welcome video/infographic, learning materials, interactive activities, assessments, completion logic).
- Certificate generation for module and level completion has been tested end-to-end for at least one test user per role.

6.6.2 Security and privacy

- HTTPS is enforced for all platform access and integrations.
- Administrator accounts use strong authentication (e.g. multi-factor authentication where available).
- Role-based permissions have been reviewed and tested; users cannot access data or functions beyond their role.
- A basic **incident response plan** is documented (contact persons, steps, communication channels).
- Privacy notices and consent mechanisms are implemented in all supported languages.
- A Data Protection Impact Assessment (or equivalent analysis) has been completed and any necessary mitigations applied.

6.6.3 Accessibility and usability

- A sample of core pages (login, dashboard, course page, assessment, certificate view) has been checked against WCAG 2.1 AA criteria.
- Captions and/or transcripts are available for all mandatory video content in the pilot/course scope.
- Navigation paths for key tasks (finding and starting a course, completing an assessment, downloading a certificate) have been tested on desktop and mobile devices.
- Low-bandwidth access options (compressed content, downloadable resources) have been validated where relevant.
- Help and support information (FAQ, contact, guidance on using the platform) is available and accessible in all partner languages used in that phase.

6.6.4 Interoperability and credentialing

- At least one form of **SSO** integration has been tested successfully with a partner institution; fallback local account processes are in place.

- LTI 1.3 integration has been configured and tested with at least one external tool (e.g. webinar system or simulation environment) used in the pilot.
- xAPI event capture is operational and xAPI statements from the LMS are reaching the LRS.
- Credential templates (module, level, AGRITECH Manager) are configured with complete metadata (learning outcomes, workload, EQF/EHEA references where applicable).
- Credential verification (via URL or QR code) works correctly for test credentials.
- Agreements on which organisations may issue AGRITECH-branded credentials are documented and implemented in the permissions model.

6.6.5 Analytics and operational preparedness

- Role-specific dashboards (learner, trainer, admin) display the expected information and have been validated against test data.
- Export of anonymised datasets for QA and evaluation has been tested.
- Monitoring metrics (e.g. basic performance and uptime data) are available to technical administrators.
- Support processes (helpdesk routing, response time expectations) are defined and communicated.
- A brief **pilot operations manual** exists, summarising key procedures for enrolment, support, issue escalation and reporting.

The checklist is intended to be used iteratively. Items may be marked as “in development” during early internal testing, but all must be fully satisfied before the first official training cycles. As the platform evolves in response to pilot feedback and technological updates, the checklist itself can be revised, maintaining a living alignment between design specifications and real-world operation.

7. IMPLEMENTATION ROADMAP

This chapter translates the AGRITECH Learning Ecosystem design into an actionable implementation roadmap, showing how the consortium moves from a "designed ecosystem" to an "operational ecosystem" through a staged rollout. It sets out a phased plan (P1 Design Freeze, P2 Pilot, P3 Scale) aligned with project work packages and deliverables, clarifies what is realistically achievable within the project lifetime (and what is intentionally deferred to post-project scaling), and establishes the logic for implementation governance, monitoring, risk management, and change/adoption support across partner countries and pilot hubs. The intention is to ensure that curriculum, platform/tooling, hub operations, and microcredential pathways mature in a controlled way, with evidence and feedback loops informing iterative improvement rather than a one-off "launch and hope" approach.

7.1 Phased Plan and Milestones

Implementation follows a phased plan aligned with the current delivery status and timeline. The eLearning platform and training materials are already under development and **must be finalised by latest 20 March 2026** to ensure operational readiness. Pilot training implementation runs from **1 April 2026** to **26 May 2026** for both **HEI** and **VET** pathways. After the **pilot**, results are assessed and targeted adjustments are implemented so the **AGRITECH ecosystem** is ready for **wider implementation** during academic year **2026–2027**.

PHASE 1: FINALISATION AND PILOT READINESS (MID-MARCH 2026)

PURPOSE : Finalise the eLearning platform and training materials and ensure readiness for structured pilot delivery.

CORE OUTPUTS :

- Pilot-ready eLearning platform release (stable end-to-end learning and assessment flow).
- Finalised pilot training materials for HEI and VET pathways (trainer and learner packages).
- Pilot delivery pack: onboarding guidance, learner support workflow, assessment templates, evaluation instruments.
- Change-control rules for pilot delivery (how fixes are handled without disrupting delivery).

EXIT CRITERIA (PHASE 1 IS COMPLETE WHEN ALL ARE TRUE) :

- Platform is stable and tested for pilot workflows (access, learning, submissions, tracking, feedback).
- Pilot learning materials are finalised, versioned, and packaged for delivery.
- Trainers and hub coordinators are onboarded and equipped with delivery and assessment guidance.
- Credential steps are operational for pilot scope (eBadges and ECTS microcredential issuance process).
- Pilot logistics are confirmed (cohort plan, access rules, support routes, reporting lines).

PHASE 2: PILOT TRAINING IMPLEMENTATION (1 APRIL 2026 TO 26 MAY 2026)

PURPOSE : Deliver pilot training through the ecosystem, generate evidence, validate usability and learning pathways, and apply the recognition approach in practice.

PILOT DELIVERY SITES (PROPOSED) :

- **HEI:** USAMV, MATE, AUTH (countries: RO, HU, GR)
- **VET:** LAND, WRLS, ELGO (countries: IT, CZ, GR)

RECOGNITION APPROACH APPLIED DURING THE PILOT :

- **eBadges** issued upon completion of each module.
- **Microcredentials awarded in ECTS** after successful submission and assessment of the **Capstone Project**:
  - **VET:** 3 ECTS
  - **HEI:** 4 ECTS
- Issuing responsibility: each institution delivering the training issues credentials within its scope, following agreed project rules and documented learner evidence.

EXIT CRITERIA (PHASE 2 IS COMPLETE WHEN ALL ARE TRUE) :

- Pilot training is delivered within the agreed period (**1 April** to **26 May 2026**).
- Module completion and capstone evidence are complete and traceable.
- **eBadges** and **ECTS microcredentials** have been issued using the agreed process at all pilot sites.
- Learner feedback, trainer feedback, and platform use evidence are collected and structured for review.
- A consolidated pilot findings package exists to drive improvements.

PHASE 3: POST-PILOT ASSESSMENT, ADJUSTMENTS, AND SCALE READINESS (JUNE 2026 TO ACADEMIC YEAR 2026–2027)

PURPOSE : Assess pilot results, implement targeted improvements, and prepare an implementation-ready package for **wider adoption** in academic year **2026–2027**.

CORE OUTPUTS :

- Pilot evaluation package (learning outcomes, completion, assessment outcomes, qualitative feedback, platform usability and performance findings).
- Prioritised improvement backlog (platform fixes, content refinements, assessment refinements, delivery adjustments).
- Consolidated release of platform and materials for replication (stable package for 2026–2027 delivery).
- Updated guidance for delivery teams based on pilot evidence.

EXIT CRITERIA (PHASE 3 IS COMPLETE WHEN ALL ARE TRUE):

- Pilot evaluation results are documented and agreed internally.
- Platform and materials are updated and versioned based on approved changes.
- Replication guidance is finalised for additional adopters (delivery steps, support steps, assessment and credential steps).
- The ecosystem package is ready for implementation during academic year 2026–2027.

MILESTONE SCHEDULE

ID	MILESTONE	TARGET DATE	COMPLETION EVIDENCE
M1	Platform scope frozen for pilot release	31 Jan 2026	Signed-off pilot feature scope and change-control rule
M2	Draft training materials complete (HEI + VET)	28 Feb 2026	Full draft packages per module and pathway (trainer + learner + assessments)
M3	Platform release candidate ready	29 Feb 2026	Release candidate deployed; core flows tested
M4	Pilot readiness gate passed	10 Mar 2026	QA checklist completed; support workflow tested; assessment templates ready
M5	Pilot v1.0 released (platform + materials)	15 Mar 2026	Versioned pilot package published; onboarding pack issued
M6	Pre-pilot onboarding and technical verification	21 - 26 Mar 2026	User accounts, enrolment workflows, trainer rehearsal, issue log closed or accepted
M7	Pilot launch	27 Mar 2026	Cohorts active at all confirmed sites; onboarding completed
M8	Mid-pilot checkpoint	22 Apr 2026	Monitoring note; issues log; controlled fixes applied if needed
M9	Pilot training completed	26 May 2026	Completion list; capstone submissions collected; credential evidence ready
M10	Pilot evaluation completed	10 Jun 2026	Evaluation summary, feedback synthesis, agreed improvement backlog
M11	Updated release prepared for 2026–2027 implementation	31 Aug 2026	Versioned improved platform/materials package + replication guidance

Table 5. MILESTONE SCHEDULE

7.2 Roles and Responsibilities

Effective implementation of the **AGRITECH learning ecosystem** requires clear ownership across curriculum and ecosystem design, platform deployment, pilot hub operations, quality assurance and evaluation, and recognition and policy dialogue. While partner roles are described throughout the report, this chapter consolidates them into an operational responsibility model to support execution across the three implementation phases (**P1- P3**), including the pilot delivery period (**1 April 2026** to **26 May 2026**) and the subsequent adjustment cycle leading to **wider implementation** in academic year **2026–2027**.

7.2.1 Governance layers and implementation logic

Implementation responsibilities are structured across four interacting layers:

- **Project governance (PMB)**: strategic direction, approval of major changes, and escalation point for cross-work package decisions.
- **Technical and thematic leadership (WP Leaders / Tech Lead / QA Lead)**: delivery ownership for specific workstreams (*curriculum/ecosystem, platform, QA & evaluation, recognition*).
- **National hub coordination (Hub Coordinators + National Hub Leads)**: operational execution of pilots and scaling at country level (*delivery logistics, stakeholder engagement, data collection*).

- **External expert support (IEP)**: advisory input to ensure relevance, quality, and alignment with sector needs.

Decision-making follows a "closest competent level" rule (operational issues handled locally; cross-cutting issues escalated to WP leads; strategic changes escalated to PMB), supported by structured consultation with expert and stakeholder bodies where needed.

7.2.2 Role definitions (implementation perspective)

Core implementation roles

- **PMB (Project Management Board) -** Accountable for overall implementation governance; approves major scope changes, scaling decisions, and risk responses affecting multiple workstreams.
- **WP2 Lead (Ecosystem & Curriculum Design - PAMEA) -** Responsible for curriculum portfolio coherence, learning pathway design, content governance (updates and versioning), and alignment with the competency framework. Coordinates WP2 execution, including Activity 2.5 gamified materials in terms of design coherence and pedagogical integration..
- **Tech Lead (Platform Deployment - CARDET) -** Responsible for platform configuration, deployment, maintenance, user management support, interoperability decisions, release management, and platform-related technical support processes.
- **Technical supervision (MATE)** - Provides technical oversight to ensure platform and delivery integration quality, supports technical validation of releases, and contributes to resolving cross-workstream technical dependencies.
- **Hub & Pilot Lead (DDTG + Partner's network) -** Responsible for hub implementation methodology, pilot rollout coordination, train-the-trainer delivery alignment, and operational readiness support to national hubs, including coordination of the intensive pilot delivery period.
- **QA & Evaluation Lead (WP1 - ACQUIN) -** Responsible for evaluation design, QA instruments, monitoring loops, evidence integrity, and synthesis of pilot findings into improvement actions.
- **Recognition & Policy Dialogue Lead (selected HEIs + authorities) -** Responsible for alignment of microcredentials/recognition pathways, engagement with relevant authorities, and portability/recognition agreements and guidance.
- **National Hub Leads (one lead institution per country) -** Responsible for country-level delivery coordination, stakeholder mobilisation, pilot delivery, reporting, and sustainability embedding as described in Section 7.2.4.

Pilot delivery responsibilities linked to credentials

During the pilot (**1 April 2026** to **26 May 2026**), each delivering institution is responsible for implementing the agreed recognition process within its scope:

- **eBadges** are issued after module completion.
- **ECTS microcredentials** are issued after successful submission and assessment of the Capstone Project:
  - **VET:** **3 ECTS**
  - **HEI:** **4 ECTS**

Capstone assessment is carried out locally by the trainer or teacher at the delivering institution, using common assessment guidance and evidence requirements agreed at project level.

7.2.3 RACI responsibility matrix by phase

RACI legend: R = Responsible (does the work) | **A** = Accountable (owns the outcome) | **C** = Consulted | **I** = Informed

Phase and implementation area	PMB	WP2 Lead PAMEA	Tech Lead CARDET	Hub and Pilot Lead DDTG	QA Lead (WP1) ACQUIN	Recognition and Policy Lead	National Hub Leads
P1 – DESIGN FREEZE AND READINESS							
Ecosystem and curriculum design freeze (module set, pathways, governance rules)	I	A/R	C	C	C	C	I
Platform configuration and readiness checklist (pilot release)	I	C	A/R	C	C	I	I
Hub model definition (readiness criteria, onboarding package, hub stages)	I	C	C	A/R	C	I	C
QA baseline (evaluation plan, instruments, evidence standards)	I	C	C	C	A/R	I	I
Recognition principles agreed in principle (pathway options, minimum data, templates)	I	C	I	I	C	A/R	C
P2 – PILOT DELIVERY VIA NATIONAL HUBS (1 APRIL 2026 TO 26 MAY 2026)							
Hub setup and train-the-trainer delivery (local onboarding, staffing, logistics)	I	C	C	A	C	I	R
Pilot cohorts delivery (all 7 modules delivered as an intensive course)	I	C	C	A	C	I	R
Platform operations (accounts, support, analytics access, releases)	I	I	A/R	C	C	I	C
Pilot QA and evaluation (data capture, surveys preparation, reporting routines)	I	C	C	C	A/R	I	R
First credential pilots (eBadges, ECTS microcredentials after capstone)	I	C	C	C	C	A/R	R
P3 – SCALING AND CONSOLIDATION (POST-PILOT ADJUSTMENTS AND READINESS FOR 2026–2027)							
Module library expansion and localisation process	I	A/R	C	C	C	C	R

Hub network expansion (replication package, community rhythm)	I	C	C	A	C	I	R
Recognition scaling (portability guidance, adoption pathways)	I	C	I	C	C	A/R	R
Continuous improvement loop (pilot findings to updates to rollout)	I	A	C	C	R	C	R
Sustainability embedding (post-project operating model, stakeholder commitments)	A	C	C	C	C	C	R

Table 6. RACI responsibility matrix by phase

This matrix reflects the five "major areas" that must be covered in Chapter 7: ***ecosystem & curriculum design (WP2), platform deployment (Tech Lead/CARDET), hubs & pilots (DDTG & partners), QA & evaluation (WP1), and recognition & policy dialogue (selected HEIs/authorities)***.

7.2.4 Country-level responsibilities for National Hub Leads

National Hub Leads operationalise AGRITECH within each country and ensure that pilots and scaling are feasible in real institutional settings. Across P2 and P3, National Hub Leads are expected to:

National Hub Leads operationalise AGRITECH within each country and ensure that pilots and scaling are feasible in real institutional settings. Across P2 and P3, National Hub Leads are expected to:

Coordinate delivery and stakeholder engagement

- Convene local stakeholders (VET providers, employers, farmers, mentors, authorities as relevant).
- Schedule cohorts, trainers, and learning activities for intensive delivery during the pilot period.

Ensure implementation readiness

- Confirm staffing, access to required resources, and learner recruitment.
- Support trainer onboarding and adherence to the common delivery approach.

Operate QA and reporting routines

- Collect evaluation data (participation, completion, assessment outcomes, satisfaction).
- Submit agreed evidence packages and implement improvement actions.

Support recognition and sustainability

- Implement eBadge and ECTS microcredential issuance within the agreed project process.
- Engage national or sector bodies for recognition discussions where feasible.
- Identify realistic routes for embedding modules and maintaining hub operations post-project.

NAMED NATIONAL HUB LEADS FOR THE PILOT PERIOD

The following institutions act as National Hub Leads for pilot delivery:

HEI pathway :

- Romania: **USAMV**
- Hungary: **MATE**
- Greece: **AUTH**

VET pathway:

- Italy: **LAND**
- Czech Republic: **WRLS**
- Greece: **ELGO/OECON**

Where a country hosts both pathway types, delivery coordination is organised to keep responsibilities clear per pathway and to ensure consistent reporting.

7.2.5 Decision channels and escalation path

To prevent responsibility dilution and slow decision cycles, implementation issues follow a structured escalation path:

1. **Local resolution (Hub level):** Hub Coordinator and trainer team address operational issues (delivery scheduling, learner support, minor platform guidance).
2. **Workstream resolution (Lead level):**
    1. Platform issues → **Tech Lead (CARDET**), with technical supervision support as needed
    2. Curriculum and content issues → **WP2 Lead (PAMEA)**
    3. QA and evidence issues → QA Lead (WP1) (**ACQUIN**)
    4. Recognition issues → Recognition (**MATE**) and Policy Dialogue Lead (**ELGO**)
3. **Cross-workstream resolution:** WP leads coordinate integrated fixes (for example content changes requiring platform updates, or QA findings requiring curriculum revision).
4. **Strategic escalation:** unresolved or high-impact issues are escalated to the PMB (scope change, major resource shifts, or conflicts across governance layers).

7.3 Monitoring and Evaluation Framework (KPIs)

To ensure the **AGRITECH learning ecosystem** is implemented with consistent quality and measurable results, monitoring and evaluation will be carried out through a compact set of **Key Performance Indicators (KPIs)** combining: ***(i)*** quality assurance indicators, ***(ii)*** platform analytics, and ***(iii)*** pilot evidence. KPI monitoring is structured across the three implementation phases (P1–P3) and supports continuous improvement by feeding directly into the project's **Plan - Do - Check - Act (PDCA**) quality cycle.

The **KPI framework** is designed for the project timeline and delivery model: platform and training materials finalised by mid-March 2026, pilot delivery from **1 April 2026** to **26 May 2026** (intensive delivery of all **7 modules** for both **HEI** and **VET**), followed by a structured post-pilot adjustment cycle to prepare wider implementation during academic year **2026–2027**.

7.3.1 KPI dimensions and phase alignment

KPIs are grouped into five dimensions to ensure balanced monitoring of readiness, adoption, learning performance, recognition, inclusion, and ecosystem/service performance:

1. **Readiness and delivery capacity** (P1 focus)
2. **Access and participation** (P2–P3 focus)
3. **Learning performance** (P2–P3 focus)
4. **Recognition and portability** (P2–P3 focus)
5. **Ecosystem and service quality** (P1–P3 focus)

KPIs are used differently by phase:

- **P1 (Design freeze and readiness):** confirm instrumentation, readiness status, and minimum operational performance before pilot launch.
- **P2 (Pilot delivery):** track participation, completion, assessment evidence, hub delivery performance, and first credential issuance.

- **P3 (Scale and sustainability preparation):** track improvement implementation, replication readiness, and signals that support 2026–2027 implementation.

Targets are confirmed during Phase 1 based on realistic recruitment and delivery capacity. Where numeric targets are not yet agreed, pilot reference values are used to ensure the pilot produces evaluable evidence rather than "measuring nothing".

7.3.2 Data sources, frequency, and governance use

KPI data will be collected through a mixed-method approach, using:

- **Platform analytics (automatic):** registrations, active usage, module progress, completions, assessment submissions, credential issuance logs, support tickets.
- **Cohort surveys (per cohort and lightweight module pulse checks):** learner satisfaction, perceived skills gain, usability and accessibility feedback. Surveys will be implemented using SurveyMonkey and aligned across sites.
- **Hub evidence packages (per pilot cycle):** delivery reports, attendance proof, local implementation notes, and lessons learned.
- **QA logs and review minutes (periodic):** non-conformities, corrective and preventive actions, audit trail, and improvement backlog tracking.

Review cadence and governance use

- **P1 (readiness period):** readiness dashboard reviewed at least biweekly until pilot launch.
- **P2 (pilot period 1 April - 26 May 2026):** KPI dashboard reviewed monthly, with a mid-pilot checkpoint review to trigger controlled corrective actions.
- **P3 (post-pilot):** KPI review linked to improvement backlog closure and release planning for academic year 2026–2027.

KPI results are used for operational decisions (fixes, delivery support, trainer guidance updates), governance decisions (scope changes, rollout readiness), and improvement prioritisation within the PDCA cycle.

7.3.3 Compact KPI set

The table below defines the proposed compact KPI set for P1–P3. Where numeric targets are not yet agreed consortium-wide, **pilot reference thresholds** are provided as starting points to avoid "measuring nothing", and should be validated during Phase 1.

KPI Dimension	KPI	Definition / how measured	Phase	Data source	Frequency	Responsible (data owner)	Target / reference value
Readiness and delivery capacity	Readiness gate passed	Pilot readiness confirmed (platform stable for delivery and assessment; materials finalised and versioned; support and credential process operational)	**P1**	Readiness checklist + review minutes	Once, before pilot	WP2 Lead + Tech Lead + QA Lead	Target: Pass by 15 Mar 2026
Readiness and delivery capacity	Training package completion	All 7 modules packaged for delivery (trainer guide, learner materials, activities, assessments, capstone guidance) for HEI and VET pathways	**P1**	Content repository + QA checklist	Once, before pilot	WP2 Lead	Target: 100% by 15 Mar 2026

Access and participation	Unique learners enrolled	Count of unique learners enrolled in the pilot cohorts (by pathway and site)	**P2–P3**	Platform analytics + hub registers	Per cohort + monthly	National Hub Leads + platform admin	Reference: set target in P1 per site; minimum viable cohort size defined in P1
Access and participation	VET/HEI participation mix	Share of learners by pathway (VET vs HEI)	**P2–P3**	Registration profiles	Per cohort	WP2 Lead + National Hub Leads	Track baseline in P2; target set for P3 if needed
Access and participation	Active usage rate	% of enrolled learners active at least once per week during the intensive delivery period	**P2**	Platform analytics	Weekly summary + monthly	Platform admin	Reference: ≥60% weekly active during delivery weeks
Learning performance	Module completion rate	% of learners completing required elements for each module	**P2–P3**	Platform analytics + trainer records	Per cohort	National Hub Leads	Reference: ≥80% completion
Learning performance	Capstone submission rate	% of enrolled learners submitting a capstone project	**P2–P3**	Platform records + hub evidence	Per cohort	National Hub Leads	Reference: ≥70% submission
Learning performance	Assessment success rate	% of learners meeting pass criteria (module assessments and capstone)	**P2–P3**	Assessment records	Per cohort	Delivering institution (trainer) + QA Lead	Reference: ≥80% pass among submissions
Learning performance	Learner perceived gain	Self-reported skills gain (pre/post) or end-of-course perceived competence increase	**P2–P3**	SurveyMonkey surveys	Per cohort	QA Lead	Baseline in P2; target set after first cohort
Recognition and portability	eBadges issued	Count of eBadges issued for module completion (by module and site)	**P2–P3**	Credential logs	Monthly + end of cohort	Delivering institutions + platform admin	Reference: issuance for all verified completions
Recognition and portability	ECTS microcredentials issued	Count of ECTS microcredentials issued after capstone assessment: VET 3 ECTS, HEI 4 ECTS	**P2–P3**	Issuance logs + assessment evidence	End of cohort + monthly	Delivering institutions + Recognition Lead	Reference: issuance for all eligible capstone passes
Ecosystem and service quality	Active hubs operational	Number of hubs meeting minimum criteria (delivery completed + evidence package submitted)	**P2–P3**	Hub evidence packages	Per pilot cycle	Hub and Pilot Lead + National Hub Leads	Target for P2 pilot: 6 hubs operational
Ecosystem and service quality	Platform uptime	% uptime over reporting period during readiness and pilot	P1–P3	Monitoring logs	Monthly	Tech Lead	Reference: ≥99% during pilot months
Ecosystem and service quality	Support performance	Median time to close support tickets and % resolved within SLA	P2–P3	Helpdesk logs	Monthly	Tech Lead + platform admin	SLA set in P1; reference compliance ≥85%

Table 7. Proposed KPIs

* ***Note on targets:*** *Reference values above are* ***starter benchmarks*** *meant to avoid a "no-target" evaluation in P2; they must be validated in Phase 1 based on final pilot scope and realistic partner capacity.*

7.3.4 How KPI results feed the QA improvement loop (PDCA)

KPI data is used to drive improvement actions:

- **Plan:** confirm KPI definitions, baselines, dashboards, targets, and data responsibilities during P1.
- **Do:** deliver the intensive pilot cohorts (all 7 modules for HEI and VET) while capturing analytics, hub evidence, and survey data.
- **Check:** review KPI dashboards during the pilot and consolidate results after completion, triangulating platform metrics, surveys, and hub evidence.
- **Act:** raise corrective actions and improvement items (content updates, platform fixes, trainer support improvements, accessibility changes), track them to closure, and incorporate them into the consolidated package for academic year 2026–2027.

This links monitoring directly to the continuous improvement mechanism and ensures pilot evidence leads to measurable adjustments before scaling.

7.4 Risk Management and Mitigation

Effective delivery of the **AGRITECH learning ecosystem** depends on proactively managing operational, technical, regulatory, and adoption risks across the full implementation cycle. In line with widely used risk management approaches (e.g., ISO 31000, COSO ERM, and European Commission project risk management templates), **AGRITECH** applies a structured process to: ***(i)*** identify risks early, ***(ii)*** assess likelihood and impact, ***(iii)*** define mitigation and contingency actions, ***(iv)*** assign clear ownership, and ***(v)*** monitor and escalate issues through the project governance structure. This section presents a learning-ecosystem-focused risk view and is designed to be used as an operational companion to the **implementation roadmap (phases P1–P3)** and the **Monitoring and Evaluation Framework (KPIs)**.

As noted in the internal “missing data” review, the current gap is not the *reference to risk management standards*, but the absence of a concrete ecosystem-specific risk register with scored risks, mitigation measures, and owners.

7.4.1 Risk management process and governance

Risk identification. Risks are identified continuously through:

1. implementation planning (Phase P1), pilot preparation and launch activities (Phase P2), and scaling and sustainability planning (Phase P3);
2. feedback loops from hubs, Communities of Practice (CoPs), and train-the-trainer activities;
3. signals from KPIs (e.g., low completion rates, low engagement, platform availability issues) as defined in Section 7.3.

Risk assessment. Each risk is assessed using a simple **Likelihood / Impact** scale (Low/Medium/High). This intentionally lightweight approach supports fast decision-making during pilots, while allowing more detailed scoring if needed later.

Risk treatment. For each risk, AGRITECH defines:

- **Mitigation measures** (to reduce likelihood and/or impact),
- **Contingency actions** (what to do if the risk materialises), and
- **Early warning indicators** (how we detect it quickly).

Ownership and escalation. Every risk has a **risk owner** (WP/role) responsible for monitoring and coordinating mitigation actions. High-impact risks are escalated through the project governance channels (WP leads → Project Management Board), especially when they affect cross-country roll-out, compliance, or platform reliability.

Review cadence. The ecosystem risk register is reviewed:

- **monthly** within WP operational meetings during active pilots and platform releases, and
- **quarterly** at governance level (or earlier if an escalation trigger occurs).

7.4.2 Ecosystem risk register (initial operational version)

The table below provides the operational risk register for learning ecosystem implementation. It will be refined using country-level inputs and pilot evidence (hub reporting, platform analytics, learner and trainer feedback) and will feed directly into the continuous improvement loop after the pilot.

Risk ID	Risk description	Phase most affected	Likelih	Impact	Early warning indicators	Mitigation measures	Contingency actions	Risk owner (role / WP)
LE-R1	Limited acceptance or portability of microcredentials (ECTS) reduces perceived value and institutional uptake	P2–P3	M	H	Low stakeholder interest; questions on recognition; delays in issuance rules	Define clear issuing rules and evidence requirements; align credential metadata and learner evidence pack; engage relevant stakeholders where feasible; communicate "what is guaranteed in-project"	Issue project-recognised certificates and portfolio evidence in parallel; focus scaling first where recognition routes are feasible	Recognition and Policy Lead (with HEIs) + WP2 Lead
LE-R2	Institutional resistance to integrating modules due to workload, calendar constraints, or administrative friction	P2–P3	M	H	Slow internal approvals; reluctance to allocate teaching hours; low commitment to continuation	Provide implementation options (intensive course, blended, CPD); provide workload guidance; share pilot evidence and delivery playbook; enable modular adoption	Offer lighter adoption pathway (selected modules, non-credit CPD) and stepwise integration	National Hub Leads + WP2 Lead
LE-R3	Platform stability and performance issues during intensive pilot delivery disrupt learning and assessment	P1–P2	M	H	Failed end-to-end tests; repeated critical incidents; surge in support tickets	Readiness gate by mid-March; rehearsal with trainers; release candidate testing; change control during pilot (critical fixes only); monitoring of availability and key user flows	Temporary fallback to downloadable materials and alternative submission channels; rollback to last stable release; extend deadlines where needed	Tech Lead (CARDET) + Technical supervision (MATE)
LE-R4	Training materials not finalised or inconsistent across modules and pathways (HEI/VET), affecting quality and learner experience	P1–P2	M	H	Missing components; unclear instructions; mismatched assessments; late edits	Content freeze and versioning by mid-March; module QA checklist; coherence check across the 7 modules; controlled change process	Publish corrected errata pack and updated versions with clear release notes; prioritise fixes impacting assessment and learner guidance	WP2 Lead (PAMEA) + Delivering institutions
LE-R5	Hub delivery readiness gaps (staffing, scheduling, learner recruitment, logistics) reduce pilot quality	P1–P2	M	H	Unconfirmed cohorts; trainer availability issues; weak recruitment; timetable clashes	Pre-pilot onboarding window (mid-March to 31 March); delivery calendar locked; local readiness checklist; defined local support routines	Adjust cohort size and pacing; add support sessions; reallocate trainer capacity locally	National Hub Leads

LE-R6	Intensive delivery format (all 7 modules in one pilot period) causes learner overload, attrition, and weak completion evidence	P2	M	H	Drop in activity after week 1; late submissions; complaints about workload	Clear pacing plan and weekly rhythm; explicit workload expectations; minimum viable learning activities per module; proactive learner support; structured catch-up points	Extend submission windows; offer targeted catch-up sessions; prioritise completion of essential activities tied to capstone	National Hub Leads + Hub and Pilot Lead
LE-R7	Trainer capacity limits, uneven delivery quality, or staff turnover undermines consistency across sites	P2–P3	M	M/H	Deviations in delivery approach; inconsistent learner guidance; replacement trainers mid-course	Train-the-trainer alignment; delivery playbook; shared session plans; backup trainer identification; short coordination check-ins during pilot	Rapid onboarding for replacement trainers; standardised materials pack; escalation for delivery drift	Hub and Pilot Lead + National Hub Leads
LE-R8	Assessment inconsistency for capstone projects (local trainer-only assessment) affects credibility of ECTS microcredentials	P2–P3	M	H	Grade variance across sites; learner disputes; weak feedback quality	Common rubric and pass rule; short calibration using sample capstones; evidence pack requirement (submission, rubric, feedback)	Second-marker option inside the same institution for disputes; structured resubmission rule; additional moderation on selected samples	QA and Evaluation Lead (WP1) + Delivering institutions
LE-R9	Credential issuance delays or process confusion (eBadges per module, ECTS microcredentials after capstone)	P2	M	M/H	Backlog after pilot end; missing evidence; inconsistent issuance timelines	Simple issuance workflow and checklist; assign local issuing responsibility; maintain issuance log; define expected issuance timeline	Issue provisional completion confirmation; complete issuance after evidence pack is corrected	Delivering institutions + Recognition and Policy Lead
LE-R10	Data protection or cybersecurity incident (platform accounts, learner data, surveys via SurveyMonkey)	P1–P2	L /M	H	Unclear consent; requests for unnecessary personal data; suspicious access patterns	Data minimisation; privacy notice for pilot; controlled access; secure storage; survey settings aligned to project policy; incident response procedure	Suspend affected processes; switch to anonymised surveys; remediate access; notify governance level immediately	Tech Lead (CARDET) + QA Lead (WP1) + PMB (escalation)
LE-R11	Connectivity and device constraints limit access and participation, especially for rural learners	P2	M	M	Learners report access barriers; low activity from specific groups	Mobile-friendly access where feasible; downloadable materials; flexible deadlines; low-bandwidth alternatives	Allow offline completion with later submission; local support sessions at hub sites where possible	National Hub Leads + Tech Lead
LE-R12	Weak or inconsistent evaluation evidence limits the value of pilot findings and slows improvement	P2–P3	M	M	Missing data; low response rates; inconsistent reporting formats	Define minimum indicator set; deploy short SurveyMonkey questionnaires (entry, module pulse, exit); standard reporting notes; combine survey evidence with platform analytics	Use structured interviews with trainers; focus analysis on available KPIs; run a short follow-up survey after pilot	QA and Evaluation Lead (WP1) + WP2 Lead
LE-R13	Cross-workstream coordination failures cause late changes and version confusion	P1–P2	M	M	Multiple versions in circulation; conflicting instructions; late	Single source of truth for versions; release notes; change control approvals; fixed coordination rhythm in March and during pilot	Freeze changes except critical fixes; issue a consolidated “pilot pack” re-release	WP2 Lead + Tech Lead + Hub and Pilot Lead

	(platform vs content vs delivery)				change requests			
LE-R14	Post-project sustainability risk (governance, funding, operational ownership after pilots)	P3	M	H	No commitment signals; unclear operating model; no resources allocated	Define continuation options early; map ownership and minimal operating requirements; embed into institutional plans for 2026–2027 where feasible	Narrow scope to what can be maintained; formalise a light governance model and minimal service offer	PMB + National Hub Leads

Table 8. Operational Risk Register

7.5 Change Management and Adoption

Effective implementation of the **AGRITECH learning ecosystem** depends on the quality of the curriculum, platform, and credential design, and on structured change management that supports people and institutions in adopting new ways of teaching, learning, and recognising achievement. This section describes how **AGRITECH** will drive adoption across partner countries through capability building, institutional embedding, communication and engagement, and support mechanisms. The approach is aligned with the phased roadmap (P1 - P3) and uses the **hub model** and **Communities of Practice (CoPs)** to enable local uptake, consistency, and scaling.

7.5.1 Change levers

Change management is operationalised through four mutually reinforcing levers:

1) Capability building (staff training pathways and onboarding)

To enable consistent delivery and assessment across countries and institutions, AGRITECH uses structured onboarding pathways, including:

- **Train-the-Trainer (ToT)** for trainers, hub facilitators and mentors, covering pedagogy, delivery sequencing for the intensive format, assessment rubrics, inclusion practices, and credential workflows.
- **Platform onboarding** for trainers and learners, covering navigation, learning pathway flow, assignments, evidence upload, and credential access and verification.
- **Assessor calibration sessions** to support consistent capstone evaluation and credible ECTS microcredential issuance.

This ensures adoption does not depend on individual trainers but becomes repeatable across hubs.

2) Institutional embedding (curriculum and regulatory integration)

Adoption becomes sustainable when AGRITECH modules are embedded into formal and semi-formal structures rather than delivered as isolated pilots. Institutional embedding includes:

- Mapping the 7 modules to existing VET and HEI curricula and learning outcomes, and aligning to national requirements where feasible.
- Defining how credentials are used in practice: module completion tracked through eBadges; ECTS microcredentials issued after capstone assessment (3 ECTS for VET and 4 ECTS for HEI).
- Using hub governance and institutional coordination to align delivery with institutional calendars, assessment rules, and feasible recognition routes.

This reduces resistance by fitting AGRITECH into existing operational realities while updating content and delivery practice.

3) Communication and engagement (clarity, value, and legitimacy)

Adoption increases when stakeholders understand the value and the operational implications. AGRITECH communication will:

- Provide a simple value narrative tailored to each stakeholder group (learners, trainers, institutions, employers).
- Use local champions (hub leads, experienced trainers, employer contacts) to reinforce legitimacy and peer diffusion.
- Share concise pilot evidence and learner outputs to demonstrate relevance and credibility.

4) Support mechanisms (help, troubleshooting, and continuity)

A predictable support model reduces friction and dropout, especially during the intensive pilot delivery. Support includes:

- A central technical support channel for platform issues and system-level incidents.
- A structured knowledge base (FAQs, how-to guides, assessment guidance, credential issuance guidance).
- Hub-based support routines (office hours or structured support slots) and peer exchange via CoPs.

Escalation routes to the relevant workstream leads when issues affect delivery quality, platform stability, or credential integrity.

7.5.2 Adoption milestones by phase

P1 (Design Freeze and Readiness, up to mid-March 2026)

- Establish change governance and communication cadence (who communicates what, when, and where decisions are recorded).
- Finalise ToT and onboarding materials for trainers and learners.
- Confirm operational readiness: platform pilot release, training materials packaged for all 7 modules, assessment and capstone workflow ready, credential process ready (eBadges and ECTS microcredentials).
- Complete readiness checks and a short rehearsal run to validate end-to-end delivery steps before pilot launch.

P2 (Piloting through national hubs, 1 April to 26 May 2026)

- Deliver ToT and platform onboarding at hub level for each pilot site.
- Deliver the full pilot as an intensive course covering all 7 modules for both pathways (HEI and VET).
- Apply the recognition process in practice:
  - Issue eBadges after module completion.
  - Issue ECTS microcredentials after capstone submission and assessment (3 ECTS VET, 4 ECTS HEI).
- Capture structured feedback from learners, trainers, and hubs and consolidate evidence packages for post-pilot improvements.

P3 (Post-pilot adjustments and readiness for wider implementation, June 2026 onward)

- Review pilot evidence and implement approved improvements (platform, materials, delivery guidance, assessments).
- Consolidate an implementation-ready package for academic year 2026–2027 (platform release, finalised materials, delivery playbook, support routines, credential guidance).

- Strengthen recognition and portability guidance based on pilot feasibility and stakeholder engagement results.
- Establish continuity mechanisms (CoP rhythm, refresh cycles for materials, and support routines for adopters).

Minimum adoption milestones (verifiable, no placeholders):

- By **mid-March 2026**: pilot-ready platform and finalised training packages for all 7 modules; ToT and onboarding resources prepared; assessment and credential workflow operational.
- By **26 May 2026**: all pilot hubs complete delivery and submit evidence packages; eBadges and ECTS microcredentials issued within the agreed process for eligible learners.
- By start of **academic year 2026–2027**: consolidated updated release and replication guidance ready for wider institutional use.

7.5.3 Feedback mechanisms and change control

AGRITECH operates a structured feedback and change-control loop so adoption improves over time and issues are handled consistently across hubs.

Feedback channels (operational level):

- **Learner feedback:** end-of-module pulse checks and end-of-course survey (implemented via SurveyMonkey), plus qualitative comments captured through the learning pathway.
- **Trainer feedback:** post-delivery debrief notes, CoP reflection sessions, and assessor calibration outcomes.
- **Platform feedback:** issue reporting and usability feedback, combined with analytics signals (drop-off points, time-on-task patterns, completion bottlenecks).
- **Employer feedback (where engaged):** feedback on relevance of outputs, skills fit, and credential usefulness.

How feedback becomes improvements (control level):

1. Issues and suggestions are logged and categorised (content, pedagogy, platform, assessment and credentialing, hub operations).
2. A change review process determines whether changes are:
   - Immediate fixes (minor corrections and clarifications),
   - Scheduled enhancements (module revisions, added resources, usability improvements),
   - Controlled changes (assessment rules, credential metadata, major platform updates).
3. Approved changes are released with version notes and tracked through the QA system and KPI monitoring.

Pilot stability rule: during the pilot period (1 April to 26 May 2026), changes are limited to critical fixes that prevent delivery, block access, or compromise evidence integrity. Non-critical improvements are queued for post-pilot consolidation.

7.5.4 Link to Communities of Practice and hub activities

The hub model and CoPs are the primary adoption multipliers:

- **Hubs** provide the local operational setting for onboarding, delivery, mentoring, and stakeholder interaction. They also host local dissemination and practical demonstrations.
- **Communities of Practice** enable peer learning and standardisation across institutions by sharing lesson plans, troubleshooting delivery issues, aligning assessment practice, and exchanging adaptation strategies.

- CoPs also function as structured checkpoints for surfacing adoption barriers and agreeing improvement actions that feed back into platform and curriculum updates.

This ensures adoption is supported through local practice and peer exchange, while remaining coordinated through common standards and controlled change management.

8. SUSTAINABILITY AND SCALABILITY

This chapter outlines how the **AGRITECH Learning Ecosystem** can continue operating after the funded project period and how it can scale to additional institutions, regions, and countries while maintaining delivery quality and credential trust. **Sustainability** is treated as an operating setup that answers four practical questions: who maintains the digital and content core, how ongoing delivery is financed, how changes are governed, and how new adopters join through a repeatable onboarding pathway.

Chapter 7 defines the implementation roadmap, adoption milestones, and the feedback and change-control loop used during the pilot. **Chapter 8** builds directly on that logic. Pilot delivery produces the evidence needed to confirm what should be maintained, what should be improved, and what can be scaled. This includes **KPI results**, **structured feedback** from learners and trainers, **platform issue logs**, and **hub-level implementation evidence**.

Several long-term choices are therefore intentionally staged and finalised after the pilot evaluation. Following post-pilot consolidation, the consortium will confirm:

I. the preferred funding mix for core operations and hub delivery,
II. the post-project governance setup and decision rights,
III. the replication package and onboarding workflow for new hubs, and
IV. the open licensing and IPR rules for reuse and future contributions.

Responsibilities for preparing these decisions are assigned as follows: overall coordination and consolidation under ELGO as project Coordinator; sustainability inputs connected to WP2 and WP6 under PAMEA; platform and ecosystem design inputs under WP3 led by DDTG; pilot evidence and evaluation inputs under WP4 led by CARDET; and training delivery and learning resources inputs under WP5 led by WRLS. National Hub roles and responsibilities will be confirmed during pilot implementation and reflected in the final post-pilot setup.

These decisions will be documented in the **Sustainability and Exploitation Plan** and translated into clear partner responsibilities for the first post-project year.

In line with the project application, continuity is supported through ongoing evaluation and prioritisation of the most impactful components, securing follow-on resources through additional funding and partnerships, and building complementarities with related EU initiatives. **AGRITECH** also supports reuse through open access to materials, publication under open licenses, a dedicated online repository, and training and support so partners and adopters can integrate outputs into education and training provision.

The post-project funding direction is a blended model. AGRITECH aims to continue delivery through further trainings and capacity-building actions, combined with external funding opportunities and partnerships. This approach recognises ongoing cost drivers, including platform and repository maintenance, quality assurance and content updates, credential workflows, and trainer and teacher fees for delivery and assessment.

8.1 Business and Funding Models

Sustainability requires a funding approach that matches the ecosystem's cost structure. In practice, AGRITECH has (a) **fixed "core" costs** (platform hosting, maintenance, QA, content updates, credential issuing/verification processes) and (b) **variable "delivery" costs** (hub operations, trainer time, equipment kits, local outreach, learner support). The most robust model is therefore **layered**: keep the digital core stable and low-friction, while allowing hubs and national partners to fund delivery in ways that fit their national contexts.

A pragmatic approach is to position AGRITECH as a **public-good learning infrastructure** that can be co-financed through a mix of EU/national skills funding and targeted stakeholder contributions. In the national analyses, scaling is linked to existing public investment streams and recovery funding, for example Hungary's VET 4.0 digital investment programme and REPowerEU-linked green-skills training targets, and Greece's planned use of national strategies and Recovery and Resilience Facility funding to support scale-up.

Candidate funding models (combinable)

Model	What it means in practice	Typical revenue/funding sources	Strengths	Watch-outs
Open core + publicly financed delivery	Platform + baseline curriculum stay free/open; delivery funded via hubs	National VET/HE budgets, EU programmes, recovery/skills funds	Maximises access; easiest adoption	Needs stable public sponsor(s) for the core
Consortium membership model	Institutions pay annual fee to access governance/services	Partner/institution fees, network subscriptions	Predictable income; shared ownership mindset	Can create barriers for small/rural providers
Service-based model	Core is open; paid value-add services	Certification/exam fees, tailored cohorts for industry, QA audits, curriculum localisation services	Scales with demand; transparent value	Requires clear pricing + capacity to deliver services
Public–private co-sponsorship	Employers co-fund hubs/modules aligned to workforce needs	Sponsorships, equipment donations, sector associations	Strong labour-market relevance; reduces public burden	Needs conflict-of-interest rules and governance safeguards
Project pipeline model	Continuous innovation via new funded projects	Erasmus+/EU calls, national innovation funding	Keeps ecosystem evolving	Not "stable" by itself; can turn into permanent grant-chasing

Table 9. Candidate funding models

Recommended "baseline" configuration (realistic post-project)

- **Core platform and content maintenance**: funded by a small set of anchor institutions (consortium or host organisation) plus periodic project-based upgrades.
- **Hub operations**: funded locally (public VET/HE funding, regional development funds, employer co-sponsorship where appropriate).
- **Microcredential issuance**: free or low-cost for target groups during expansion years, with an option for paid advanced tracks or employer-sponsored cohorts.
- **In-kind contributions**: trainers, facilities, and pilot equipment contributed by hub institutions, especially during early replication waves.

8.2 Governance Options

Sustainable scaling needs governance that is legitimate for partners, operationally lightweight, and able to manage cross-border delivery, quality assurance, and credential trust. Chapter 7 defines the hub model, Communities of Practice, and the feedback and change-control loop used during the pilot. Governance in the post-project phase should formalise those working routines so continuity does not depend on informal coordination.

Given that pilot evidence is needed to confirm what should be maintained, updated, and scaled, the consortium will finalise the post-project governance design at the **5th project meeting**, based on consolidated pilot results and an agreed set of recommendations. The confirmed setup will be documented in the Sustainability and Exploitation Plan, including decision rights, membership rules, and named responsibilities for the first post-project year.

Practical governance layers (recommended structure)

- **Ecosystem Board (strategic governance) -** ets strategic direction, approves annual plans and budgets, validates partnerships, and owns high-level policy decisions (quality, ethics, brand, credential integrity). It confirms major changes that affect the ecosystem as a whole (new microcredential offers, admission of new hub institutions, significant platform or assessment rule changes).
- **Academic/Training & Curriculum Committee (content governance) -** Oversees curriculum updates, competence alignment, assessment standards, and microcredential design rules. It manages versioning of learning outcomes, assessment rubrics, and trainer guidance, aligned with the change-control approach defined in Chapter 7.
- **Technical Steering Group (platform governance) -** Manages the platform roadmap, release cycles, security, interoperability, data governance, and operational continuity (hosting, maintenance, access management). It ensures that technical changes follow a controlled release process and that updates remain compatible with credential verification workflows.
- **Quality and Credential Committee (credential trust)** - Maintains the rules for issuing and verification, evidence requirements, auditability, and quality assurance checks across hubs. It links delivery evidence to credential integrity, including review of incidents and corrective actions.
- **National Hub Councils (delivery governance) -** Coordinate local rollout, trainer capacity, stakeholder engagement, and national recognition pathways. Hub councils operationalise delivery within national constraints while applying common standards. National Hub roles and leads will be confirmed during the pilot and reflected in the final post-pilot setup.
- **Industry/Stakeholder Advisory Panel (market legitimacy) -** Provides structured feedback on labour-market relevance, work-based learning needs, equipment trends, and employability alignment. It acts as an input channel to curriculum and delivery decisions, aligned with the Communities of Practice logic in Chapter 7.

Governance “form factors” (options of which can choose from)

The recommended layers can be implemented through one of the following organisational forms. These options are compatible with a staged decision at the 5th project meeting.

Option A. Coordinator-hosted governance with consortium agreement - A partner hosts the operational core and acts as secretariat under a consortium Memorandum of Understanding. Decision rights sit with the Board and committees, supported by a small operational team.
Option B. Rotating secretariat within the consortium - The secretariat role rotates across partners on a fixed cycle. The Board and committees remain stable while operational hosting and coordination rotate based on capacity.
Option C. Dedicated legal entity (association or similar) - Partners create a separate legal structure to host the platform, manage contracts, and handle membership and fees. This option supports long-term continuity and growth in membership.
Option D. Federated network with national hosts - A shared framework defines standards, credential rules, and interoperability. National entities host delivery locally under common governance and verification rules, coordinated by a lightweight central body.

Decision and responsibility path

To keep governance conceptual at this stage while still actionable, AGRITECH stages decisions as follows:

During the pilot:

- Apply the Chapter 7 feedback and change-control loop through the committees and Communities of Practice.
- Document operational roles through a RACI-style mapping for content updates, platform releases, QA checks, and credential issuing workflows.
- Define interim working arrangements for releases, issue triage, and approval thresholds.

At the 5th project meeting (post-pilot consolidation):

- Confirm the selected governance form factor (Option A–D).
- Confirm legal hosting and contracting responsibility for the platform and repository.
- Approve membership rules, voting and quorum rules, dispute escalation, and admission criteria for new hubs.
- Confirm the first post-project year responsibility map and operating calendar (committee cycles, release cycles, annual planning).

Responsibility owners for preparing governance inputs:

Overall coordination and consolidation under **ELGO** as project Coordinator. Sustainability inputs linked to **WP2** and **WP6** under **PAMEA**. Platform governance inputs under WP3 led by **DDTG**. Pilot evidence and evaluation inputs under WP4 led by **CARDET**. Training delivery and learning resources inputs under WP5 led by **WRLS**. **National Hub Councils** and leads will be identified during pilot implementation and formalised in the post-pilot governance setup.

8.3 Replication and Expansion Pathways

Scaling is easiest when replication is treated as a product. New adopters need a clear, reusable package: curriculum, platform configuration, QA checklist, trainer onboarding, and partnership templates.
The national analyses provide practical signals for what replication can look like:

- **Czech Republic:** scaling conditions are supported by national investment in upgrading agri-school equipment and modernisation, which fits a hub model built around minimum viable training kits and local practice settings. The National Register of Vocational Qualifications (NSK) also provides a formal route for recognising non-formal and informal learning, which is relevant for modular AGRITECH units.

- **Czech Republic:** an emerging microcredential framework is being developed, led by HEIs with an intention to extend into the VET sector. This offers a realistic early carrier for portable AGRITECH microcredentials during expansion.
- **Hungary:** replication can leverage established regional structures and coordination mechanisms (regional agricultural training centres and strong intermediary networks). The Hungarian Chamber of Agriculture's regional coverage and sectoral coordination structures provide ready-made channels for employer engagement, dissemination, and organising roll-out in regional waves.

RECOMMENDED REPLICATION PATHWAY (HUB + CURRICULUM + CREDENTIAL)

Step 1: "Hub readiness" onboarding (4–8 weeks) - Minimum requirements: named hub lead, trainer pool, learner recruitment channel, and a baseline equipment plan (including low-cost kits). This step includes trainer onboarding and Train-the-Trainer alignment, following the Chapter 7 capacity-building approach.
Step 2: Curriculum localisation and delivery design (6–12 weeks) - Translate/adapt examples to local crops and regulations; map modules into existing VET/HE pathways; define work-based learning placements (farms, SMEs, labs).
Step 3: QA and assessment calibration (pilot cohort) - Run one cohort with common assessment anchors and shared rubrics; compare outcomes across hubs; refine content, support materials, and delivery guidance.
Step 4: Credential recognition pathway (parallel track) - Engage national authorities, HEIs, and employers early; align microcredentials with national practices and verification systems where available; prepare the documentation needed for recognition and credit/stacking decisions
Step 5: Scale wave (2–4 cohorts/year) - Expand cohorts, add modules, and broaden hub partnerships (employers, advisory services, technology providers). Use Communities of Practice and hub peer-learning routines to keep delivery consistent as replication expands.

This pathway aligns with the phased roadmap in Chapter 7: Steps 1–3 support pilot preparation and delivery (P1), Step 4 builds recognition routes alongside delivery (P2), and Step 5 operationalises scale-up waves (P3).

8.4 Open Licensing and Intellectual Property

This section prevents future chaos by making one thing clear: what is open, what is shared-but-controlled, and what is third-party proprietary. Without that, scaling becomes a legal and operational minefield.
Asset classification (what belongs where)

- **Open assets (OER and reusable templates):** learning materials created by AGRITECH partners (slides, handouts, assignments, trainer guidance), non-sensitive templates (MoUs, stakeholder mapping templates), and public dissemination outputs. These can be reused widely under an open license.

- **Shared-but-controlled assets (common rules and trust anchors):** assessment rubrics and calibration anchors, microcredential issuing and verification rules, QA checklists, the competence framework mapping, release notes and versioning rules, and the AGRITECH brand and marks. These are shared across adopters, but changes are controlled through governance to protect consistency and credential trust.
- **Third-party proprietary assets:** external platforms, tools, datasets, images, and course materials that are owned by others and require permission or a license. These can be referenced or integrated through permitted mechanisms, but not re-published as AGRITECH outputs.

Two realities show up in the national mapping:

- There are multiple open-access platforms and resources in the ecosystem space. Cyprus lists several resources explicitly marked as open and owned by consortia (for example RELIEF, DG-VET Learning Hub, Digital Farmer and others). This supports an open-by-default approach for educational content where feasible.
- Some high-value resources are not open source and require usage licenses. Italy notes xFarm Education as not open source and subject to a usage license with an indicative annual cost. This implies AGRITECH must support integration pathways that do not require re-licensing or re-publishing proprietary content.

Recommended IP and licensing principles (clear and scalable)

- **Educational content (OER-first):** default to releasing AGRITECH learning materials as Open Educational Resources under a Creative Commons license (recommended default: CC BY 4.0), unless restricted by third-party rights.
- **Platform and technical components (open where owned):** components developed within AGRITECH should, where feasible, be released under an open-source license selected in the Sustainability and Exploitation Plan. External proprietary tools remain external and are integrated via APIs, links, or approved embedding mechanisms.
- **Partner and third-party materials (rights-respecting integration):** if a tool or course is proprietary, AGRITECH references it, links to it, embeds only where permitted, or provides an independently created equivalent. AGRITECH does not copy, re-host, or redistribute third-party content.
- **Brand, marks, and credential trust:** open content does not mean open credentialing. Credential issuing rules, verification workflows, assessment anchors, and the AGRITECH brand must remain governed and protected to preserve trust and prevent uncontrolled variants.
- **Contributor agreements and ownership clarity:** define whether outputs are jointly owned, or owned by the producing partner with a broad reuse license granted to the ecosystem. Define contribution rules for updates (who can propose changes, who approves, how versioning works).

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

1. A complete learning ecosystem design is in place - AGRITECH combines a modular curriculum, platform-enabled delivery, work-based learning routes, and a shared microcredential logic into one replicable model. The design supports both VET and HE use-cases and accommodates national differences through hub-level localisation.

2. Delivery consistency is the main determinant of credibility - The ecosystem's value depends on consistent trainer preparation, comparable assessment practices, controlled curriculum updates, and audit-ready credential workflows. Without these, scaling produces uneven outcomes and weakens microcredential trust.

3. The hub model is the practical scaling unit - Scaling works when replication is organised through hubs with clear minimum requirements: a named lead, trained trainers, recruitment channels, a baseline equipment plan, and structured partnerships for work-based learning.

4. Controlled improvement is required for long-term stability - The feedback loop (learner and trainer feedback, platform issue management, QA checks) needs a formal decision pathway so improvements are implemented without fragmenting versions across countries or hubs.

5. Sustainability is viable through a blended funding approach - The cost structure separates fixed core costs (platform, QA, content maintenance, credential workflows) from variable delivery costs (hub operations, trainers, outreach, learner support). A layered model is realistic: stable core financing paired with locally funded delivery and paid training offers where appropriate.

6. Post-pilot evidence must drive post-project decisions - Governance form, funding mix, replication rules, and licensing arrangements are best confirmed after pilot evaluation. The consortium should lock these decisions at the 5th project meeting using an agreed evidence pack and decision criteria, then assign named responsibilities for the first post-project year.

7. IP clarity is a scaling requirement, not paperwork - The ecosystem must separate open educational content, shared-but-controlled trust assets (assessment anchors, credential rules, QA protocols, brand use), and third-party proprietary tools. This prevents legal risk and operational confusion during replication.

RECOMMENDATIONS

1) GOVERNANCE AND DECISION RIGHTS

- Adopt a layered governance structure with clear separation of responsibilities:

- Strategic direction and partnerships (Board-level)
- Curriculum and learning outcomes governance (Curriculum Committee)
- Platform roadmap and operations (Technical Steering Group)
- Credential integrity and QA enforcement (Quality and Credential Committee)
- National delivery coordination (National Hub Councils once identified)
- Market relevance input (Industry Advisory Panel)

- Define decision thresholds and approval routes for:
  - Curriculum changes (minor update vs major revision)
  - Assessment rubric changes and calibration anchors
  - Microcredential rules (issuing, verification, evidence requirements)
  - Platform releases (bugfix, feature release, breaking changes)
  - Admission of new hubs and partner institutions

- Lock the governance form factor at the 5th project meeting and document it in the **Sustainability and Exploitation Plan** with an operating calendar (committee cycles, release cycles, annual planning cycle).

2) QUALITY ASSURANCE AND ASSESSMENT COMPARABILITY

- **Set mandatory minimum QA checks** for all hubs, covering:
  - Trainer readiness requirements
  - Minimum contact time and learning activities per module
  - Work-based learning placement requirements where applicable
  - Assessment evidence retention and review rules
- **Run assessment calibration** using shared anchors and moderation routines:
  - Standardised rubric interpretation guidance
  - Cross-hub moderation on a defined sample per cohort
  - A process for resolving divergence and updating guidance
- **Maintain an incident and corrective action process** for quality issues linked to credential integrity.

3) MICROCREDENTIAL ISSUANCE AND VERIFICATION

- **Keep credential integrity assets shared-but-controlled, not open-edit** - Treat learning outcomes, assessment rules, evidence requirements, credential metadata, and verification workflows as controlled assets with versioning.
- **Define a minimum evidence package per microcredential** (assessment artefacts, attendance/participation proof if used, WBL evidence if used).
- **Implement audit-ready record keeping** at hub level with clear retention rules aligned to national requirements.

4) PLATFORM OPERATIONS AND DATA GOVERNANCE

- **Define the minimum viable operational core** required post-project:
  - Hosting and maintenance ownership
  - User management and access control
  - Security patching and backups
  - Release management and rollback routine
  - Support triage and issue resolution workflow
- **Maintain a stable core configuration** for credential-related functions and allow hub-level flexibility for delivery features that do not affect trust.
- **Apply minimum data governance rules** across hubs for learner consent, access rights, retention, and secure handling of assessment evidence.

5) HUB READINESS AND DELIVERY ENABLEMENT

- **Standardise hub onboarding** with a readiness checklist and evidence-based sign-off:
  - Named hub lead and operational contact

  - Trainer pool with completed Train-the-Trainer pathway
  - Learner recruitment and selection mechanism
  - Equipment plan with minimum viable kits
  - Identified WBL partners and placement model
- **Deliver a Train-the-Trainer pathway** that includes:
  - Pedagogy and inclusion
  - Platform use
  - Assessment practice with shared rubrics
  - Microcredential workflows and evidence rules
- **Use Communities of Practice** as the default method for peer support, continuous improvement, and dissemination of delivery guidance.

6) REPLICATION AND EXPANSION PATHWAY

Package replication as an operational product, including:

- Curriculum and trainer guidance
- Platform configuration and user roles
- QA checklist and evidence templates
- Assessment anchors and moderation guidance
- Microcredential issuing and verification guidance
- Partnership templates (WBL agreements, stakeholder MoUs)

Apply a staged replication pathway:

1. Hub readiness onboarding
2. Localisation and integration into existing programmes
3. Calibration cohort with QA and moderation
4. Recognition and stakeholder alignment in parallel
5. Scale waves with 2–4 cohorts per year, expansion of partners and modules

Use wave-based expansion where regional structures and intermediary networks support coordinated growth.

7) SUSTAINABILITY AND BUSINESS MODEL

- **Adopt a blended funding model** that combines:
  - Public funding streams for core stability where feasible
  - Local hub financing for delivery
  - Employer co-sponsorship where appropriate and governed
  - Paid training offers and advanced tracks to cover real delivery costs
- **Separate core costs from delivery costs** in planning and reporting:
  - Core: hosting, maintenance, QA, content updates, credential processes
  - Delivery: trainers, hub coordination, outreach, learner support, kits
- **Define the post-project service offer** for continuation trainings:
  - What remains open-access
  - What is paid (training delivery, advanced tracks, tailored cohorts, QA support, localisation services, certification events)
  - Pricing logic and capacity requirements to deliver services reliably

8) IP, LICENSING, AND ASSET CLASSIFICATION

- **Adopt an explicit three-bucket classification**:
  - Open assets (OER learning materials, public templates)
  - Shared-but-controlled assets (credential rules, QA protocols, assessment anchors, brand use)
  - Third-party proprietary assets (licensed tools, external content)
- **Default to OER-first for educational content** under a clear Creative Commons license, selected and fixed in the Sustainability and Exploitation Plan.
- **Enable rights-respecting integration** of proprietary tools through links, APIs, or permitted embedding, without re-hosting third-party content.
- **Protect brand and credential trust** through governed usage rules and controlled credential workflows.

9) MONITORING, EVIDENCE, AND CONTROLLED IMPROVEMENT

- **Operate one continuous improvement loop** connecting:
  - KPIs and cohort results
  - Learner and trainer feedback
  - QA findings and moderation outputs
  - Platform issues and release notes
- **Maintain strict versioning and change control** for curriculum and assessment assets, with upgrade guidance for hubs.
- **Use pilot evidence to finalise post-project choices** at the 5th project meeting using a defined decision pack.

DECISION PACK TO APPROVE AT THE 5TH PROJECT MEETING (minimum content)

- Pilot evaluation summary and KPI dashboard
- QA findings and calibration outcomes
- Platform operations report (issues, fixes, readiness, required maintenance effort)
- Proposed governance option and decision rights matrix
- Cost model split core vs delivery and proposed blended funding mix
- Replication package v1 and hub onboarding checklist
- IP and licensing classification and default license choices
- Named responsibility map for the first post-project year

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28. AGRITECH National Report (VET/HEI) – Czech Republic (2025). Consortium documentation.
29. AGRITECH National Report (VET/HEI) – Cyprus (2025). Consortium documentation.
30. AGRITECH National Report (VET/HEI) – Hungary (2025). Consortium documentation.
31. AGRITECH National Report (VET/HEI) – Romania (2025). Consortium documentation.

Annexes

NATIONAL REPORTS ON VET

	RESPONSIBLE PARTNER	DOCUMENT
1	CARDET	NATIONAL ANALYSIS REPORT CYPRUS
2	WIRELESS INFO, ZSCR	NATIONAL ANALYSIS REPORT CZECH REPUBLIC
3	ELGO	NATIONAL ANALYSIS REPORT GREECE
4	GK	NATIONAL ANALYSIS REPORT HUNGARY
5	LAND	NATIONAL ANALYSIS REPORT ITALY
6	AGR	NATIONAL ANALYSIS REPORT ROMANIA

NATIONAL REPORTS ON HEI

	RESPONSIBLE PARTNER	DOCUMENT
1	CARDET	NATIONAL ANALYSIS REPORT CYPRUS
2	WIRELESS INFO, ZSCR	NATIONAL ANALYSIS REPORT CZECH REPUBLIC
3	AUTH	NATIONAL ANALYSIS REPORT GREECE
4	MATE	NATIONAL ANALYSIS REPORT HUNGARY
5	POLITO	NATIONAL ANALYSIS REPORT ITALY
6	USAMV	NATIONAL ANALYSIS REPORT ROMANIA

AGRITECH LEARNING ECOSYSTEM - STAKEHOLDER FEEDBACK QUESTIONNAIRE

30 APRIL 2025

70

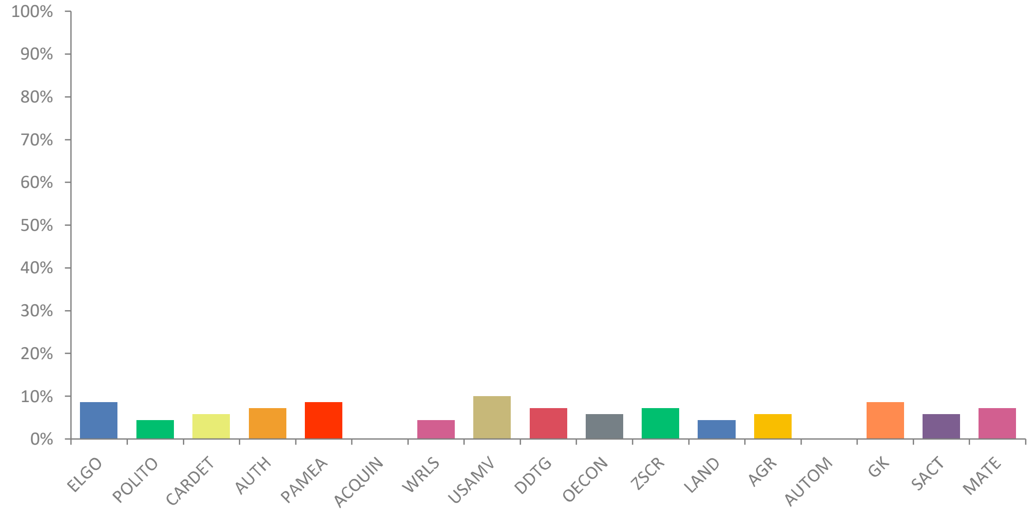
Total Responses

Date Created: Saturday, August 02, 2025

Complete Responses: 70

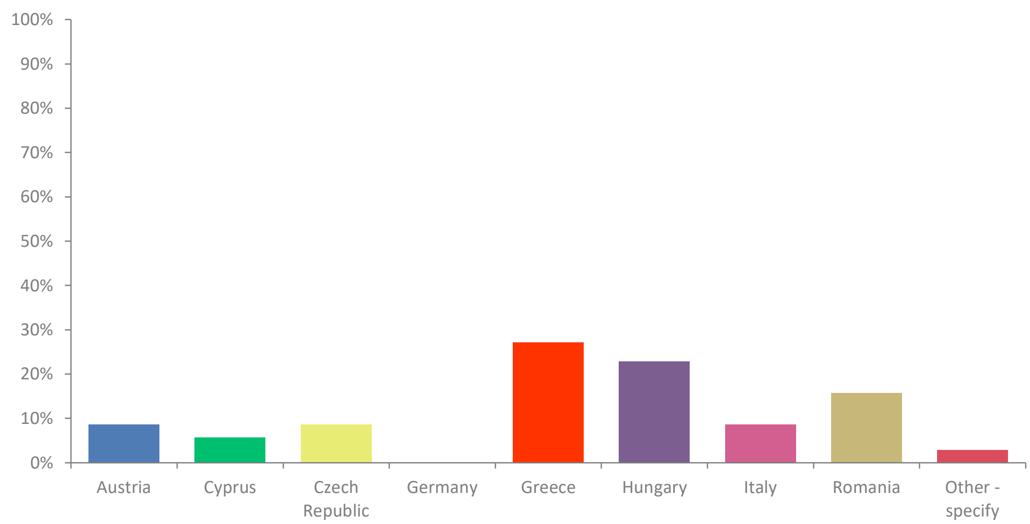
Q3: Please choose your organisation

Answered: 70 Skipped: 0



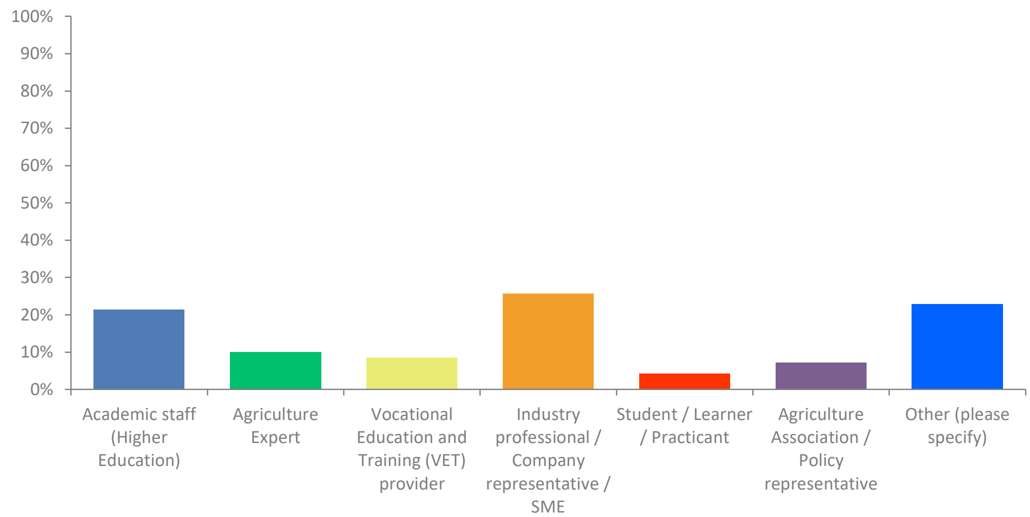
Q4: In which country do you operate?

Answered: 70 Skipped: 0



Q5: What best describes your role?

Answered: 70 Skipped: 0



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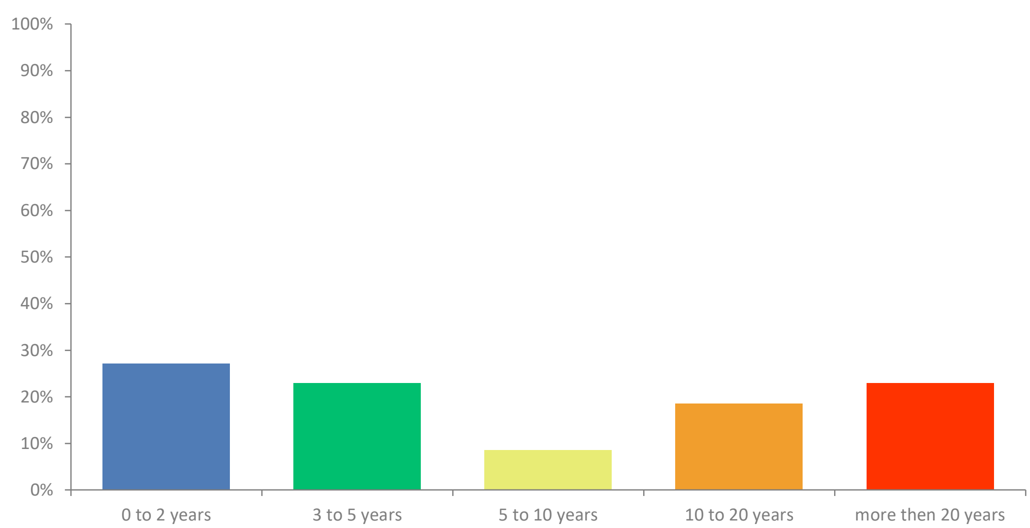
Q6: How many years of experience do you have in the agricultural domain?

Answered: 70 Skipped: 0



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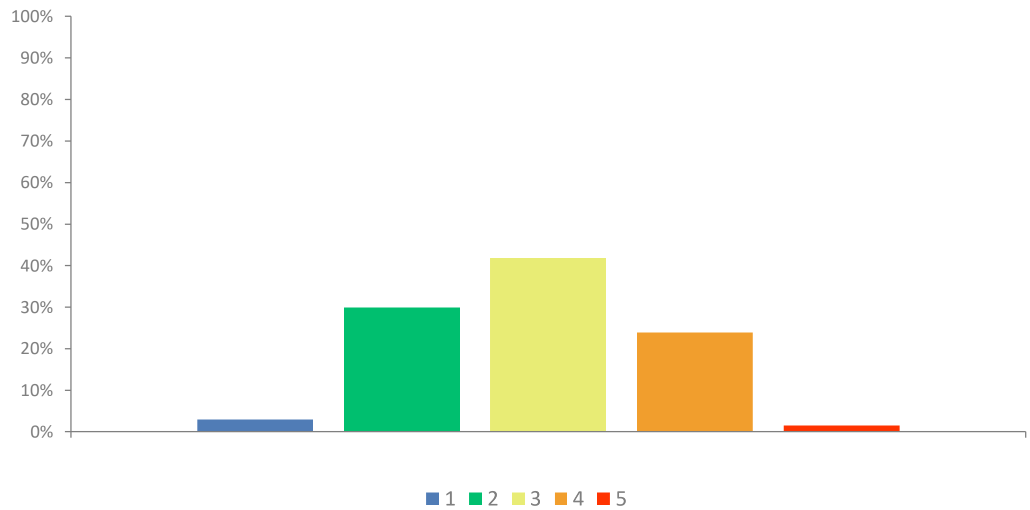
Q7: How would you rate the current availability and quality of digital educational resources in Agricultural Technology in your country?

Answered: 67 Skipped: 3



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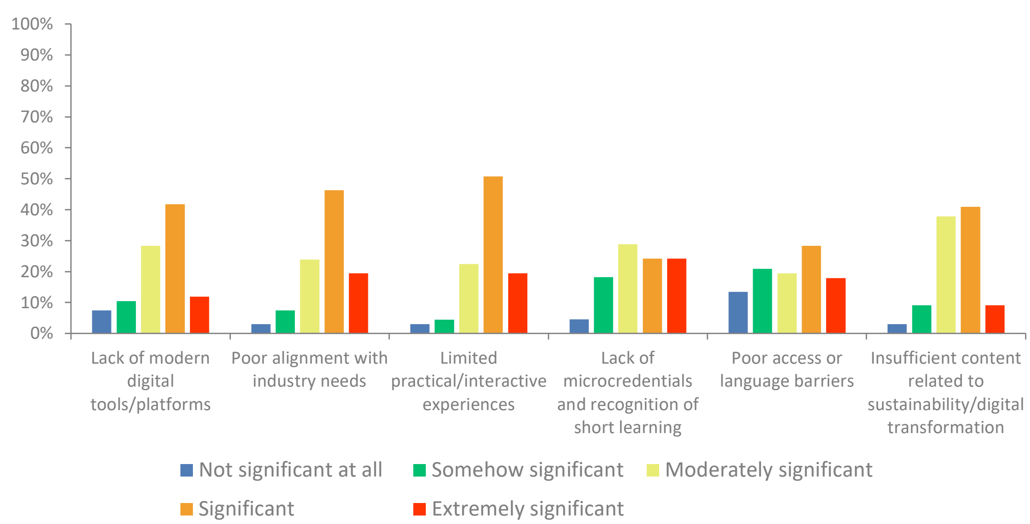
Q8: Please indicate the major gaps you currently perceive in Agricultural Technology education (Multiple selections allowed)

Answered: 67 Skipped: 3



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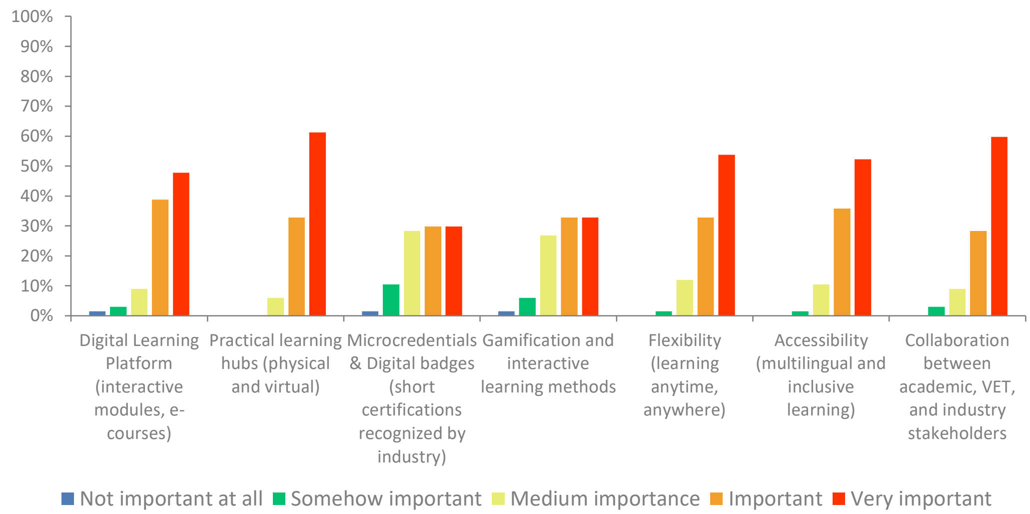
Q9: AGRITECH aims to create an integrated learning environment. How important do you rate the following elements for such an ecosystem?

Answered: 67 Skipped: 3



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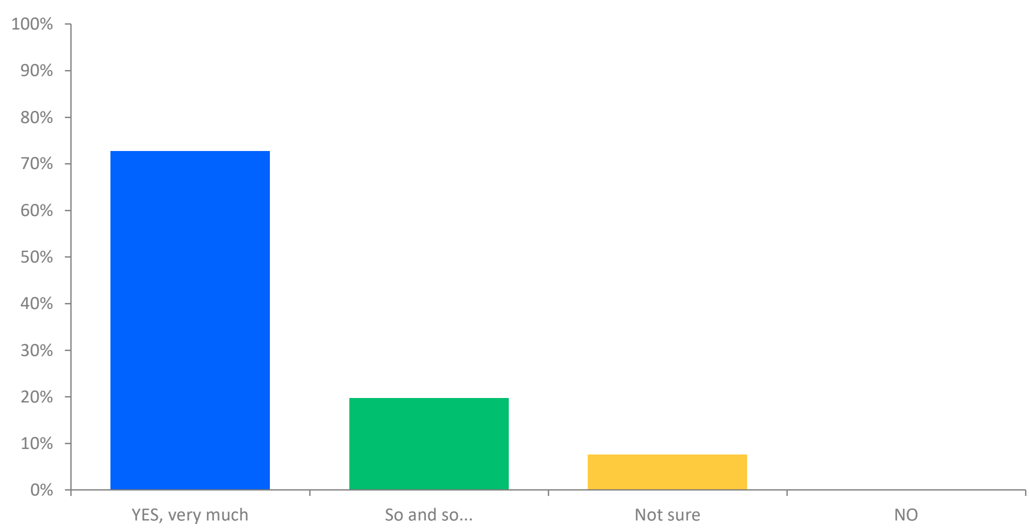
Q10: Would you value microcredentials as part of AGRITECH educational offerings?

Answered: 66 Skipped: 4



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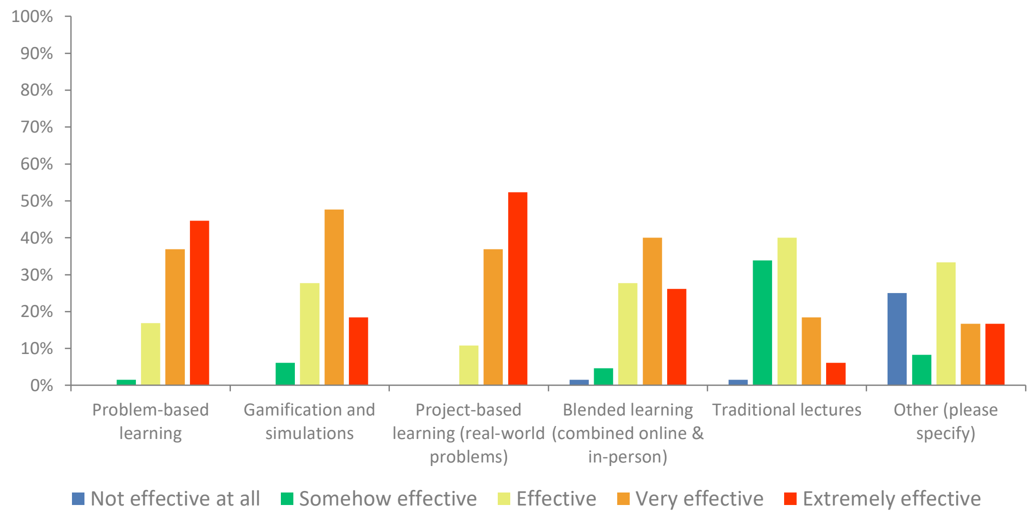
Q12: Which learning methodologies would you consider most effective for Agricultural Technology education? (Multiple selections allowed)

Answered: 65 Skipped: 5



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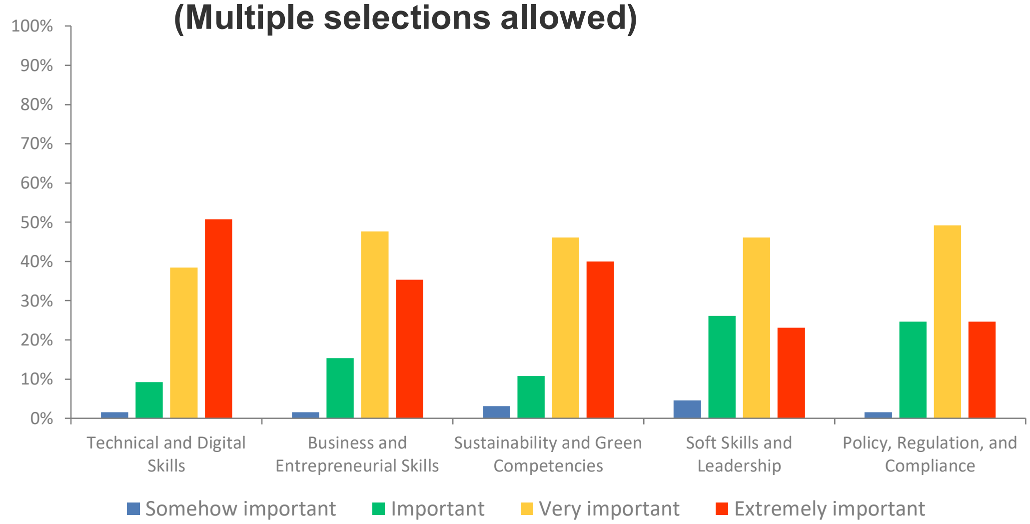
Q14: What specific competencies you consider should be prioritized (detailed descriptions are in D.2.1 pg. 59-67)? (Multiple selections allowed)

Answered: 65 Skipped: 5



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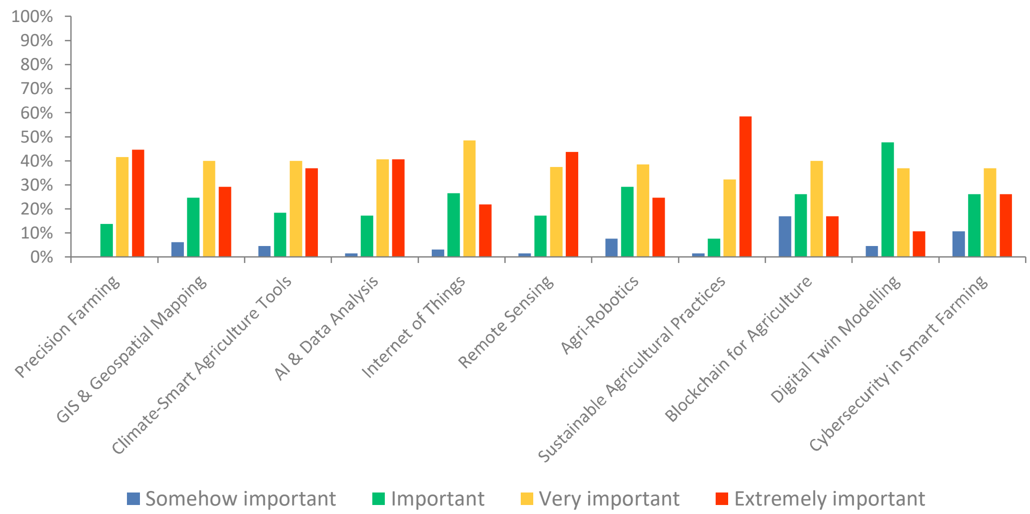
Q15: In this regard, which specific technical skills should be prioritized? (Multiple selections allowed)

Answered: 65 Skipped: 5



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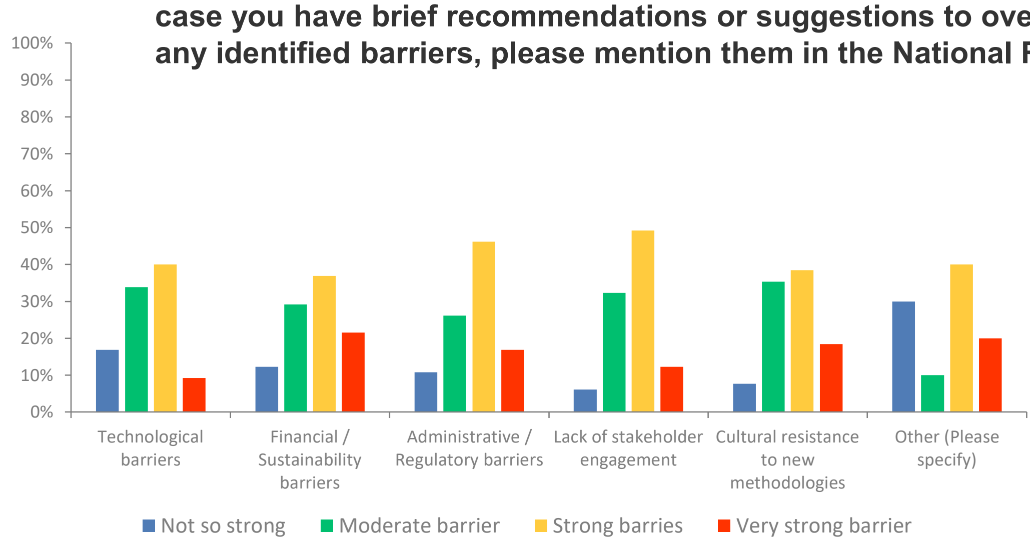
Q16: Do you foresee any potential barriers or challenges for the successful implementation of AGRITECH Learning Ecosystem? In case you have brief recommendations or suggestions to overcome any identified barriers, please mention them in the National Report.

Answered: 65 Skipped: 5



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