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USAGE-NG

Up-skilling Agricultural Engineering Next Generation

Smart Farming Education: Mapping Modular Training Offers and Mobile Learning and Microcredentials in Europe

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Contents

1 Executive Summary

Activity 3.1 of the USAGE-NG project provides a structured mapping of current European education and training offers in smart farming, AgTech, and climate-smart sustainable agriculture at EQF levels 6–8. The report responds to the accelerating pressures of climate change and digital transformation in farming by establishing a benchmark of existing formal degree programs, non-formal professional courses, and informal online learning opportunities.

Using a combination of institutional surveys (25 higher education institutions across 10 countries), qualitative curriculum analysis, and a module matrix covering 189 relevant course modules, the study identifies dominant thematic priorities and pedagogical patterns. The findings show that sustainability and precision agriculture technologies are the most prevalent focus areas, while climate change is typically integrated as a cross-cutting element rather than treated as a standalone specialization.

Most programs rely on blended delivery with strong in-person components, with fully online provision still rare in formal higher education. Traditional teaching methods (lectures and seminars) dominate, complemented by project work and case studies, while more innovative approaches such as flipped classrooms remain uncommon. Competence development emphasizes critical awareness, problem-solving, and managing complexity over narrow technical specialization, reflecting the interdisciplinary demands of modern sustainable farming systems.
Overall, the report concludes that Europe's smart farming education landscape is rich but leaves room for innovation, particularly in strengthening explicit climate adaptation content, expanding learner-centered pedagogies, and supporting flexible, credit-bearing micro-credentials for lifelong learners. These insights directly inform the next steps of USAGE-NG module development and pilot training implementation.

2 Introduction and Scope

Agricultural education in Europe is undergoing rapid evolution in response to climate change and the digital transformation of farming. Modern "AgTech" – the application of advanced technologies and data-driven methods in agriculture – is increasingly integrated with sustainability and climate-smart practices. To develop new educational offers (especially micro-credential modules) in this domain, it is essential first to survey and analyze existing training programs. Activity 3.1 of the USAGE-NG project addresses this need by researching current formal higher education and lifelong learning (LLL) offers at European Qualifications Framework (EQF) levels 6–8 (roughly corresponding to bachelor's, master's, and doctoral levels) that relate to smart farming, climate change adaptation, and sustainable agriculture. This report presents the findings of that research, drawing on original research results and prior findings from the LATEST project (Local-focused AgTech Education for Successful Agricultural Transitions). The analysis identifies prevalent course offerings, formats, pedagogical approaches, and content themes in relevant programs, thereby establishing a benchmark for designing new curriculum modules. In doing so, it pays special attention to how sustainability and climate change topics are incorporated, and how course design (in terms of delivery mode, teaching methods, and competencies targeted) can inform the development of micro-credentials and flexible learning pathways.

Smart farming, often overlapping with precision agriculture and digital agri-tech, comprises the use of data-driven and IoT-based solutions to improve farm productivity and sustainability. Given the challenges of climate change and the lag in digitization among many small-scale farmers, the USAGE-NG project aims to empower these stakeholders through education by specifically mapping current training opportunities in smart farming, as an input for developing new modules in subsequent project activities. This report surveys formal (university degree programs), non-formal (short courses, professional certificates, workshops), and informal (open online courses, MOOCs, OER) training offers in smart farming. Emphasis is placed on European programs and globally accessible online courses targeting smallholder farmers and lifelong learners.

3 Method

The research approach combined quantitative mapping of programs with qualitative content analysis, leveraging the methodology developed in the LATEST project. First, an extensive survey of European higher education institutions (HEIs) was utilized to collect data on existing AgTech-related programs in agriculture and engineering at EQF levels 6–8, as well as on life-long learning courses in these fields. The survey yielded complete responses from 25 HEIs across 10 countries, covering 70 study programs (bachelor's, master's and PhD-level) and 13 LLL programs in the AgTech and sustainable agriculture domain. The survey instrument gathered information on general program features (duration, ECTS credits, language of instruction, delivery format), target learner groups, and the presence of sustainability- or climate-focused content in curricula. In addition, it queried the extent of learner-centered pedagogical approaches and the mix of instructor profiles involved in teaching (academic, industry, etc.).

Complementing the HEI survey, the team conducted a mapping of modules and short courses from both formal programs and EU-funded educational initiatives. This resulted in a "module matrix" (Project Result 3 of LATEST) cataloguing 189 individual course modules relevant to smart farming and sustainability. Each module entry was coded for its main topical focus (e.g. farming systems, data management, artificial intelligence applications, modeling, etc.) and for the didactic methods used and competences targeted. Didactic methods were classified following an established typology (e.g. traditional classroom instruction, group discussions, project work, case studies, flipped classroom, etc.), while competences were categorized in line with EQF descriptors (e.g. advanced knowledge, critical awareness, problem-solving skills, ability to manage complex tasks, autonomy/responsibility). Where necessary, semi-structured interviews with course instructors were conducted to supplement missing information on teaching methods or learning outcomes.

Finally, a meta-analysis was performed to detect patterns and clusters among these modules – illuminating how certain teaching methods align with certain competence outcomes – to draw implications for curriculum design. All data analyzed in this report are drawn from these internal project sources, ensuring that the findings reflect the latest consolidated knowledge from the LATEST and USAGE-NG projects.

4 Results

4.1 Program Overview and Thematic Scope

The landscape of relevant educational offers in AgTech and sustainable agriculture is rich and multidisciplinary. According to the mapping, the prevailing themes of current programs (EQF 6–8) center on agricultural engineering and technology, including precision agriculture and smart farming tools, and on sustainability (environmental and resource management). These two themes were reported as major focus areas in the majority of programs surveyed (for example, 77% of master's programs emphasized sustainability). Digitalization and automation topics (e.g. robotics, data analytics, artificial intelligence in farming) also feature prominently, being covered by roughly half of the programs. In contrast, climate change per se is less often a standalone focus: nearly half (49%) of the surveyed programs address climate change content to some extent, but typically as part of a broader sustainability or agricultural systems curriculum. In fact, none of the mapped degree programs offered a specialization solely in "climate change" – whenever climate change appears as a study track or module, it is combined with other sustainable agriculture topics rather than treated in isolation. For example, programs might integrate climate change issues into courses on sustainable farming systems, agroecology, or environmental management. Notably, at the doctoral (EQF 8) level, sustainability emerges as the top thematic priority (appearing in ~79% of PhD-level curricula), ahead of AgTech engineering content. This underscores that at the highest qualification level, environmental sustainability considerations are deeply embedded in agricultural technology research and training. Overall, while sustainability and technology jointly define the core knowledge domain, the synergy between these is evident, curricula are increasingly geared toward "climate-smart" agriculture that marries digital innovation with sustainable practices.

Integration of Climate Change and Sustainability: The survey results confirm a pattern of integrating climate change topics under the broader umbrella of sustainability education. A focused analysis of curriculum content found that a standalone focus on climate change is generally absent in current offerings. Instead, climate change is usually taught in conjunction with other sustainability challenges (e.g. biodiversity loss, resource scarcity) or within applied agricultural contexts (such as crop production, agroecology, or environmental impact mitigation). Approximately one quarter of programs (24%) offer a dedicated track or specialization in sustainability (often titled with keywords like "sustainable agriculture" or "environmental management"), whereas an additional 11% of programs explicitly combine climate change with sustainability in a track or module. In life-long learning courses, a similar tendency was observed: none of the identified short courses was exclusively about climate change, but many included climate-related content as part of training in sustainable farming or resource management. Importantly, even when not the primary focus, sustainability and climate topics are treated as important cross-cutting themes by the majority of programs: 71% of surveyed programs incorporate sustainability education in some form, and nearly half (49%) include climate change topics within their syllabi. The survey illustrates that, after AgTech engineering, sustainability is the second most prevalent theme across undergraduate and graduate curricula, and climate change ranks fourth (trailing digitalization/robotics) but still ahead of other niche topics like agribusiness or food science. These findings reflect a clear synergy between climate change and sustainability in contemporary agricultural education: climate change mitigation and adaptation are not taught in isolation but are woven into the fabric of sustainable agricultural development training. This integrative approach aligns with the competencies needed for climate-resilient farming – for instance, understanding how climate impacts soil, water, and crop systems is naturally part of a holistic sustainability curriculum.

Course Formats and Delivery Modes: In terms of format and delivery, almost all identified programs rely on blended learning with a strong in-person component. Notably, none of the surveyed higher education programs at EQF 6–8 were delivered entirely online. Face-to-face teaching remains predominant, with on-campus coursework being a core part of every program's design. That said, online components are increasingly common: about one-third (36%) of the degree programs incorporate some form of online or distance-learning element (e.g. online lectures, e-learning modules), typically in a hybrid model. The prevalence of partial online delivery is similar for LLL courses (~30% include an online component). These online elements often complement practical in-person sessions, allowing flexibility for learners. The duration and credit structure of offerings varies: Bachelor's programs span 3–4 years (180+ ECTS), Master's 1–2 years (60–120 ECTS), while LLL short courses are much shorter (often a few weeks or months) and frequently credit-bearing as well (many offer a certificate and sometimes 5–10 ECTS that could be recognized elsewhere). Crucially, roughly half of the institutions offering LLL courses grant ECTS credits for those courses, and the majority award a certificate or diploma upon completion, underscoring that these short trainings could be conceived as micro-credentials that can be formally validated. This is an important finding for USAGE-NG, which aims to create micro-credential modules – it indicates that recognition of short courses is becoming standard practice, and alignment with ECTS/EQF frameworks is feasible and expected. Additionally, the study found considerable overlap between formal degree education and LLL: nearly half of the surveyed bachelor's/master's programs were reported to be accessible to lifelong learners (adult or non-degree students can enroll in some of the same modules), whereas at the PhD level about 30% of programs allowed external LLL participation. Few institution in the sample ran LLL courses entirely separate from its degree programs, instead, continuing education is integrated into the offerings of universities, often drawing on the same faculty and resources. This indicates a blurring line between traditional higher education and professional upskilling training, again reinforcing the utility of modular, credit-bearing courses that serve both full-time students and lifelong learners.

Language of Instruction: Given the international nature of AgTech and climate issues, a significant portion of programs use bilingual or English-language instruction. The survey reported that English is used as a teaching language in nearly 75% of the mapped degree program. In many cases English is combined with the local language: for example, a program might offer some modules in English (especially at master's level or for international student cohorts) and others in the national language. Indeed, almost all programs had at least some content in the local language; only 10 programs (out of 70) were delivered entirely in English with no local-language content. Those fully-English programs were concentrated in certain countries (notably Germany and Italy, offering English-taught MSc or PhD tracks to attract international students). By contrast, lifelong learning courses tend to be taught in the local language, targeting domestic participants such as local farmers or professionals. The study found that in 12 of 13 LLL cases, the primary instruction language was the national language (German, Italian, etc.), although about half of those did provide some English materials or options (e.g. bilingual course materials, or an English offering in parallel). This suggests that while higher education in AgTech is increasingly internationalized via English, continuing education remains more locally tailored, likely due to the specific needs of local farming communities and practitioners. For USAGE-NG, which involves an international partnership, this finding highlights the importance of multilingual support: to maximize impact, modules might be developed in English but with translations or local case studies to ensure accessibility for non-English-speaking stakeholders.

Teaching Methods and Pedagogical Approaches: The internal analysis of 189 course modules across Europe provides insight into the didactic methods commonly employed in AgTech and sustainable agriculture education. The most frequently used teaching methods are conventional classroom methods (lectures, seminars; coded as m1) and group discussion-based methods (interactive discussions, tutorials; m2). These traditional approaches were reported in a large majority of modules. In addition, a substantial share of modules incorporate case-study analyses (m6) and project-based work (m3) as part of their pedagogy. For instance, many programs include capstone projects, lab projects or field projects where students apply technology to real-world agricultural problems, as well as case studies examining farm innovation or sustainability challenges. On the other hand, more novel or student-driven methods appeared to be relatively rare: conversational methods (moderated peer dialogues, debates; m4) and flipped classrooms/online preparatory work (m5) were each observed in only a small fraction of modules. Because these latter methods were infrequent, the PR3 analysis grouped them with related categories (m4 combined with m2, and m5 with m3) for statistical analysis. Overall, the dominance of classical teaching formats suggests that while programs recognize the value of practical and collaborative learning (via projects and case studies), fully innovative pedagogies like flipped classrooms have not yet been widely adopted in this field. This is mirrored by the survey self-assessment: program coordinators rated the degree of learner-centered pedagogy in their programs as moderate on average (3 out of 5), indicating only a partially realized shift towards student-centered teaching.

Another dimension of pedagogy is who delivers the training. According to survey data, the primary instructors in these programs are academic staff (university faculty and researchers), which is expected for higher education. However, many programs also feature contributions from industry professionals or consultants as guest lecturers, especially in applied topics like farm management systems or emerging AgTech products. In fact, on average each program had 2–3 different categories of instructors involved. In LLL courses, the involvement of non-academic experts is relatively greater: while scholars still deliver most content, a number of courses invite farmers, extension agents, or government specialists to teach certain components, reflecting the practical orientation of adult training. The presence of farmers and even school teachers as educators was noted to be slightly higher in LLL programs than in standard degree programs. This mix of teaching personnel enriches the learning experience by providing real-world perspectives alongside scientific theory. It also aligns with the concept of micro-credentials and upskilling, which often rely on collaboration between academia and industry to ensure relevance.

Competences Targeted: In conjunction with teaching methods, the analysis considered which competences and learning outcomes are most emphasized by existing modules. Across the 189 modules reviewed, the most commonly delivered learning outcomes are higher-order cognitive and practical skills rather than narrow technical knowledge. Specifically, the competences “critical awareness of knowledge” (i.e. the ability to critically evaluate and contextualize knowledge, labeled c1.2), problem-solving skills (c2), and the ability to manage complex situations (systems-thinking and decision-making in complex contexts, c3.1) were each addressed by a large majority of modules. These three competences are closely aligned with the needs of sustainable agriculture professionals who must solve multifaceted problems (e.g. optimizing yields while reducing emissions) and continuously adapt knowledge to new scenarios. In contrast, the competence of acquiring highly specialized knowledge in a narrow field (c1.1) was less prevalent – only about one-third of modules explicitly aimed to impart such specialized theoretical knowledge. Similarly, the competence of taking responsibility and autonomy (c3.2), which relates to leadership and ethical responsibility, was only partially addressed in the modules (present but not strongly in most cases). These findings suggest that current curricula prioritize broad analytical skills and problem-solving in sustainable AgTech contexts, possibly assuming that very specialized expertise or leadership capacity will be developed further in professional practice or higher research. Indeed, a strong complementarity among the delivered competences was observed: modules that teach problem-solving (c2) almost always also cultivate critical thinking (c1.2) and complexity management (c3.1), these three form a cluster of competences delivered together. On the other hand, modules that provide highly specialized knowledge (c1.1) tend not to focus on critical awareness or vice versa. This indicates that educators design some courses to be foundational/theoretical and others to be applied/reflective, rather than attempting to cover the full spectrum in a single module.

4.2 Illustrative examples

4.2.1 Formal University Programs in Smart Farming

Head Formal programs are typically degree-granting courses (Master's or Postgraduate certificates) that integrate smart farming into higher education curricula. These multi-year programs deliver comprehensive theoretical and practical knowledge, often aligning with EQF Level 7 (Master's) or higher, and may incorporate work placements or research. They prepare graduates for roles like agricultural engineers, farm managers, or agri-tech specialists by covering topics from digital technologies to sustainable farm management. Formal degree programs typically confer academic credits (ECTS) and may require full-time study. They are well-suited to those seeking comprehensive education or careers in agri-tech R&D, but are less accessible to in-service farmers due to time and cost. Below are examples of relevant formal programs.

4.2.1.1 Master of Science and Engineering in Smart Farming & Sustainable Agriculture

The Master of Science and Engineering in Smart Farming & Sustainable Agriculture is a 2-year MSc engineering program focusing on innovative farming tech and sustainable practices. Emphasizes integration of smart technologies to improve productivity and environmental sustainability. Courses span crop & livestock management, data analysis, automation, resource management, as well as economic and social aspects of sustainability. Taught in English (optionally French) and accredited as an engineering degree. (Junia 2022)
Institution: Junia – ISA Lille Graduate School (FR)
Target Group: BSc graduates in agriculture, agronomy or related fields seeking an advanced degree in digital/sustainable farming.
Format: On-Campus, full-time.
Language: English (optionally French).
Duration: 2 years / 4 semesters
EQF Level: EQF 7 (Master's)
Website: https://www.junia.com/en/academics/master-of-science-and-engineering-in-smart-farming-and-sustainable-agriculture/
Tuiton Fee per year: €9000 + €500

Key Learning outcomes:
Understand core agricultural science (crop, livestock production) in technical, economic, and ethical contexts.
Apply data analysis and smart farming technologies (sensors, automation) to agriculture. Manage farm production systems for sustainability (incl. climate adaptation measures).
Integrate multidisciplinary perspectives (economics, sociology) in farm decision-making for sustainability.
Lead projects in international/multicultural agricultural contexts.

4.2.1.2 Master of Science "Digital Farming"

The Master of Science "Digital Farming" is a 2 year program blending agricultural science with digital technology and data science. Provides a comprehensive mix of theory and practice to solve modern farming challenges. Curriculum covers precision crop and livestock farming, programming & data literacy, AI and robotics in agriculture, and project-based work on smart farming innovations. It prepares students for expert roles in the digital transformation of agriculture. (HSWT 2023)
Institution: Weihenstephan-Triesdorf UAS – HSWT (DE)

Target Group: Graduates (BSc) in agriculture, engineering, or related fields aiming to specialize in agri-digitalization.
Format: On-Campus, full-time.
Language: English (international program).
Duration: 2 years / 4 semesters
EQF Level: EQF 7 (Master's)
Website: https://www.hswt.de/en/study/study-offer/master/digital-farming
Tuiton Fee per year: €0 (public tuition)

Key Learning outcomes:
Build strong foundation in agricultural production systems (plant and animal) and sustainability principles.
Develop competency in programming, data analysis, GIS and sensor technologies for farm management.
Apply AI, robotics, and automation in precision farming (crop and livestock).
Conduct interdisciplinary projects addressing real-world farming problems (project-based learning).
Gain leadership and communication skills for implementing digital innovations in agriculture (global/intercultural context

4.2.2 Non-Formal Courses and Certificates (Short Courses & Workshops)

Non-formal training offers are shorter, focused learning opportunities outside the traditional degree system. These include university-affiliated certificate courses, professional development programs, and workshops by industry or networks. Many are designed for lifelong learners such as farmers, advisors, or agri-professionals who seek upskilling in specific smart farming skills. Notably, some of these courses yield certificates or micro-credentials (sometimes with ECTS credits) that can be stacked towards larger qualifications.
Many universities and institutions offer similar short courses e.g. University of Hohenheim's "Smart Farming" certificate or agritech training by national agricultural chambers, often focusing on precision crop management, farm data analytics, or specific technologies (drones, farm management software). Industry-led courses (by machinery or tech companies) and EU projects (e.g. DEMETER, SmartAgriHubs) also conduct training sessions, though these may be one-off. Non-formal courses are usually shorter (days to weeks), more accessible to practitioners, and increasingly provide micro-credentials that can count towards further education. (Gamage und Dehideniya 2025)

4.2.2.1 Smart Agriculture Farming (SMAF) Workshops

SMAF is a series of seminars/workshops across Europe (Hungary, Greece, Spain, Italy) on data-driven farming innovations. Each 1–2 day workshop provides an overview of challenges and opportunities of adopting digital tech on farm. Latest technologies (AI, IoT sensors, decision support tools) are showcased along with case studies demonstrating benefits in efficiency, traceability, and sustainability. Events include demos (e.g. water-saving irrigation, nutrient management) and even proposal-writing training for agri-innovation funding. (EIT Food 2024)
Institution: EIT Food (EU) + local partners.
Target Group: Small-scale farmers, agri-entrepreneurs, farm advisors, and students in agriculture. Particularly those looking to adopt or learn about digital farming tools.
Format: In-person workshops (often 1-day events) at pilot farms or training centers; some hybrid sessions.
Language: Local language or English (with translation) depending on country.
Duration: ca. 1 day
EQF Level: n/a
Credit: n/a
Website: https://learning.eitfood.eu/courses/smaf-smart-agriculture-farming
Fee: Free (EU-funded)

Key Learning outcomes:
Recognize the latest digital solutions in agriculture (sensors, data platforms, AI tools) and their contributions to farm productivity.
Understand how integrating digital tech can improve supply chain efficiency, transparency, and reduce food waste.
Learn concrete examples of smart farming applications (e.g. precision irrigation, greenhouse climate control, machine learning for crop monitoring).
Assess barriers to adoption for small-scale farmers and identify strategies to increase digital adoption rates (incl. training needs and support).
Network with innovators and gain knowledge on accessing EU funding for agri-tech projects (e.g. insights from EIT Food projects.

4.2.3 Informal and Open Online Learning (MOOCs & OER)

Informal learning opportunities in smart farming are typically online courses and open educational resources that learners can access freely (or at low cost). These include MOOCs (Massive Open Online Courses) offered by universities or international organizations, often self-paced and focusing on specific aspects of climate-smart and digital agriculture. Such courses do not require enrolment in a university and are ideal for lifelong learners – farmers, students, or professionals – who need flexibility. Many MOOCs provide a certificate of completion and micro-credentials (sometimes digital badges), but more importantly, they serve as modular learning that can be combined according to one's learning pathway. (Paliwal, Harshit Singh, Arun Kumar Kumar, Gaurav 2025)

4.2.3.1 The Future of Farming: Exploring Climate Smart Agriculture

A 3-week online course introducing Climate-Smart Agriculture (CSA) in the context of European farming. Covers how farming can adapt to climate change while reducing emissions and safeguarding food production. Uses examples from dairy and wine sectors to illustrate mitigation, adaptation, and productivity – the three pillars of CSA. (Future Learn 2020)

Status: Not currently running (was offered free with optional certificate)
Institution/Author: University of Reading (UK) – supported by EIT Climate-KIC
Target: Designed for a general audience interested in farming & environment; no prior knowledge required.
Format: 100% online MOOC (approx. 3 hrs/week for 3 weeks) with videos, articles, discussions.
Language: English
Credential: Certificate of Completion (digital, optional)
Fee: Free (self-paced access; optional paid upgrade for cert)
Website: https://www.futurelearn.com/courses/climate-smart-agriculture

Learning Outcomes:
Describe the principles of Climate Smart Agriculture, including its three pillars (mitigation, adaptation, productivity).
Investigate how climate change and agriculture interact – effects of farming on GHG emissions and how climate shifts impact food production.
Outline challenges and solutions for dairy farming (e.g. enteric emissions) and viticulture under climate change.
Discuss barriers to implementing CSA and ways to overcome them (e.g. consumer behaviour, policy, financial incentives).
Reflect on sustainable farming alternatives and data-driven decision tools that can help farmers become more climate-resilient

4.2.3.2 Climate Smart Agriculture – Beginner and Advanced Level

An introductory MOOC (4 weeks, self-paced) covering what Climate-Smart Agriculture is and basic techniques to improve farm management for climate adaptation and biodiversity. Part of an EU-funded series ("Growing Smarter for a Greener Tomorrow") that also offers an advanced course with a virtual farm simulator. The beginner course (in English, with Italian, Spanish, Lithuanian versions) provides foundational knowledge in sustainable practices and climate change impacts on farming. (Università di Padova 2023)
Institution/Author: University of Padova & FarmBox Project (IT)
Target: farmers, students, and practitioners seeking an entry-level understanding of CSA. No prerequisites.
Format: 8 hours of online content (videos, quizzes) over 4 weeks
Language: multiple
Credential: Open badge; Certificate of participation (free)
Fee: Free
Website: https://learn.eduopen.org/eduopenv2/course_details.php?courseid=545
Learning Outcomes:
Identify key issues affecting sustainable agriculture and food security under climate change
Understand how sensing technologies support crop monitoring and how traceability can improve food system resilience.
Learn the global and national policy context for climate change mitigation and adaptation in agriculture.
Discover different climate change mitigation/adaptation measures in the agri sector and tools to calculate carbon footprint on farms.
Recognize practices that enhance on-farm biodiversity and their value in climate-smart systems.

4.2.3.3 Master Level Open Online Smart-Farming Course (MLOOSC)

A 135-hour open online course created by an Erasmus+ consortium, equivalent to master's level study. Covers core smart farming topics: precision agriculture, data analysis & modelling, and geographic information systems (GIS) in agriculture. Designed to be free and accessible to anyone interested in advanced smart farming concepts. Modules likely include remote sensing, farm data management, and IoT applications on the farm. (Erasmus Plus Smart-Farming Consortium 2025)
Institution/Author: University of Trás-os-Montes e Alto Douro (Portugal) and Erasmus+ partners
Target: Advanced students, agri-professionals, and motivated farmers
Format: Online courseware (readings, videos, self-paced via Moodle)
Language: English
Credential: Non-degree certificate of completion (Master-level)
Fee: Free
Website: https://ead.utad.pt/course/index.php
Learning Outcomes:
Apply variable-rate and GNSS technologies in precision agriculture
Use modeling and analytics for yield prediction
Operate GIS tools for field zoning and spatial decisions
Analyze smart farming adoption cases
Design applied digital agriculture solutions

4.2.3.4 Drones for Agriculture: Prepare and Design Your Drone Mission

A short MOOC (3 weeks) focused on the practical use of drones (UAVs) in precision agriculture. Teaches how to plan a drone flight for farm monitoring – from imagery acquisition to data visualization. Participants also learn how to process drone-collected data (e.g. stitching images, analysing NDVI maps) for agricultural applications. Part of WUR's portfolio of MOOCs on smart agriculture and agri-food technology. (WUR 2024)

Institution/Author: Wageningen University & Research (WUR)
Target: Farmers, agronomists, agri-tech learners
Format: Self-paced MOOC (3 weeks, 2–5 hours/week)
Language: English
Credential: Verified Certificate (paid); free audit
Fee: Free (audit); €50 for certificate
Website: https://www.wur.nl/en/show/drones-for-agriculture-prepare-and-design-your-drone-uav-mission.htm
Learning Outcomes:
Understand UAV types, sensors, and regulations
Plan crop-monitoring missions
Process aerial imagery and generate maps
Interpret data to assess field variability
Evaluate drone use in multiple farming contexts

5 Discussion

The mapping of existing training offers in AgTech, climate change, and sustainable agriculture reveals a vibrant educational landscape that nonetheless has identifiable gaps and patterns, which carry important implications for curriculum development in projects like USAGE-NG. A key observation is the interdisciplinary integration of content: successful programs blend engineering know-how with environmental and sustainability science. The findings show that engineering-oriented curricula (e.g. agricultural engineering, precision farming technology) are increasingly infused with sustainability principles. Likewise, programs originally rooted in environmental sciences are incorporating digital agriculture tools. This synergy reflects an educational response to the complex challenges of modern agriculture, where technological innovation must be applied in environmentally responsible ways. For the USAGE-NG project, which aims to develop new modules on smart farming for climate adaptation, the lesson is that climate change should be taught not as an isolated subject, but in concert with broader sustainability and agri-tech topics. The fact that no surveyed program had a pure "climate change" specialization suggests that learners gain more value when climate topics are contextualized – for instance, learning about climate-smart irrigation as part of a precision agriculture course, or understanding climate policy in a sustainable food systems course. Therefore, the curriculum design should ensure each module connects climate mitigation/adaptation content to practical farming and technology applications, maintaining the interdisciplinary framing that current programs have found effective.

Another implication concerns the breadth of topics and the depth of specialization. The data indicate that most programs strive to produce graduates with a holistic skill set – emphasizing critical thinking and problem-solving across diverse subjects – rather than ultra-specialized experts in a single niche. This was evident from the prevalence of systems-thinking competencies (managing complex situations) and the relatively lower emphasis on narrowly specialized knowledge in individual modules. For developing micro-credentials, this suggests that each short course should be scoped to cover applied problem-solving within a defined thematic context, rather than overload on abstract theory. The programs surveyed typically partition content such that some modules tackle practical challenges and case studies, whereas other modules cover fundamental science or engineering principles. Notably, LATEST's cluster analysis found that modules delivering advanced theoretical knowledge (c1.1) rarely deliver critical awareness (c1.2) concurrently, implying two pedagogical pathways. In curriculum planning, this means USAGE-NG might design certain modules to be more theoretical (ensuring scientific rigor and specialized content) and others to be more reflective and skill-based and ensure that the overall package of micro-credentials balances these elements. A joint program must avoid over-emphasizing one type of competence at the expense of the other; a balance between knowledge-oriented and skillsoriented learning outcomes is recommended. For example, a micro-module on "IoT for climate monitoring" could focus on specialized technical knowledge (sensors, data analysis techniques), whereas a complementary module on "Climate-adaptive farm management" might focus on applied problem-solving, decision-making, and critical evaluation of interventions. Together, they would ensure learners acquire both the know-what and the know-how – an approach directly informed by the gap LATEST identified when single modules tried to do both.

The analysis of didactic methods provides further guidance. The continued dominance of lecture-based delivery in many programs suggests an opportunity to introduce more innovative teaching strategies to increase learner engagement. Traditional lectures (often necessary for core content delivery) can be augmented by interactive and experiential learning. LATEST findings confirm that methods are not interchangeable but complementary as each pedagogical method offers unique benefits, and no single method suffices to develop the full range of desired competencies. For instance, while lectures are efficient for transmitting foundational knowledge, methods like case studies and project work are superior for cultivating problem-solving and real-world application skills. The strong co-occurrence of problem-solving competence with group discussions and projects in current modules underscores this point. Conversely, certain competencies may be under-served by a given method: the finding that case-study driven modules (m6) had weaker links to developing critical awareness (c1.2) and problem-solving (c2) suggests that case studies alone might not prompt sufficient reflection or methodical problem analysis, unless paired with discussions or projects. The practical insight is that blended pedagogical approaches should be built into each module. USAGE-NG's module design can intentionally combine methods, e.g. an online preparatory segment (flipped classroom) followed by in-person discussion and a project assignment, to leverage the strengths of each approach. Encouragingly, the analysis also noted that even innovative didactic methods can be coupled with traditional ones in a complementary fashion, rather than replacing them. For example, a traditional lecture can be immediately followed by a collaborative problem-solving workshop or a case analysis session, linking theory to practice. Adopting such multi-method designs will likely enhance the learning outcomes, catering to different learning preferences and reinforcing key competencies from multiple angles. In terms of didactic innovation, the moderate use of learner-centered pedagogy so far (self-rated ~3/5) implies room for improvement; micro-credentials provide an excellent testing ground for student-centered techniques (like project-based learning, field immersion, or peer-to-peer knowledge exchange) because of their shorter, focused format. The USAGE-NG team can draw on best practices from the benchmarked courses – many of which included field projects or industry guest lectures – to make modules engaging and relevant to real farm scenarios.

The integration of lifelong learning (LLL) and formal education in existing programs also carries important messages. The fact that many universities allow adult learners to enroll in regular courses reflects a growing demand for upskilling and the move towards more flexible learning pathways. Micro-credentials are inherently designed to serve both traditional students and lifelong learners, so the success of current programs in attracting mixed audiences suggests that USAGE-NG modules should be marketed and structured to be accessible to diverse learner groups (from full-time university students to working farmers). One challenge noted is language: LLL courses often default to the local language to reach local farming communities, which may limit broader mobility of the credential. USAGE-NG will need to balance the use of English (for international scalability) with localized content delivery (for direct impact on target communities). Perhaps the modules can be offered in English but with subtitled video lectures or translated materials to serve non-English speakers, taking inspiration from projects that produced bilingual MOOCs or multilingual course content. Additionally, the heavy involvement of industry and practitioner instructors in LLL programs reinforces the value of engaging stakeholders outside academia in the module development and teaching process. Doing so not only grounds the material in practical reality, but also enhances recognition of the micro-credentials among employers and farming networks. The USAGE-NG project's consortium, which includes academic and industry partners, is well positioned to incorporate this approach – for example, ENAMA (a partner specializing in farm machinery) could contribute to a module on sustainable mechanization, lending credibility and real-world insight.

Lastly, the treatment of climate change and sustainability across curricula offers a strategic perspective. The meta-analysis makes it clear that sustainability is pervasive in agricultural training, and climate change is usually addressed under that umbrella rather than as a separate silo. This suggests that future offerings (including the ones USAGE-NG will develop) might have greater impact by framing climate change in terms of tangible sustainability challenges relevant to learners. For instance, instead of a generic "Climate Change Impacts" module, a more resonant approach could be "Climate Change and Sustainable Land Management" or "Smart Farming for Climate Resilience," which inherently links the climate theme to actionable agricultural practices. Embracing the synergy between climate and other sustainability topics also fosters interdisciplinarity; students learn to see climate adaptation as part of a systems approach that also tackles biodiversity, soil health, and socio-economic factors. The survey finding that 71% of programs treat sustainability as an important theme, compared to 49% for climate change might indicate that some programs still underplay climate issues. As climate risks accelerate, there is arguably a need to strengthen climate-specific content within the sustainability curricula. USAGE-NG can contribute by making climate change an explicit learning outcome of its modules (e.g. each module could include how the topic contributes to climate mitigation/adaptation), thereby slightly shifting the balance to ensure at least parity in attention between general sustainability and direct climate change issues. In sum, the synergy observed should be leveraged: the new modules can integrate climate science with sustainable tech solutions (such as using IoT sensors to reduce water use under drought conditions), reflecting exactly the kind of holistic education that current best-in-class programs exemplify.

6 Conclusion

This research into existing training offers at EQF levels 6–8 demonstrates that European higher education and professional courses in AgTech are actively evolving to meet the twin imperatives of technological innovation and sustainable, climate-resilient agriculture. Programs across the continent are, to a large extent, aligning with the goals of the European Green Deal and digital transformation agendas by producing graduates skilled in smart farming techniques and well-versed in sustainability concepts. Formal degree programs embed digital agriculture in academic curricula, while numerous short courses and workshops offer targeted upskilling opportunities for practitioners. Meanwhile, open-access MOOCs and e-learning modules lower barriers for smallholder farmers to learn about innovations at their own pace. Notably, the trend toward micro-credentials is evident – from university certificates (5–6 ECTS) to digital badges for MOOCs – allowing learners to accumulate modules into larger qualifications or professional portfolios.

Key findings include the widespread integration of climate change topics within broader sustainability curricula, the emphasis on multidisciplinary skills (critical thinking, problem solving, systems management) over narrow specialization, and the prevalent use of blended learning formats and bilingual instruction to reach diverse audiences. Lifelong learning has emerged as an integral component of the agricultural education ecosystem, with many short courses offering micro-credential-like certificates and even academic credit, thereby bridging formal and non-formal learning. These insights carry significant implications for the USAGE-NG project. They suggest that the project's new module offerings should be crafted to by combining theoretical and applied content, using a mix of teaching methods to engage learners, and embedding each technical topic within the context of sustainability and climate impact.
The analysis also highlights areas for improvement or innovation: few programs currently employ highly novel pedagogies (like flipped classrooms) or focus intensely on climate change alone,

indicating room for USAGE-NG to innovate in teaching approach and to foreground climate-smart farming for small-scale producers as a distinctive theme. By building on the strengths of existing courses and addressing their gaps, USAGE-NG's modules (aligned with EQF 6–8) can offer cutting-edge education that is academically rigorous, practically relevant, and geared towards empowering learners, whether university students or active farmers, to champion sustainable technological change in agriculture. In conclusion, the benchmarking of current training offers provides a solid foundation for designing the next generation of educational programs. It ensures that the development done in USAGE-NG is evidence-based and responsive to identified needs, such as integrating climate change content, adopting diverse didactic methods, and enabling flexible learning pathways. This report not only documents the state of the art but also guides future actions: the forthcoming development of modules and pilot courses will be informed by these findings, maximizing their relevance and impact in fostering climate-smart, technology-enhanced agricultural innovation.

Moving forward, the insights from this Activity 3.1 survey will inform the development of new courses (Activity 3.2) and the implementation of pilot trainings (WP4), ensuring they build on existing best practices while filling the identified gaps (e.g. localized content for mountain farming, mobile learning integration, and recognition via European frameworks like EQF).

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