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CAAIVE

Comprehensive Analytical Report

Factor Mapping and Focus Group Validation for Precision Farming Digital Skills

Synthesis of uploaded national reports and focus group transcripts from:
Italy, Greece, North Macedonia, Latvia, and Romania

Prepared as a consolidated project document to support subsequent work packages, including the development of the Digital Skill Profile, curricula, micro-credentials, and related implementation actions.

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Note: The broader project partnership includes additional countries; however, this report synthesizes only the materials made available in the present documentary set.

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1. Executive Summary

This report presents a consolidated analysis of the ideas, observations, concerns, and recommendations generated through the Factor Mapping process and its subsequent validation through Focus Group interviews in the uploaded project materials. The documentary evidence reviewed for this synthesis comes from Italy, Greece, North Macedonia, Latvia, and Romania. Taken together, these materials provide a robust qualitative basis for refining the project's understanding of digital skill needs in Precision Farming and for informing the next stages of work, particularly the development of the Digital Skill Profile, curricula, training pathways, and micro-credential mechanisms.

A central finding across all national materials is that digital transformation in agriculture is not understood by stakeholders as a simple matter of purchasing software, machinery, drones, or artificial intelligence tools. Instead, participants consistently framed digitalization as an organizational, educational, and practical process that depends on a combination of factors: reliable data, clear work processes, usability of tools, access to support, affordability, role-specific competences, and confidence in the value of change. In several countries, the discussion made clear that digitalization is not a single technological step but a gradual pathway involving record-keeping, traceability, data interpretation, work redesign, and continuous learning.

A second major conclusion is that **data readiness precedes meaningful AI adoption**. This principle was especially explicit in the Italian evidence, but it was strongly supported in the other national materials as well. Participants repeatedly stressed that artificial intelligence is only useful when data is correctly collected, validated, structured, and interpreted. Good data quality, in this sense, is not a technical detail but a foundational condition for successful digital adoption. This has direct implications for project outputs: data literacy and data interpretation should be central components of the Digital Skill Profile and should not be treated as secondary to advanced AI-related content.

A third consistent finding is that **basic digital skills cannot be assumed**, either among older farmers or among younger learners entering agricultural education. Several participants noted that some farmers still struggle with email, computers, digital forms, and basic applications, while schools and training institutions in some contexts reported that students do not always leave education with sufficient confidence in routine digital tasks. This means that any realistic training and competence framework must begin with foundational digital confidence rather than presuming it.

A fourth key finding is the necessity of **role differentiation**. The materials clearly show that digital competence requirements vary by professional role, level of responsibility, farm size, and production system. All actors need some degree of digital confidence, but not all need to become advanced analysts, system integrators, or drone specialists. Stakeholders consistently distinguished between what is required from farmers, operational workers, students, managers, advisors, teachers, and technical specialists. This supports a progressive skill framework organized into levels such as foundation, operational, advanced or managerial, and specialist.

A fifth major conclusion concerns **scale and access conditions**. Larger and more structured enterprises generally have better access to capital, infrastructure, and staff capacity, making it easier for them to adopt integrated digital systems. Smaller farms often face additional barriers, including limited financial resources, lack of time, administrative overload, lower confidence,

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restricted access to advisory support, and weak broadband or infrastructure conditions. However, the evidence also shows that smaller farms are not inherently resistant to digitalization. On the contrary, they are often willing to adopt targeted tools when the benefit is immediate, the interface is simple, the cost is manageable, and support is available. The implication is that smaller farms need different access models, including shared services, cooperative support, mobile learning, equipment-as-a-service, and administrative assistance.

A sixth strong finding is the universal preference for **practical, problem-based, accessible training**. Across all uploaded materials, participants favored training that is short, applied, understandable, and directly connected to real work processes. Demonstration farms, hands-on workshops, peer exchange, field visits, guided practice, and blended delivery formats were consistently preferred over abstract or highly technical instruction. This indicates that future curricula should be built around real agricultural and administrative problems rather than around technologies alone.

A seventh important theme concerns **recognition and validation of skills**. The Romanian material was especially strong on this point, but similar implications emerged in other countries. Stakeholders want certifications and micro-credentials that are meaningful, portable, practical, and recognized beyond the company or vendor that delivers the training. Certificates linked only to commercial providers or not aligned with formal education were seen as inadequate. This strongly validates the project’s intention to create structured micro-credential mechanisms.

Finally, the evidence suggests that the Factor Maps should be revised so that several enabling conditions become more visible. These include data quality, organizational readiness, interoperability, usability, access to advisory support, administrative digitalization, public digital infrastructure, and portable certification. The strongest overall message is that project outputs should be designed around **real farm tasks and clear value**, not around technology categories in isolation.

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2. Introduction

European agriculture is undergoing simultaneous digital, environmental, and demographic transitions. Precision Farming, connected devices, sensors, automated systems, artificial intelligence, remote monitoring, and data-driven decision-support tools are increasingly visible across the agricultural sector. At the same time, the adoption of these technologies remains uneven across countries, territories, and production systems. It is shaped not only by technical availability, but also by educational preparation, farm economics, institutional support, and organizational capacity.

The CAIVE/CAAIVE project has been developed in response to this changing landscape. Its core ambition is to support the agricultural sector by identifying and strengthening the digital competences required for contemporary and future agricultural work. The project's methodology places significant emphasis on stakeholder consultation, both through the initial Factor Mapping process and through subsequent Focus Group validation. This is methodologically important because it ensures that training-related outputs are not based solely on theoretical assumptions or generalized policy narratives, but on the lived experience of farmers, advisors, trainers, teachers, and agricultural professionals.

The present report consolidates the uploaded evidence emerging from this validation process. It is designed to function both as a detailed analytical record and as a developmental tool for subsequent project tasks. In doing so, it seeks to maintain fidelity to the practical concerns raised by participants while also organizing those concerns into a coherent framework that can inform curriculum design, micro-credential development, policy engagement, and future validation work.

3. Purpose and scope of the Report

The purpose of this report is threefold.

First, it provides a **comprehensive analytical synthesis** of the available documentary evidence gathered during the Factor Mapping process and its validation through Focus Group interviews. The goal is not merely to summarize national reports separately, but to extract broader patterns and project-relevant implications across them.

Second, it serves a **developmental purpose**. The findings are intended to support subsequent project tasks, especially the refinement of the Factor Maps, the construction of a Digital Skill Profile for Precision Farming, and the design of future curricula, micro-credentials, and implementation actions.

Third, it serves a **communication purpose**. Because the final document is intended not only for internal use but also for public use, it must provide a credible and understandable narrative of what stakeholders said, what themes emerged, and what conclusions can be drawn from the evidence.

In terms of scope, the report is limited to the uploaded materials reviewed in the present exchange. These materials provide evidence from Italy, Greece, North Macedonia, Latvia, and Romania. The broader project partnership may include additional national evidence, but that

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evidence is not part of the present synthesis. Accordingly, this document should be read as a comprehensive synthesis of the uploaded documentary set, rather than as a complete representation of all evidence generated by the entire project partnership.

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4. Methodological note

The evidence base underpinning this report is qualitative in nature. It consists of analytical reports, transcripts of focus group discussions, session summaries, and question-by-question thematic notes. The findings therefore do not claim statistical representativeness. Rather, they capture the perceptions, practical experiences, and professional judgments of relevant stakeholder groups across multiple national contexts.

The analytical approach used in preparing this report involved close comparative reading of the uploaded materials and thematic coding around recurring issues. These included:

- the meaning of digitalization and Precision Farming in practice;
- technologies currently used or considered relevant;
- basic digital skills required before engaging in Precision Farming;
- additional digital, data, and AI-related competences;
- barriers to adoption;
- facilitating conditions and support structures;
- differences by farm size, age, sector, and role;
- implications for education, training, and certification.

The evidence reviewed varies in depth and structure. Some national documents, such as the Italian and Romanian reports, provide extensive analytical framing and detailed transcripts. Others, such as the Greek transcript and the North Macedonian Strumica report, provide a shorter but still useful picture of stakeholder views. The Latvian evidence is especially valuable for its practical observations, while the North Macedonian documents provide strong insight into structural barriers, generational issues, and the role of practical training.

Because the source materials differ in level of detail, the present report gives greatest analytical weight to findings that recur across multiple national contexts and stakeholder types. At the same time, country-specific observations that add conceptual or practical value are highlighted where relevant.

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5. Documentary evidence base

The present report is based on the following uploaded materials:

1. **Italy**
   - Focus Group Analytical Report, dated 13 July 2026
   - English transcript of the focus group session
2. **North Macedonia – Skopje**
   - NGO NOVA KREATIVA report on validation of factor maps
3. **North Macedonia – Strumica / South-East Planning Region**
   - Focus group report with structured summary, questions, and conclusions
4. **Latvia**
   - English transcript of the national focus group session
5. **Romania**
   - National Focus Group Report with full English transcript
6. **Greece**
   - English transcript of a focus group organized with Geotechniki and the International Hellenic University

The materials collectively cover stakeholders from crop farming, livestock production, mixed farming, agricultural education, vocational training, advisory and support roles, digital service provision, and territorial development structures. The evidence therefore captures a wide range of perspectives relevant to the project's objectives.

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6. Stakeholder perspectives represented

A notable strength of the uploaded evidence is the diversity of stakeholders represented. This diversity improves the credibility and practical usefulness of the findings, as digital skill needs in agriculture do not arise in a single professional setting.

At the level of direct farming practice, the materials include contributions from arable farmers, dairy farmers, mixed farmers, livestock producers, vegetable growers, viticulture-related actors, family farmers, and farmers operating at different scales. This allows the analysis to account for the practical implications of digitalization under varying economic and operational conditions.

The evidence also includes substantial contributions from agronomists, agricultural consultants, software and mapping specialists, and technical actors who work at the interface between technology development and practical farm use. These participants provide insight into system integration, decision-support tools, data use, and the challenges of translating technology into operationally meaningful practice.

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Education and training perspectives are strongly represented as well. The materials include agricultural teachers, vocational education and training providers, university lecturers, agricultural students, and project-based training organizations. These perspectives are especially important because the project's core outputs concern skill profiles, curricula, and micro-credentials.

In addition, several documents include territorial, organizational, and institutional actors such as cooperative managers, NGO representatives, advisory service actors, public administration staff, regional development bodies, and farmers' organizations. Their inclusion helps illuminate the enabling conditions that exist beyond the individual learner, such as access to funding, advisory support, shared services, and public digital infrastructure.

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7. National findings

7.1 Italy

The Italian material provides one of the clearest and most conceptually developed accounts of how agricultural stakeholders understand digitalization. Participants consistently described digitalization not as a one-off technological investment, but as a process of organizational transformation. This transformation concerns operations, documentation, decision-making, traceability, and communication, and it unfolds gradually across field, livestock, logistics, and management functions.

A central Italian contribution to the overall evidence base is the insistence that **data is a prerequisite for AI**. Participants made the point repeatedly that artificial intelligence cannot produce useful outputs if the underlying data foundation is weak. For them, data collection, data validation, integration across processes, and interpretation in context are not optional preliminary steps; they are the basis upon which any more advanced analytics or AI applications must rest.

The Italian focus group also broadened the concept of digitalization beyond production activities alone. Data was described as important not only for internal efficiency but also for sustainability communication, external transparency, and strategic positioning. This is significant because it shows that digital skill needs extend into reporting, communication, and stakeholder-facing functions.

In terms of technologies already used or considered relevant, the Italian material referenced a wide array of systems: mobile applications for records and traceability, automated milking, automated feeding, environmental controls, livestock sensors, smart collars, precision irrigation, data platforms, AI-supported administrative tasks, and machine-learning-related anomaly detection in livestock systems. The diversity of examples suggests that digitalization in Italy is not confined to a single agricultural niche.

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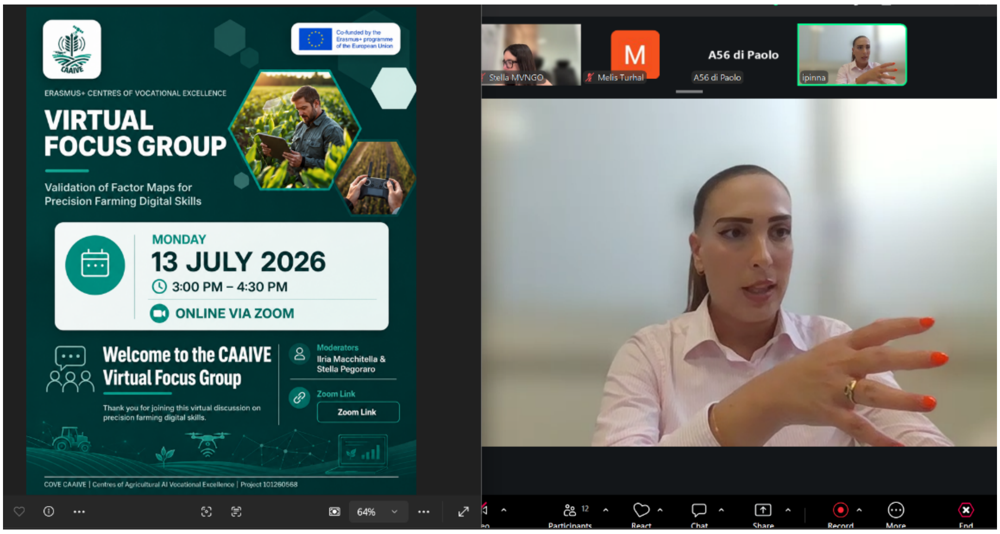

(Picture 1: Italian CAAIVE Focus Group)

With regard to skills, Italian participants emphasized the need for a basic layer of digital competence that includes device use, document handling, data entry, basic office tools, and the ability to read simple dashboards and indicators. Beyond this, Precision Farming was understood to require contextual interpretation of agricultural data, use of connected systems, human verification of digital recommendations, and the ability to communicate effectively with providers, consultants, and researchers.

The barriers identified in the Italian material extend beyond equipment cost. Participants stressed the cost of integration, the need for staff training, the time required for process redesign, the uneven maturity of AI tools, and the lack of support structures for smaller farms. At the same time, they cautioned against interpreting non-adoption simply as "resistance." In many cases, farms are willing but lack scale, structure, time, or trusted support.

A particularly valuable Italian recommendation concerns the use of shared and territorial structures. Cooperatives, consortia, schools, VET providers, and advisory bodies were seen as essential intermediaries that can reduce barriers, create economies of scale, and offer recognizable access points for training and support. The Italian material also proposed an especially innovative idea: a controlled AI assistant to help small farms with administrative processes such as funding applications, while preserving professional oversight.

Overall, the Italian evidence strongly supports a project approach that foregrounds data readiness, role differentiation, practical problem-solving, and local support ecosystems.

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(Picture 2, Italian CAAIVE Focus Group)

7.2 Greece

The Greek transcript is more concise than some of the other national materials, but it provides important insight into stakeholder expectations, current technology use, and the perceived value of institutional training centers.

The Greek session placed strong emphasis on the broader strategic ambitions of the project, including the establishment of regional training centers, the development of modern curricula, the provision of mobility opportunities, and the aspiration to generate policy-relevant results. This framing is important because it indicates that stakeholders in the Greek context are thinking beyond short-term training delivery and are attentive to the sustainability and institutional permanence of project outputs.

The participants represented a mix of agronomists, farmers, students, consultants, software providers, and surveyors. This group discussed both existing digital tools and the practical benefits of precision agriculture. Technologies already in use or referred to included GPS systems, auto-steer, drones, weather stations, precision planting and fertilization systems, automatic irrigation management, remote sensing applications, and software for field-level analysis and advisory support.

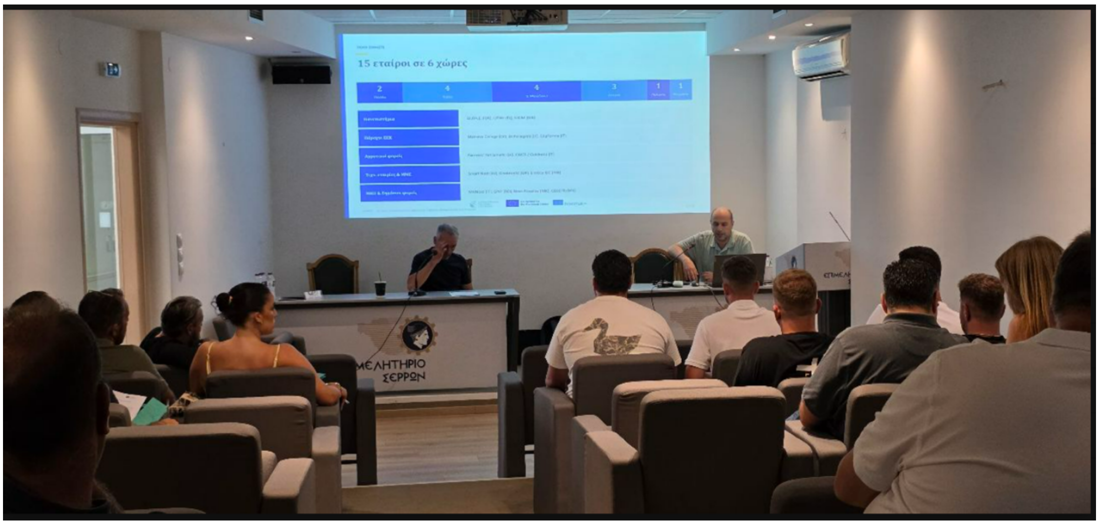
One of the most practically grounded contributions from the Greek discussion related to the use of GPS in night spraying, especially where pollinator protection is a concern. A farmer explained that GPS makes it possible to spray safely and accurately at night, thereby reducing the risk of harming bees. This is a useful example because it links digital technology not only to efficiency but also to environmental management and good practice.

(Picture 1: Focus group at International Hellenic University, Greece)

Another important Greek contribution concerned the use of drones. A participant noted that, although drone use is increasing, operational practices are not always scientifically grounded. In particular, concerns were raised that in-field drone spraying may not always follow appropriate dosage or water-volume standards, with operators sometimes privileging speed and acreage over agronomic correctness. This points to a clear training need: not simply how to use drones, but how to use them properly in accordance with evidence-based application principles.

The Greek discussion also highlighted stakeholder interest in the long-term sustainability of regional training centers. Participants explicitly asked whether the centers would continue functioning after the project ended and whether they would become hubs that integrate knowledge, training, and technical expertise. This is significant because it suggests that stakeholders see value in permanent or semi-permanent institutional structures capable of providing ongoing support rather than isolated interventions.

Overall, the Greek evidence reinforces the importance of practical application standards, regional hub models, and sustainability in training provision.



(Picture 2: Focus group at International Hellenic University, Greece)

7.3 North Macedonia

The uploaded evidence from North Macedonia consists of two complementary materials: the NGO NOVA KREATIVA report from Skopje and the South-East Planning Region focus group report from Strumica. Taken together, these documents provide a broad picture of the country's agricultural digitalization challenges and opportunities.

(Photo 1: Focus groups at Strumica, North Macedonia)

The Strumica report characterizes digitalization in agriculture as moderately developed, with growing adoption among larger enterprises and significant unrealized potential across the wider sector. It notes the use of GPS systems, drones, soil moisture sensors, farm management software, and AI-related applications, while also emphasizing that this adoption is uneven and often concentrated among more resource-rich actors.

The Skopje report provides a particularly strong account of the gap between larger and smaller holdings. Large enterprises with more intensive production systems are described as more likely to adopt automation and digital solutions, while many small farms remain heavily dependent on traditional methods. The report points to structural constraints such as limited capital, low-input farming conditions, lack of infrastructure, insufficient advisory presence, and weak confidence in digital tools.

Both North Macedonian materials identify a strong generational dimension. Older farmers are often described as less familiar with precision agriculture and less willing or able to engage with digital tools, whereas younger farmers, researchers, and students are seen as more open to technologies such as sensors, GPS, drones, mobile applications, and software. At the same time, the Strumica evidence suggests that knowledge of AI remains relatively limited even among younger actors. This indicates that the project should avoid assuming deep technological competence among youth simply because they belong to a younger age group.

Educational mismatch is a recurring theme in both documents. Vocational and higher education are acknowledged as important, but not yet fully aligned with the technological realities of modern agriculture. Participants indicated that many young people enter the sector with

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theoretical knowledge but insufficient practical experience of digital tools, data analysis, and decision-support systems. Accordingly, both sources call for stronger practical components, closer links between educational institutions and farms, and better alignment between training content and labour market needs.

(Photo 2, Focus group at Nova Kreativa, North Macedonia)

Training format is one of the clearest areas of consensus in the North Macedonian materials. Practical learning, learning by doing, field presence of advisory services, accessible training centers, and demonstration-based methods were all strongly favored. The Strumica report also supports a blended model that combines practical sessions, workshops, online courses, and work-based learning. This is especially relevant for adult learners and working farmers who need flexibility without sacrificing practical value.

The Strumica report is also notable for its structured recommendations regarding future curriculum areas. These include precision agriculture, GIS and GPS, remote sensing, IoT, AI and data-driven decision-making, digital record-keeping, climate-smart practices, entrepreneurship, and EU policy literacy. This broad framing is useful because it situates digital skills within a larger agricultural competence ecosystem rather than as an isolated technical subject.

Finally, both North Macedonian sources support the validation of practical skills through recognized credentials, including micro-credentials. They suggest that employers would value certifications more when they are linked to demonstrated competence and when they complement rather than replace real practice.

Overall, the North Macedonian evidence supports a training strategy built on practical delivery, training-of-trainers, advisory strengthening, targeted support for smallholders, and explicit attention to the divide between better-equipped enterprises and the broader population of smaller farms.

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7.4 Latvia

The Latvian transcript offers some of the most concrete operational examples in the evidence base and provides valuable insight into economic decision-making, digital literacy differentiation, peer learning, and support structures.

A notable feature of the Latvian discussion is that several participants were already using a broad range of precision agriculture tools. These included soil analysis systems, precision tillage and sowing, navigation and assisted steering, depth control, nitrogen management technologies, machinery monitoring, robotic milking and feeding, greenhouse climate-control systems, drones, and digital field-management platforms. This suggests a relatively mature degree of adoption among at least some stakeholders.

At the same time, the Latvian material also documents coexistence between highly digitalized and more traditional farms. This makes the Latvian evidence particularly useful for understanding how digital skill strategies must be differentiated by context rather than simply by country.

(Photo 1, Focus group in Latvia)

One of the strongest Latvian themes is the economic rationale for adoption. Participants repeatedly highlighted cost reduction, better resource targeting, and profit per hectare as key benefits of precision agriculture. Technologies were valued not because they were novel, but because they could improve input efficiency, reduce waste, and support better agronomic decisions. This finding aligns well with evidence from other countries and reinforces the importance of framing training around tangible value.

Latvian participants also offered an important insight into access models for small farms. Several comments suggested that smaller holdings do not necessarily need to purchase expensive technologies themselves. Instead, they may be able to access relevant tools through contractors, service providers, or shared arrangements. This is highly relevant for the project because it implies that the Digital Skill Profile should not assume technology ownership as a prerequisite for digital competence.

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Another distinctive contribution from the Latvian transcript concerns the need for **independent advisors**. Participants expressed concern that many farmers rely on information linked to particular brands or suppliers and argued that there is a shortage of neutral consultants able to advise on digitalization more broadly. This was described as a real gap in the support ecosystem and even as a potential future service niche. The implication is that training and regional centre design should consider the role of trusted, non-vendor-bound advisory functions.

The barriers identified in Latvia extend beyond cost. Participants referred to equipment integration difficulties, weak or unstable internet and GPS performance, electricity reliability issues in livestock systems, high maintenance complexity, shortage of IT specialists, system obsolescence, social reluctance to stand out from peers, and weather-related limits on satellite-based tools. These findings are valuable because they remind the project that digital adoption depends not only on learner motivation but also on the technical and service environment surrounding agricultural tools.

The Latvian focus group also offered a nuanced discussion of digital literacy levels. Participants acknowledged that some farmers still struggle with basic tools such as email and computers, while others are using advanced data systems. They explicitly recommended distinguishing between levels of digital literacy rather than expecting uniform competence. This is fully consistent with findings from Italy, North Macedonia, and Romania.

In terms of learning formats, Latvian participants strongly supported lifelong learning, adult education, exchange visits, peer mentoring, audio materials for listening while working, and practical support resources. There was also discussion of “senior helping senior” models, which suggests that intergenerational and peer-based approaches may be effective in reaching farmers who are reluctant to engage through more formal routes.

Overall, the Latvian material adds important depth to the report in relation to support structures, peer learning, service access models, and the practical conditions needed for sustained adoption.

7.5 Romania

The Romanian report is one of the most systematically structured contributions in the uploaded set and is especially valuable because it directly traces the validation of a national Factor Map through a guided focus group process.

A dominant feature of the Romanian evidence is the economic context in which digitalization decisions are made. Participants repeatedly referred to high equipment costs, low producer prices, volatile input-output relationships, climatic uncertainty, bureaucracy, and weak investment predictability. In this context, interest in digitalization is real, but it is filtered through concerns about risk, survival, amortization, and viability. This is a crucial reminder that digital skill strategies cannot be disconnected from the broader economic realities of farming.

The Romanian focus group confirmed that the existing Factor Map reflected real needs on the ground. GPS/RTK systems and assisted steering were repeatedly identified as the natural entry point into precision agriculture, while livestock-related monitoring in controlled environments was also seen as clearly relevant. Participants considered the listed competences understandable and realistic rather than excessively technical or detached from farm practice.

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(Photo 1, Focus group in Romania)

At the same time, the Romanian evidence generated important additions and refinements to the Factor Map. One of the strongest additions concerned the need for interoperable public digital infrastructure, especially a digitalized cadastre connected to the APIA declaration system and GPS-enabled field operations. Farmers expressed frustration that land already measured through formal systems still has to be manually redrawn in slow and fragmented administrative software. This point is significant because it shows that digital competence in agriculture depends not only on farm tools, but also on the usability and interoperability of public systems.

A second important Romanian addition concerned digital payment and direct-sales tools. Participants discussed the increasing need to accept card payments and to use digital applications relevant to farm-gate or direct-sale activity. This broadens the concept of agricultural digital competence in a way that should be reflected in the project's future outputs.

The Romanian discussion also clarified relationships between factors. Participants explicitly observed that precision machinery and GPS are functionally inseparable in practice, that irrigation-related digital skills are only meaningful where water access exists, and that drone-related adoption depends partly on regulatory certainty. These observations are methodologically important because they show that the Factor Maps should capture dependencies and enabling conditions rather than treating all skills as independent units.

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Another major Romanian contribution concerns certification. Participants strongly criticized fragmented and vendor-bound training arrangements in which courses produce certificates with limited recognition, duplicate existing knowledge from formal education, or fail to reflect real competence. They emphasized the need for portable and nationally meaningful recognition mechanisms. This finding gives particularly strong support to the project's micro-credential agenda.

The Romanian material also contributes useful reflections on education. Participants supported the integration of digital competences into agricultural schools and universities, but they also noted that many existing farmers did not benefit from such pathways and therefore need practical adult training routes. Simulators, practical demonstration, modular learning, and recognized certification were all considered important.

Taken as a whole, the Romanian evidence strongly supports a project approach that links competence development to practical usefulness, public-system interoperability, economic realism, and credible recognition of skills.

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8. Cross-country comparative analysis

The comparative reading of the uploaded evidence reveals a high degree of thematic convergence across national settings. This convergence is particularly striking given the differences in farm structure, economic conditions, institutional landscapes, and levels of technological adoption visible across the materials.

First, stakeholders across countries converged on the idea that digitalization is an **organizational and practical process**, not simply a matter of equipment acquisition. Whether in the Italian discussion of process redesign, the Romanian emphasis on economically justified investment, the Latvian concern with integrating multiple systems, or the North Macedonian focus on practical capacity, participants consistently framed digitalization as something that has to be embedded into work routines, decision-making structures, and organizational readiness.

Second, there is strong cross-country agreement that **data is the basis for meaningful digital use**, including AI. Participants repeatedly referred to the need for traceability, correct data entry, dashboard interpretation, field-level records, sensor outputs, and validation of information before decisions are made. This suggests that any future project outputs should position data literacy at the center of agricultural digital competence.

Third, all countries in the evidence set indicate that **basic digital confidence remains uneven**. Even in settings where precision technologies are in active use, some participants stressed that many farmers still struggle with routine digital tasks such as email, online communication, forms, files, and simple applications. This finding is especially important because it indicates that a layered skill framework is required. Training that begins too far above the actual baseline of many users risks being ineffective.

Fourth, the materials consistently show that **Precision Farming competences are inseparable from agricultural judgement**. Participants did not want to be trained merely to obey digital outputs. They emphasized the need to compare digital signals with field conditions, to interpret indicators in context, and to maintain human oversight when using AI-related or automated systems. This points to the importance of including critical interpretation and responsible use as formal competence areas.

Fifth, the issue of **farm size and structural capacity** recurs in every national context. Large or well-organized farms are generally better placed to invest in automation, data systems, and integrated tools. Smaller farms face more acute barriers related to cost, time, infrastructure, and advisory access. However, the materials also show that smaller farms can and do adopt useful digital tools when these are appropriately scaled, easy to use, and practically beneficial. In this sense, the project should focus not on a binary distinction between digital and non-digital farms, but on differentiated pathways of access and use.

Sixth, the importance of **support ecosystems** emerges strongly across countries. Cooperatives, advisory services, local organizations, schools, colleges, VET providers, universities, and neutral consultants all appear as potentially important mediators of adoption. This suggests that the project's training outputs should not be conceived only as educational products delivered to isolated individuals. They should be embedded in a territorial support logic.

Seventh, the preference for **practical training** is nearly universal. Stakeholders favored short modules, demonstrations, case-based learning, peer exchange, on-farm practice, and understandable materials. This preference was explicit in every national source and should therefore be treated as a core design principle rather than an optional recommendation.

Eighth, the uploaded materials indicate that **administrative and business-related digital skills are increasingly important**. Several documents expanded the notion of agricultural digitalization beyond production technologies to include funding applications, direct sales, digital payments, traceability, sustainability reporting, and public digital portals. These areas should not be treated as peripheral.

Ninth, many participants expressed a need for **usable, understandable, and trustworthy technology**. Systems that produce complex, opaque, or highly technical outputs are less likely to be adopted, even when technically sophisticated. Usability and plain-language communication therefore deserve more prominence in the Factor Maps and skill framework.

Finally, the cross-country evidence clearly supports the creation of **recognized and portable micro-credentials** linked to real competence rather than mere attendance. This is particularly important if the project seeks to build trust among both employers and learners.

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9. Validation outcomes for the Factor Maps

The uploaded materials broadly validate the central logic of the Factor Mapping process. Participants across countries confirmed that factors such as cost, infrastructure, training access, expected value, and organizational capacity strongly affect digital skill development and digital technology adoption in agriculture. At the same time, the validation process also revealed several areas in which the maps should be refined or expanded.

The first strongly validated area concerns the role of **economic viability**. Stakeholders consistently stated that digitalization decisions are made in relation to affordability, profit expectations, and investment risk. Technology is evaluated not in abstract terms, but in relation

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to whether it can solve real problems and whether the investment makes sense under actual farm conditions.

The second validated area concerns **basic digital confidence and practical usability**. The evidence shows that many adoption barriers emerge long before advanced tools are introduced. If basic applications, digital records, or routine online systems are difficult for users, more advanced digital transitions become correspondingly harder.

The third validated area concerns the centrality of **data and interpretation**. Participants repeatedly confirmed that the value of digital tools depends on the ability to collect accurate data, read outputs meaningfully, and compare recommendations with reality.

However, the validation process also showed that some enabling conditions should be more visible in the maps than they currently are. Among the most important are data quality, organizational readiness, interoperability between systems, access to neutral advisory support, usability of tools, digital public infrastructure, and recognition of acquired competences.

Romania contributed particularly useful evidence regarding structural relationships between factors. The close linkage between GPS and precision machinery, the dependence of irrigation-related skills on water availability, and the administrative role of cadastre-system interoperability all point to the need for more relational rather than merely categorical Factor Maps.

Latvia contributed evidence on the importance of technical integration, independent consultants, and service-based access models. Italy highlighted traceability, organizational readiness, and local support structures. North Macedonia emphasized practical training, limited advisory capacity, and the divide between larger and smaller holdings. Greece underscored the need for scientifically grounded application of tools such as drones and for sustainability of support structures.

A revised Factor Map should therefore make visible not only isolated influences, but a system of mutually reinforcing conditions. Real farm problems, expected value, basic digital confidence, data quality, advisory access, infrastructure, affordability, and recognition mechanisms should all be visible as interacting dimensions rather than as separate and unrelated items.

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10. Implications for the digital skill profile

The evidence strongly supports a Digital Skill Profile that is progressive, role-differentiated, and anchored in observable practice. A single undifferentiated list of “digital skills for farmers” would not adequately reflect the diversity of needs documented in the source materials.

At the foundational level, the profile should include competences that many participants still consider non-trivial: using devices, managing files, communicating online, entering data correctly, accessing digital services, and reading simple digital outputs. These are essential entry conditions for any later engagement with Precision Farming tools.

At the operational level, the profile should include routine use of agricultural applications, GPS-related functions, digital record systems, dashboards, basic data interpretation, sensor-related outputs, and human verification of recommendations produced by automated systems. These skills correspond most closely to day-to-day agricultural use.

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At the advanced or managerial level, the profile should address skills needed by farm owners, managers, advisors, or more senior staff. These include technology selection, return-on-investment assessment, process design, integration of data across activities, responsibility assignment for data quality, use of digital tools for sustainability and reporting, and oversight of more complex digital workflows.

At the specialist level, the profile should include deeper competences in system integration, advanced analysis, platform configuration, diagnostics, technical troubleshooting, training delivery, or complex drone and AI-related applications where relevant.

Importantly, the profile should not isolate digital skills from agricultural understanding. Participants in multiple countries stressed that data and tools only become useful when interpreted in relation to crops, livestock, field conditions, water availability, or operational realities. The profile should therefore integrate digital, data, and sector-specific knowledge rather than treating them as separate silos.

The evidence also suggests the importance of including responsible use and judgement. Farmers and professionals need to understand not only how to use tools, but also their limits, the situations in which human review is required, and the conditions under which a digital recommendation may or may not be applicable.

Finally, the Digital Skill Profile should recognize that agricultural digitalization includes more than field technology. Skills relating to digital administration, compliance, funding access, direct sales, digital payments, sustainability reporting, and communication are all relevant and should be visible in the framework.

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11. Implications for curriculum design, training delivery, and micro-credentials

The uploaded materials provide a clear mandate for the design of future curricula and training pathways. Stakeholders consistently favored practical, role-relevant, and flexible learning offers over abstract or over-generalized content.

Curriculum design should therefore begin with a **diagnostic understanding of learner readiness**. Because basic digital confidence varies significantly, some learners will require entry-level bridging content before they can benefit from Precision Farming modules. This is particularly important for adult learners and for students whose previous education has not fully prepared them for digital agricultural work.

Training modules should be short, stackable, and linked to real farm tasks. Rather than being organized only around technologies, they should be organized around practical problems such as irrigation scheduling, pest or disease alerts, fertilizer optimization, livestock monitoring, digital traceability, sustainability reporting, machinery guidance, or preparation of funding-related documents.

A blended approach appears most appropriate. The evidence supports combining field practice, workshops, demonstration farms, online learning, simulations, short audio or video resources,

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and workplace application. This is particularly relevant because many farmers and agricultural workers cannot easily engage in long or highly formalized training programmes.

Future micro-credentials should certify demonstrable competences rather than attendance alone. A meaningful micro-credential might, for example, certify that a learner can accurately record farm operations digitally, use a GPS-guided system correctly, interpret a dashboard, validate sensor data, use a digital irrigation scheduler, prepare a digital administrative application, or verify the output of an AI assistant.

Assessment should therefore be practical and evidence-based. It should require learners to perform tasks, interpret outputs, explain their decisions, and show that they understand when specialist support is needed. This would align well with stakeholder concerns about the credibility and usefulness of certification.

The evidence also suggests that future training materials should be written in clear language, supported by visual explanation, and adapted to different learner types. Audio content, concise handbooks, step-by-step guides, and problem-based cases may all increase accessibility and uptake.

Finally, schools, VET providers, and universities should be engaged not only as delivery partners but also as sites of modernization. Several documents indicated that current provision does not yet fully match agricultural digitalization needs. The project therefore has an opportunity not merely to design additional training, but to influence how agricultural education itself evolves.

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12. Proposed solutions and implementation actions

Based on the uploaded evidence, a number of practical implementation actions can be recommended.

A first priority is the creation of a **digital foundations programme** for farmers, workers, and students. This should include device use, common applications, file handling, digital communication, basic online services, data entry, spreadsheets, and essential cybersecurity. Without this foundation, higher-level digitalization efforts will remain uneven.

A second priority is the development of a **farm data readiness diagnostic**. Such a tool would help farms understand what data they collect, where the gaps and errors are, who is responsible for digital records, and whether the available information is sufficient to support more advanced analytics or AI-based tools.

A third priority is the establishment or strengthening of **demonstration farms and mobile learning formats**. These would allow stakeholders to see technologies in action, understand their practical implications, and test digital workflows under realistic conditions. Mobile formats are especially important for rural or smaller-farm communities that may not easily access centralized centers.

A fourth priority is the development of **role-based learning routes**. Different modules should be tailored for operators, owner-managers, smallholders, advisors, teachers, students, and technical specialists. This would improve relevance and reduce the risk of unrealistic expectations.

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A fifth priority is the creation of **territorial digital support hubs**. These may be based in universities, colleges, cooperatives, training centers, advisory bodies, or regional development organizations. Their role would be to serve as recognizable access points for training, support, guidance, and possibly shared digital services.

A sixth action, strongly supported by the Italian and North Macedonian materials, is the piloting of an **AI-supported administrative assistant** for small farms. Such a tool could help identify funding opportunities, structure required information, and prepare draft documentation, provided that professional review remains in place.

A seventh priority is the design of a **training-of-trainers programme**. Teachers, trainers, and advisory staff need up-to-date exposure to current digital tools, real datasets, use cases, and agricultural workflows if they are to deliver credible instruction.

An eighth priority is the support of **shared service and access models** for smaller farms. These may include leasing, contractor services, cooperative purchase, or access to technology as a service rather than ownership. These models should be reflected both in implementation actions and in how the skill profile is framed.

Finally, all pilot actions should feed into a **continuous feedback loop**. Evidence from demonstrations, training delivery, learner assessment, and stakeholder reflection should be used to revise the Factor Maps, Digital Skill Profile, training materials, and micro-credential design on an ongoing basis.

13. Policy and system-level recommendations

The evidence base makes clear that skill development alone cannot drive digital transformation in agriculture if the broader enabling environment remains weak. Accordingly, the project's longer-term policy recommendations should address several system-level conditions.

First, there is a clear need to strengthen **rural digital infrastructure**, including broadband access and, where relevant, power reliability. Several documents show that technology use is constrained not only by human skills but also by connectivity and infrastructure quality.

Second, targeted **financial support mechanisms** are needed. Stakeholders repeatedly cited affordability as a major barrier. Support measures should therefore consider not only equipment grants, but also vouchers or incentives for training, advisory support, and shared-service access.

Third, policymakers should address **interoperability and public digital infrastructure**. The Romanian evidence on cadastral and declaration systems demonstrates that weak public digital integration can become a direct barrier to digital farming practice. This area deserves greater policy attention.

Fourth, the validation and portability of competence recognition should be improved. This includes greater alignment between formal education, project-based learning, commercial training, and nationally recognized certification structures.

Fifth, policy should support **advisory ecosystems and local intermediary capacity**. Extension-type functions, technical support, and neutral advisory roles remain critical, especially for smaller farms and for older or less digitally confident users.

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Sixth, practical innovation diffusion should be encouraged through support for **demonstration, peer learning, exchange visits, and applied pilot projects**. Stakeholders are more likely to trust and adopt what they can see working under real conditions.

Finally, all policy approaches should remain **farmer centred**. The goal of digitalization is not technological adoption for its own sake, but better problem-solving, improved resilience, stronger competitiveness, and more sustainable agricultural practice.

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14. Gaps, limitations, and matters requiring further validation

Although the uploaded materials provide a substantial evidence base, some limitations should be acknowledged.

The first limitation is uneven depth across national sources. Italy and Romania provide especially detailed and analytically rich material, while other national documents are shorter or more focused on summary rather than full discussion.

The second limitation is incomplete country coverage. The broader project framework includes additional countries, but the uploaded evidence set does not cover them all. This report therefore cannot claim to represent the full transnational evidence base of the project.

The third limitation concerns the varying degree of direct factor-by-factor validation. Some focus groups explicitly addressed relationships between factors and map relevance, while others generated more thematic validation through open discussion. For this reason, the strongest conclusions are those supported by recurrence across documents rather than by isolated single-country claims.

A fourth limitation is that the evidence is qualitative and grounded in stakeholder perception. This is entirely appropriate for the purpose of validation, but it means that the findings should not be interpreted as statistical claims about national sectors as a whole.

For future work, it may be useful to conduct a short follow-up validation exercise focused specifically on revised Factor Maps, once the enabling conditions and factor relationships identified in this report have been incorporated more explicitly.

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15. Conclusion

The uploaded materials demonstrate that the Factor Mapping process and its subsequent Focus Group validation have generated a rich and coherent body of evidence on digital skill needs in agriculture. Across countries, stakeholders strongly affirmed that the project is addressing a real need. They also made it clear that effective digitalization depends on far more than access to tools alone.

The most important requirements emerging from the evidence are reliable data, practical digital confidence, role-appropriate competences, understandable technologies, organizational

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readiness, trusted support structures, and training formats that solve real agricultural and administrative problems. Artificial intelligence was not rejected by stakeholders; on the contrary, it was often welcomed. However, it was welcomed on the condition that it support human judgement, remain usable, and be embedded in practical, data-ready contexts.

The findings also make clear that future project outputs must be differentiated. Small family farms, larger enterprises, operational workers, managers, students, teachers, advisors, and technical specialists all require different combinations of skills and support. This reinforces the need for a progressive and role-based Digital Skill Profile.

In curriculum terms, the evidence strongly supports a practical, modular, blended, and problem-based approach. In credential terms, it supports the creation of micro-credentials that are recognized, portable, and linked to demonstrable capabilities. In implementation terms, it points toward territorial hubs, demonstration sites, practical support materials, independent advisory functions, and service-based access models for smaller farms.

The overall conclusion is therefore clear: the project should continue to develop its outputs around the integration of **digital capability, data interpretation, and agricultural judgement**, while ensuring that enabling conditions such as usability, support, and recognition are treated as central rather than secondary. If these directions are followed, the project will be well positioned to make a meaningful contribution to the modernization and inclusiveness of agricultural digital skills development in Europe.

16. Annex A. Cross-Country Evidence Matrix

Theme	Italy	Greece	North Macedonia	Latvia	Romania
Digitalization as organizational process	Strong	Moderate	Moderate	Moderate	Moderate
Data as prerequisite for AI	Very strong	Present	Present	Present	Present
Basic digital skill gaps	Strong	Present	Strong	Strong	Strong
Precision tools already in use	Strong	Strong	Moderate	Strong	Moderate
Strong divide between large and small farms	Strong	Present	Very strong	Strong	Very strong
Preference for practical training	Very strong	Strong	Very strong	Very strong	Very strong
Need for role-differentiated competences	Very strong	Present	Strong	Strong	Strong

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Theme	Italy	Greece	North Macedonia	Latvia	Romania
Importance of support structures	Very strong	Strong	Very strong	Very strong	Strong
Demand for recognized certification	Strong	Indirect	Strong	Moderate	Very strong
Importance of digital administration	Strong	Limited	Moderate	Limited	Strong
Interoperability concerns	Moderate	Limited	Moderate	Strong	Very strong
Need for human oversight of AI	Very strong	Strong	Strong	Strong	Strong

17. Annex B. Proposed competence areas and progression levels

B.1 Proposed competence areas

1. Digital operation and communication
2. Digital record-keeping and traceability
3. Data quality and governance
4. Data interpretation and dashboard use
5. Precision technologies and connected systems
6. AI literacy and responsible use
7. Technology selection and interoperability
8. Digital administration and access to services
9. Sustainability reporting and communication
10. Continuous learning and change management
11. Cybersecurity and responsible data handling
12. Troubleshooting and escalation to specialist support

B.2 Suggested progression levels

Foundation level

- Use devices and basic applications
- Communicate digitally
- Enter and retrieve basic data
- Use email and online forms
- Understand the purpose of digital records

Operational level

- Use farm applications and digital workflows
- Operate GPS-guided or connected tools at user level
- Read alerts, dashboards, and simple indicators
- Apply data-informed decisions in routine tasks
- Recognize inconsistencies and request support when needed

Advanced or managerial level

- Organize digital workflows and responsibilities
- Compare indicators across operations
- Evaluate technology investments and support needs
- Use digital tools for reporting, compliance, and traceability
- Integrate digital decisions into broader farm management

Specialist level

- Support integration of multiple systems
- Conduct advanced analysis
- Deliver training and technical guidance
- Configure or supervise specialized tools
- Support AI-related implementation and quality assurance

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18. Annex C. Suggested real-life training cases

1. **Irrigation under water scarcity**
   Use weather and sensor data to justify an irrigation decision.

2. **Fertilizer optimization**
   Compare soil or nitrogen-related data and adjust input planning.

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3. **Pest or disease alert interpretation**
   Evaluate an alert, check field evidence, and decide on further action.

4. **Livestock monitoring**
   Use sensor data and operational indicators to detect anomalies while maintaining human oversight.

5. **Digital traceability workflow**
   Record a real farm process, identify missing information, and produce an evidence trail.

6. **Sustainability reporting case**
   Transform operational data into a verifiable sustainability indicator.

7. **Digital administrative application**
   Prepare a funding or compliance-related digital submission using structured information.

8. **AI-supported administration**
   Use an assistant tool to identify a relevant opportunity and prepare a draft application for review.

9. **Digital payment and direct-sales case**
   Set up and use a practical digital payment solution.

10. **Technology investment assessment**
    Compare two technologies against a defined farm need, expected benefit, cost, and support requirement.

11. **Intergenerational farm innovation workshop**
    Use mixed teams of younger and more experienced participants to redesign a workflow.

12. **Parcel management and mapping**
    Practice field-level digital boundary handling and related administrative processes.

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19. Annex D. Recommended revisions to the Factor Maps

Based on the uploaded evidence, the following revisions are recommended.

D.1 Factors that should remain central

- financial affordability
- expected practical value
- access to training
- digital literacy
- infrastructure and connectivity
- motivation and perceived usefulness
- access to support

D.2 Factors that should be made more visible

- data quality and traceability
- organizational readiness
- usability and clarity of outputs
- interoperability between systems
- digital administration
- public digital infrastructure
- credibility and portability of certification
- local advisory and support ecosystems

D.3 Factors that should be added where missing

- shared service or equipment-as-a-service models
- independent or neutral consultants
- maintenance and repair ecosystem
- regulatory predictability

- language accessibility
- time pressure and workload constraints
- peer demonstration and local trust

D.4 Relationships that should be shown more explicitly

- Data quality conditions AI usefulness
- GPS and precision machinery are closely linked
- Advisory support affects successful implementation
- Farm size affects viable access model, but not necessarily motivation
- Certification recognition affects willingness to invest in training
- Administrative digital infrastructure influences broader digital adoption
- Usability influences confidence, uptake, and sustainability of use

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20.Conclusion

This report confirms that the Factor Mapping process and its validation through national focus groups have produced a credible and practically relevant evidence base for the next stages of the project. Across Italy, Greece, North Macedonia, Latvia, and Romania, stakeholders consistently affirmed that the digital transformation of agriculture is not driven by technology alone, but by the interaction of skills, data quality, organizational readiness, affordability, infrastructure, and access to trusted support. The findings therefore validate the overall direction of the project while also indicating where its analytical and educational tools should be refined.

A central conclusion emerging from the evidence is that meaningful adoption of Precision Farming depends on strong foundations. Basic digital confidence, accurate data collection, traceability, and the ability to interpret information in context are prerequisites for more advanced uses of connected technologies and artificial intelligence. AI-related applications were generally seen as promising, but only when embedded in practical workflows, supported by reliable data, and subject to human judgement. This means that the project's future outputs should place data literacy, responsible use, and practical interpretation at the core of the Digital Skill Profile.

The evidence also makes clear that digital competence needs in agriculture are highly differentiated. Farmers, workers, managers, advisors, teachers, and specialists do not require the same depth or combination of competences, and smaller farms often face different access conditions than larger enterprises. For this reason, the project should continue to develop a progressive, role-based approach that recognizes varying starting points, different operational realities, and multiple pathways into digitalization. The strongest training model emerging from the evidence is one that is practical, modular, problem-based, and closely linked to real farm and administrative tasks.

At implementation level, the report highlights the importance of demonstration-based learning, territorial support structures, independent advisory capacity, and credible micro-credentials that recognize demonstrable competences rather than mere participation. Stakeholders clearly value learning offers that are accessible, relevant, and immediately applicable. They also value recognition systems that are portable, trusted, and connected to wider education and labour market structures. These findings strongly support the development of regional hubs, blended delivery models, and flexible training pathways adapted to different learner groups.

In conclusion, the report shows that the project is well positioned to make a meaningful contribution to agricultural modernization by linking digital capability with agricultural judgement, practical usefulness, and inclusive access. The next phase should therefore focus on refining the Factor Maps, finalizing a differentiated Digital Skill Profile, designing applied curricula and micro-credentials, and strengthening the enabling conditions that make digital adoption sustainable in practice. If these directions are followed, the project can help ensure that Precision Farming digital skills are not only technologically relevant, but also usable, trusted, and effective across diverse agricultural contexts.

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