



University of Vaasa
VAASAN YLIOPISTO

OSUVA Open
Science

This is a self-archived – parallel published version of this article in the publication archive of the University of Vaasa. It might differ from the original.

From Skills to Transformative Entrepreneurial Capacity: An Agenda for Educating the Next Generation in the Digital Agri-Industry Innovation Ecosystem

Author(s): Chen, Si; Sun, Yuqing; Shokrollahi, Foad; Sun, Lipeng

Title: From Skills to Transformative Entrepreneurial Capacity: An Agenda for Educating the Next Generation in the Digital Agri-Industry Innovation Ecosystem

Year: 2026

Version: Accepted manuscript

Copyright © 2026 Authors. This self-archived version has been made available under the organisation's prior license model and under the Creative Commons Attribution (CC BY 4.0) licence.

Please cite the original version:

Chen, S., Sun, Y., Shokrollahi, F., & Sun, L. (2026). From Skills to Transformative Entrepreneurial Capacity: An Agenda for Educating the Next Generation in the Digital Agri-Industry Innovation Ecosystem. *European journal of education*, 61(2). <https://doi.org/10.1111/ejed.70681>

From skills to transformative entrepreneurial capacity: an agenda for educating the next generation in the digital agri-industry innovation ecosystem

Si Chen¹, Yuqing Sun¹, Foad Shokrollahi², Lipeng Sun^{3,*}

¹School of Economics and Management, Heilongjiang Bayi Agricultural University, Daqing, China

²School of Technology and Innovations, University of Vaasa, Vaasa, Finland

³School of Management, Wenzhou Business College, Wenzhou, China

*Corresponding Author Email: slp@wzbc.edu.cn

Abstract

Entrepreneurship education in agri-industry is being asked to prepare learners for a sector increasingly organised through platforms, data infrastructures, and traceability systems. Yet much current provision remains centred on a skills paradigm focused on tool use, operational tips, and short-term performance. This paper argues that such an approach is no longer sufficient for a sector shaped by bio-temporal constraints, quality heterogeneity, perishability, logistics dependence, and compliance burdens. It proposes transformative entrepreneurial capacity (TEC) as the central educational objective for sustainable agri-industry transitions. TEC is understood as the capacity to turn digitally mediated opportunities and constraints into viable, inclusive, and environmentally credible upgrading pathways. The paper's main contribution is to reframe entrepreneurship education in agri-industry as ecosystem-embedded capability formation rather than as the delivery of discrete digital skills. To make this argument operational, it introduces a concise CPAD–Ecosystem–Transition framework that places educational design Curriculum, Pedagogy, Assessment, and Delivery/governance at the centre of capability formation within the agri-industry innovation ecosystem. On this basis, the paper identifies four priority themes for future research: curricularising TEC under bio-temporal constraints; designing pedagogies for distributed learning environments across farms, cooperatives, extension and platforms; developing assessments and credentials that evidence TEC without creating new exclusions; and examining delivery and governance models that coordinate multi-actor education while protecting inclusion. The agenda calls for comparative and mechanism-focused research to assess how educational design can support inclusive and sustainable upgrading in digitally mediated agri-industry.

Keywords: Transformative entrepreneurial capacity (TEC); entrepreneurship education; innovation ecosystem; digitalisation; platform and metric governance.

1. Introduction

What kind of entrepreneurship education is needed when agri-industry is increasingly organised through platforms, data infrastructures, and traceability systems? Digitalisation has become a taken-for-granted horizon for contemporary agri-industry (Vahdanjoo et al., 2025; Daum, 2025). Platforms mediate market access; data infrastructures underpin grading, traceability and certification (Donaldson, 2022); and a growing share of coordination between producers, service providers, logistics, finance, and regulators now travels through digital interfaces (Sanusi et al., 2025). In many accounts, this shift is narrated primarily in terms of “technology adoption” and “skills gaps”: teach farmers and rural entrepreneurs to use tools, and innovation will follow (Daum, 2025). Skills training clearly remains useful in this context, but on its own it does not fully capture what digitally mediated agri-industry now demands. Ecosystem research increasingly shows that value creation is relational, depending on orchestration, alignment, and iterative reconfiguration rather than the isolated competence of individual actors (Qiu et al., 2025). Digital technologies, from this perspective, are not simply operational enablers; they reshape ecosystem dynamics by fostering generativity, convergence and combinatoriality, and by altering how opportunities are sensed, seized and transformed through multi-actor collaboration (Marchese et al., 2026; Qiu et al., 2025). If so, the educational challenge cannot be reduced to teaching tools alone. Education also becomes part of ecosystem governance, helping define what counts as competence, who can participate, and how upgrading pathways are legitimised (Komarudin et al., 2025; Daum, 2025).

The agri-industry case sharpens this mismatch. Unlike sectors where experimentation can be rapid and continuously iterated, agri-industry is structured by bio-temporality: seasonal windows and production cycles limit the pace of trial-and-error and raise the cost of mistakes (Boon & Schifferstein, 2022). Quality is heterogeneous and often difficult to make legible across distance, requiring grading, documentation and credible signalling (Donaldson, 2022). Perishability and loss reduction turn coordination—cold chain, storage, timing, packaging—into a central innovation problem rather than a secondary operational detail (Azab et al., 2023; Donaldson, 2022). Compliance regimes, including food safety, traceability, certification, and increasingly sustainability-related requirements, do not merely regulate markets; they also help constitute them, creating both upgrading opportunities and exclusionary burdens (Donaldson, 2022; Notarnicola et al., 2016). In this setting, a narrow skills paradigm risks producing entrepreneurs trained to optimise short-term platform metrics rather than to build resilient, standard-compliant, and collaboration-rich upgrading trajectories that can withstand shocks and scrutiny (Daum, 2025; Petropoulos et al., 2025). The issue, then, is not whether digital training has value, but whether it is educationally adequate to the temporal, material and regulatory realities of the sector (Daum, 2025).

Recent work on agribusiness digital transformation points in a similar direction, but often stops short of an education-centred synthesis. Silchenko and colleagues, for example, frame Agriculture 5.0 as a shift toward AI-enabled autonomy, human-

centricity and sustainability, and argue that small agribusinesses require organisational and methodological support to develop innovative potential under digital transformation (Silchenko et al., 2025). Their recommendations—lifelong learning, integration of digital modules, and collaboration with educational institutions, supported by broader cooperation and policy incentives—implicitly reposition education as ongoing capability formation rather than one-off upskilling (Silchenko et al., 2025). At the same time, proposals such as Komarudin et al.’s public-innovation model foreground digital education as an empowerment strategy aimed at reducing information gaps and addressing a persistent digital divide, emphasising hybrid (online–offline) learning infrastructures and multi-stakeholder collaboration (Komarudin et al., 2025). These contributions are important, but they also reveal a broader conceptual problem: the literature often treats education either as a delivery mechanism for technology adoption or as a policy tool for inclusion (Daum, 2025; Komarudin et al., 2025), without fully theorising what capabilities are needed for sustainable upgrading in a digitally mediated ecosystem, and how those capabilities can be taught, assessed and governed under agri-industry constraints (Qiu et al., 2025).

This short agenda paper responds to that gap by proposing transformative entrepreneurial capacity (TEC) as the central educational objective for sustainable agri-industry transitions. TEC refers, in concise terms, to the capacity to turn digitally mediated opportunities and constraints into economically viable, socially inclusive, and environmentally credible upgrading pathways (Qiu et al., 2025). Rather than treating “digital” as a long compound label to be repeated throughout, the paper uses agri-industry innovation ecosystem (AIIE) as its main analytical object and treats digitalisation as a set of structural conditions that reshape orchestration and evaluation through platform and metric governance, data-driven intermediation, and standards and traceability infrastructures (Donaldson, 2022; Vahdanjoo et al., 2025; Sanusi et al., 2025). This argument is anchored in agri-industry’s distinctive conditions—bio-temporal decision windows, quality heterogeneity and grading, traceability and compliance routines, and heightened exposure to risk—which shape how participation and upgrading are organised (Donaldson, 2022; Boon & Schifferstein, 2022; Azab et al., 2023). Innovation ecosystem research is instructive here: digital technologies may enhance sensing, seizing and transforming, but can also hinder orchestration when poorly aligned with ecosystem phases, for instance by generating information overload and slowing decision-making (Marchese et al., 2026). For education, this points beyond “more tools” toward judgement, sequencing, and governance-aware learning (Daum, 2025).

The paper makes one main contribution and develops two supporting moves. Its central contribution is to reframe entrepreneurship education in agri-industry as an ecosystem capacity-building infrastructure rather than an upstream supplier of discrete skills (Daum, 2025; Vahdanjoo et al., 2025). To make that argument operational, the paper introduces TEC as an agri-specific learning outcome and develops the CPAD framework to organise curriculum, pedagogy, assessment and delivery choices

(Petropoulos et al., 2025; Silchenko et al., 2025). It then advances a compact research agenda on how educational design can build TEC under the specific conditions of digitally mediated agri-industry, moving from conceptual clarification to framework development and then to four priority themes for future inquiry around curriculum, pedagogy, assessment and delivery/governance.

2. Key concepts & positioning

This paper is positioned at an intersection that is often acknowledged but less often handled with conceptual precision. Recent studies have shown that knowledge innovation increasingly depends on interdisciplinary recombination and institutional arrangements that enable collaboration across epistemic and organizational boundaries (Wu et al., 2026), while science policy and collaboration agendas are actively translated through university structures, academic practices, and institutional logics rather than simply implemented as external directives (Zhang & Wang, 2026). These insights matter for digitally mediated agri-industry because they suggest that education cannot be reduced to the delivery of individual skills, and that innovation ecosystems should not be treated merely as external contexts. Innovation ecosystem research commonly treats education as an external input—whether in the form of skills, training, or human capital—while entrepreneurship education often treats the ecosystem as contextual background rather than as an active force shaping what competence is, how it is recognised, and who is able to participate. In digitally mediated agri-industry, that separation becomes difficult to sustain. This section therefore clarifies four linked points: what the agri-industry innovation ecosystem (AIIE) means in this paper, how “digital” enters the argument, why agri-industry sharpens the educational problem, and why transformative entrepreneurial capacity (TEC) is best treated as an educational construct rather than a generic entrepreneurial attribute.

2.1 AIIE as the analytical object and as a learning environment

We use agri-industry innovation ecosystem (AIIE) to denote a meso-level configuration of interdependent actors, resources, infrastructures and governance arrangements through which innovation and value creation in agri-industry are coordinated. This is not a national innovation system, nor a broad sectoral context invoked to support a general claim. It is a more specific analytical object organised around interdependencies among producers, cooperatives, service providers, logistics and finance intermediaries, certifiers and regulators, education and advisory institutions, and, increasingly, platforms. It is also organised around evaluative regimes, including grading, traceability requirements, sustainability claims and audit processes.

What matters for the argument here is that ecosystems are not only sites of exchange and coordination; they are also environments of learning. They shape how competence is acquired, practised and recognised. Digitalisation intensifies this because evaluation increasingly travels through metrics, records, dashboards and standards. In this sense,

AIIE can be understood as a distributed learning environment: learning takes place not only in classrooms or training workshops, but also through record-keeping, grading routines, buyer interactions, responses to platform rules, and the navigation of compliance processes. Komarudin et al. similarly suggest that digital education in agribusiness is not only a means of learning but also a means of empowerment, precisely because information access, technological adoption and literacy are unevenly distributed and require coordination among technology providers, educational institutions and local governments (Komarudin et al., 2025).

The implication is straightforward. As ecosystem governance becomes more data- and standards-intensive, education cannot be treated simply as an external service delivered to the sector from outside. It becomes part of how the ecosystem reproduces itself and, potentially, how it changes.

2.2 What “digital” means here: structural conditions, not a long compound label

Although the paper addresses a digital context, we avoid repeatedly using a long compound label such as “digital agri-industry innovation ecosystem.” Here, “digital” matters not because tools are present as such, but because digitalisation reshapes three ecosystem mechanisms: coordination, evaluation and reconfiguration.

Research on ecosystem orchestration is useful in making this point more precise. Marchese et al. (2026), for example, show that digital technologies can enhance ecosystem development through generativity, convergence and combinatoriality, while also contributing to dynamic capabilities of sensing, seizing and transforming. For the present argument, this matters because it cautions against a simple equation between more digitalisation and better innovation. The same work also shows that misalignment between the type of digital technology and the phase of ecosystem development can hinder orchestration; under some conditions, generative technologies may increase information overload and slow decision-making. For education, this is as important as it is for management: teaching digital tools without teaching judgement about when and how to use them risks producing capability deficits that remain hidden behind apparent gains in literacy.

We therefore treat digitalisation as a set of structural conditions operating through three interrelated channels: platform and metric governance, data-driven intermediation, and standards and traceability infrastructures. Platforms and metrics increasingly define what counts as performance and legitimacy. Data-driven intermediation expands the role of services such as logistics, finance, testing and advisory support that depend on data integration. Standards and traceability infrastructures make audits, certification workflows and sustainability claims actionable through data practices. This is consistent with Komarudin et al.’s observation that agribusiness digital initiatives can widen gaps when they are not inclusively designed, and that limited interoperability across applications can create confusion and time burdens for farmers, making governance and coordination central rather than secondary (Komarudin et al., 2025). It

also aligns with the ecosystem-orchestration view that digital technologies shape not only intra-firm efficiency but also inter-organisational alignment.

2.3 Why agri-industry makes the educational problem sharper

A possible objection is that ecosystem dynamics and digital capabilities are now discussed across many sectors. Marchese et al. (2026), for instance, explicitly suggest that their findings, developed in the EdTech industry, offer a broader framework for sectors undergoing rapid technological change. That general insight is valuable. At the same time, an education agenda becomes too thin if it is written as though sectors differ only superficially.

Agri-industry requires a more specific treatment because the conditions of entrepreneurial learning and innovation are materially and temporally distinctive. Silchenko et al.'s discussion of Agriculture 1.0 to 5.0 shows that the current phase involves not only advanced technologies but also a broader shift toward autonomy, AI, human-centricity and sustainability, all of which require organisational support and personnel adaptation (Silchenko et al., 2025). More importantly for education, agri-industry is shaped by bio-temporality, quality heterogeneity, perishability, logistics dependence, and compliance and traceability regimes. These conditions mean that learning is often constrained by narrow decision windows and delayed feedback; upgrading depends heavily on coordination and evidence-building rather than only on market-facing sales competences; and sustainability is embedded in governance routines such as audits, standards and records rather than added on afterwards as a moral supplement.

This is the deeper reason education is treated here as ecosystem infrastructure. Where legitimacy and market access are mediated by standards and evidence chains, education is partly about making competence legible to buyers, platforms, regulators, certifiers and collaborators. The stakes are therefore also distributional: who can bear the burden of time, documentation and verification, who can access support and interpretation, and who is excluded when capability is translated into thresholds of compliance or credentials.

The argument is intended primarily for digitally mediated agri-industry settings in which market participation is increasingly shaped by platforms, intermediaries, standards and traceability systems. It speaks most directly to smallholder and cooperative-based contexts, where educational support and documentation burdens are especially consequential, but it is also relevant to broader agri-industry settings in which data-intensive coordination and compliance infrastructures shape upgrading opportunities.

2.4 Transformative entrepreneurial capacity (TEC) as an education construct

Against this background, transformative entrepreneurial capacity (TEC) can be stated more clearly. TEC refers to the capacity to translate digitally mediated opportunities and constraints into upgrading trajectories that are economically viable, socially

inclusive, and environmentally credible. It is called transformative because it is oriented not simply to better performance within a fixed position, but to changing one's role within AIIE—for example, moving from undifferentiated commodity selling toward quality differentiation, more stable contractual relations, credible traceability claims, or new coordination roles.

TEC also needs to be distinguished explicitly from neighbouring terms. It is broader than digital skills, because it includes judgement, coordination and reconfiguration rather than tool use alone. It is more ecosystem-specific than general entrepreneurial competence, because it is anchored in agri-industry conditions such as seasonality, grading, perishability and compliance. And it is more educationally actionable than a broad notion of entrepreneurial capability, because it is formulated as a set of learning outcomes that can be taught, supported and assessed. In that sense, TEC is not a new label for familiar abilities; it is a way of specifying what entrepreneurship education must build under digitally mediated agri-industry conditions.

Two further clarifications follow. First, TEC is not a rebranding of “skills.” Marchese et al. (2026)'s emphasis on sensing, seizing and transforming highlights that capability is relational and phase-specific, grounded in routines and learning mechanisms rather than isolated competences. For education, this means that knowing how to use a tool is not the same as being able to interpret weak signals, mobilise partners, or reconfigure practices under changing standards. Second, TEC is not an abstract trait; it must be expressible as assessable learning outcomes. Silchenko et al. explicitly call for organisational and methodological support, including in-house training systems, collaboration with educational institutions, and lifelong learning with digital module integration, precisely because capability formation is ongoing rather than episodic (Silchenko et al., 2025). This supports our argument that TEC develops through iterative cycles of learning, application, evidence-building and reconfiguration across seasons and compliance cycles.

For the purposes of this short agenda paper, TEC is operationalised into four interlocking learning domains. The first is bio-temporal decision capacity: the ability to plan and experiment under seasonal and production-cycle constraints. The second is quality and coordination capacity: the ability to manage grading, loss reduction, cold-chain or logistics coordination, and intermediation. The third is traceability and compliance entrepreneurship: the ability to turn standards, audits and records into trust, market access and differentiation. The fourth is risk-resilient ecosystem coordination: the ability to mobilise cooperative and service networks in response to climate, biological and market volatility. A simple example may clarify the practical meaning of these domains: a producer seeking to move from undifferentiated sales to a traceable premium channel must not only use digital tools, but also time decisions to the production cycle, document quality consistently, coordinate with intermediaries, and present compliance records in ways that buyers can trust.

These domains are recognisably agri-specific, but they also prepare the transition to the next section. Taken together, they show why education in AIIE must be theorised as more than content delivery: TEC depends on curriculum, pedagogy, assessment and delivery arrangements. The next section builds on this point by translating these conceptual distinctions into an education-centred framework linking design choices, ecosystem conditions and transition outcomes.

3. Articulation: an education-centred framework for TEC in AIIE

The conceptual move of this paper is deliberately simple: instead of treating entrepreneurship education as an upstream supplier of discrete “skills” to an otherwise independently functioning sector, we position education as a capability-building infrastructure embedded in the agri-industry innovation ecosystem (AIIE). This framing addresses two persistent blind spots. In ecosystem research, orchestration, interdependence and dynamic reconfiguration are increasingly foregrounded, yet education is often left implicit—as if the capabilities required for sensing, seizing and transforming simply emerge once digital technologies are introduced. In entrepreneurship education research, by contrast, curriculum and pedagogy are often discussed without fully specifying how competence is constituted, recognised and valued under the governing conditions of particular sectors, especially where metrics, standards, traceability and platform rules increasingly shape access and legitimacy. In agri-industry, these omissions matter because the entrepreneurial challenge is rarely reducible to tool use alone; it is also about navigating bio-temporal constraints, quality heterogeneity, compliance regimes and intermediated coordination while pursuing sustainable upgrading.

To make this argument analytically clear without over-complicating it, we propose a compact education-centred framework linking educational design, ecosystem conditions and transition outcomes. The framework starts from the proposition that transformative entrepreneurial capacity (TEC) is built through four educational levers that educators and programme designers can actively shape: curriculum, pedagogy, assessment, and delivery/governance. These are separated because they perform different functions in capability formation. Curriculum defines what is to be learned; pedagogy shapes how learning is organised and practised; assessment determines how competence is evidenced and recognised; and delivery/governance concerns how educational provision is coordinated, sustained and made accessible across actors and settings. Together, these levers influence whether TEC can be formed in ways that are meaningful under the conditions of AIIE.

Figure 1 provides a visual overview of this argument. It shows how educational design levers oriented to TEC interact with key ecosystem interfaces in AIIE—platform and metric governance, data and intermediaries, standards and traceability, and evidence and credentials—and how these interactions shape transition outcomes such as upgrading, inclusion, sustainability and resilience. **Table 1** then develops the same framework in analytic form by specifying, for each educational lever, the relevant TEC-

oriented learning outcomes, the ecosystem interface it addresses, the mechanism through which it operates, and the transition signals it is expected to support. Read together, the figure offers the conceptual architecture, while the table clarifies how that architecture can be used for analysis.

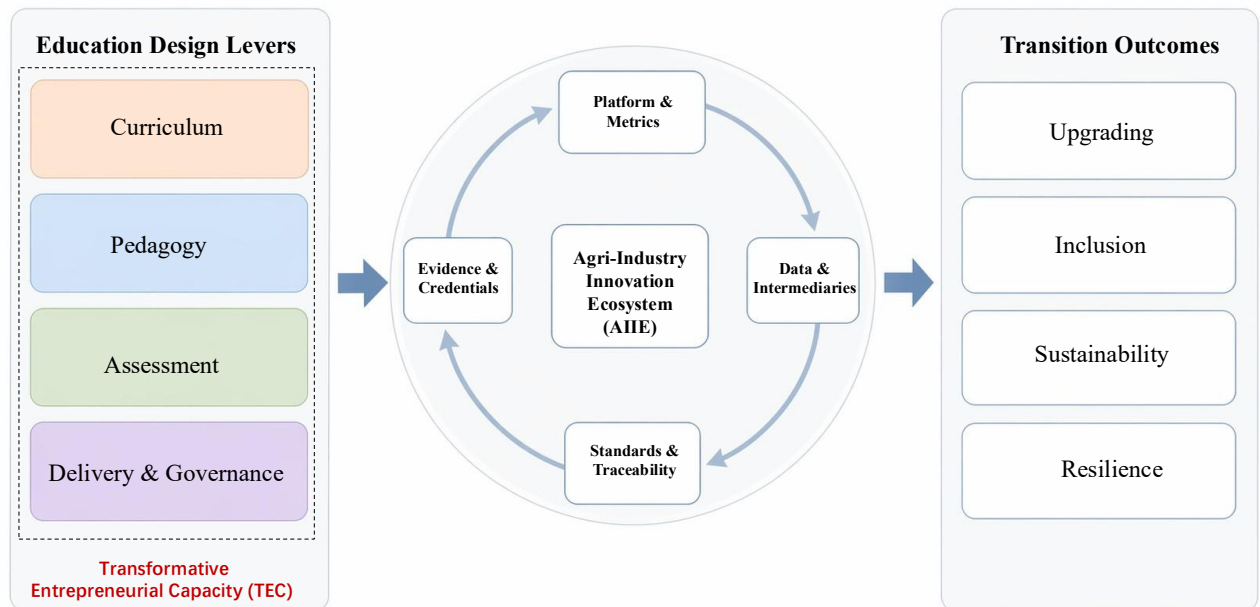


Figure 1. CPAD–Ecosystem–Transition framework

Table 1. CPAD–Ecosystem–Transition framework

Education design lever (CPAD)	TEC as learning outcomes (what learners should be able to do)	Ecosystem interface in AIEE (what the lever equips learners to navigate)	Core mechanism (how education “works” in the ecosystem)	Transition outcome signals (what changes you expect to observe)
C: Curriculum	Develop agri-specific TEC: bio-temporal decision capacity; quality/grading & cold-chain upgrading; traceability & compliance entrepreneurship; risk-resilient coordination	Bio-temporality and seasonal windows; quality heterogeneity and grading; standards/traceability regimes; platform and buyer requirements	Translates ecosystem constraints into sequenced learning pathways aligned with agricultural calendars and compliance cycles	Evidence of upgrading trajectories (commodity → graded/differentiated → contract/brand/processing); reduced reliance on short-term metric chasing at the expense of quality/compliance
P: Pedagogy	Learn through distributed practice: coordinating with intermediaries; interpreting metrics/feedback; negotiating tempo conflicts (platform rhythm vs agricultural rhythm)	Platform/metric governance; data-driven intermediation (logistics/finance/testing/advisory); cooperative/service networks	Builds hybrid learning architecture (classroom + farm/facility + cooperative/extension + platform coaching) enabling guided participation and situated judgement	Improved resilience (learning cycles across seasons), stronger coordination capacity; fewer failures caused by tempo misalignment or missing intermediaries
A: Assessment & credentials	Evidence TEC beyond tools: producing evidence chains (grading protocols, traceability logs, audit readiness, post-season reviews), plus collaboration and risk routines	Standards and verification regimes; buyer requirements; platform legitimacy signals; risk of credential gatekeeping	Makes competence legible and credible via rubrics + portfolios/artefacts, shifting incentives from outputs to capability	More inclusive recognition; credible sustainability/traceability performance; avoidance of credentialism that excludes smallholders
D: Delivery & governance	Sustain TEC formation: continuous support, coaching, and access to ecosystem resources; governance awareness (whose metrics define success; who controls data)	Multi-actor delivery: VET/universities, extension, cooperatives, platforms, local government, service providers; power asymmetries in data/standards	Treats education as ecosystem orchestration infrastructure—aligning actors, resources, accountability, and support for high-burden learners	More inclusive participation (not only resource-rich actors benefit); ecosystem-level gains in sustainability and upgrading; reduced exclusion via compliance/metric burdens

3.1 How to read the framework: education as ecosystem-embedded capability infrastructure

Figure 1 and Table 1 together reframe entrepreneurship education as an intervention into a distributed and governed environment rather than a one-way transfer of knowledge. The CPAD levers—Curriculum, Pedagogy, Assessment, and Delivery/governance—are recognisably educational, but each is defined in terms of what it enables learners to do within AIIIE. This is where the framework moves beyond a simple “skills gap” narrative: the educational object is not merely tool proficiency, but transformative entrepreneurial capacity (TEC) as an agri-specific learning outcome oriented to upgrading, sustainability and resilience.

Within the framework, digitalisation appears not as a separate object of study but as part of the ecosystem interface through which learning and entrepreneurial action are organised. This avoids treating technology as an autonomous driver. Following recent ecosystem research, digital technologies matter because they reshape how ecosystems generate opportunities, coordinate actors and recombine resources over time through characteristics such as generativity, convergence and combinatoriality, thereby influencing capabilities of orchestration. At the same time, the same research shows that digital technologies can hinder orchestration when they are poorly aligned with the phase or task of the ecosystem—for example, when generativity produces information overload and slows decision-making in seizing phases. For education, the point is straightforward: more tools do not by themselves produce a better curriculum. What matters is whether learning develops judgement, sequencing and coordination under sectoral constraints.

The framework also draws on agri-industry scholarship that treats capability formation as continuous and institutionally supported rather than as a one-off training event. Discussions of Agriculture 5.0 emphasise human-centred and sustainability-oriented transformation, while also highlighting the need for organisational and methodological support, lifelong learning, modular training, and collaboration with educational institutions, especially for smaller agribusiness actors facing capacity constraints. In framework terms, these are not only curricular questions but also questions of delivery and governance: who sustains learning across seasons, who bears the compliance burden, and who ensures access for actors least able to absorb administrative costs.

Read in this way, Figure 1 provides the visual architecture of the argument, while Table 1 specifies how each educational lever relates to TEC, ecosystem interface, mechanism and expected transition signals. The framework is therefore intended not only to describe entrepreneurship education in AIIIE, but also to analyse how different educational configurations may enable or constrain sustainable upgrading.

3.2 Three cross-cutting tensions (and why they are educational problems)

The framework is also diagnostic. It helps explain why the same entrepreneurship training may produce empowerment in some settings but disappointment or exclusion in others. Three recurring tensions are especially important and should be understood as educational design problems rather than as incidental side effects.

(1) Platform tempo vs agri-temporality. Platform environments often reward continuous optimisation and rapid iteration. Agri-industry decisions, however, are paced by seasons and production cycles, with delayed feedback and high costs of error. Pedagogy that over-prioritises metric responsiveness can therefore train short-termism at the expense of resilience and careful sequencing.

(2) Sustainability as upgrading asset vs compliance burden. Standards and traceability can enable trust, differentiation and access to premium channels, but they can also impose uneven burdens that intensify exclusion. Assessment and credentialing are central here. If evidence production is recognised and supported, education can help turn compliance into entrepreneurial assets; if credentials substitute for support, education risks becoming a gatekeeping device.

(3) Empowerment vs enclosure through dependency. Education embedded in AIIE can widen participation, but it can also deepen dependency if platforms or dominant intermediaries define curricular priorities, metrics of success and data ownership. This is why proposals for hybrid digital learning infrastructures in agribusiness so often frame education as a public innovation instrument: without inclusive governance, digital divides and uneven access can widen rather than narrow. Delivery, then, is not a technical afterthought but part of the distributional politics of who benefits.

3.3 What counts as “good entrepreneurship education” in AIIE

The CPAD–Ecosystem–Transition framework implies a more demanding notion of educational quality than is common in short-term training evaluations. In AIIE, good entrepreneurship education is not demonstrated primarily by attendance, learner satisfaction or immediate sales uplift. It is demonstrated by whether education builds TEC as an agri-specific learning outcome: capabilities that make quality and sustainability legible through evidence chains, enable coordination across intermediaries, support upgrading decisions across seasons, and reduce vulnerability to shocks without intensifying exclusion.

This framing sets up the agenda that follows. Rather than asking only whether training works, the next section asks which CPAD configurations build TEC, for whom, under what AIIE conditions, and with what distributional effects. Framed in these terms, future research can move beyond generic calls for digital skills and towards a more precise education agenda for sustainable agri-industry transitions.

4. Research agenda

This agenda translates the framework into four education-centred research themes. Together, they address a central question: how can entrepreneurship education in AIIE build transformative entrepreneurial capacity (TEC) without collapsing into tool training or turning credentials and compliance into new forms of exclusion?

Theme 1. Curriculum: How can TEC be curricularised under bio-temporal constraints?

Why this matters. Curriculum is where education most visibly defines what counts as competence. In agri-industry, however, curricular choices cannot be made as if learning

were detached from biological time. Seasonality and production cycles shape when decisions can be made, when feedback arrives, and what kinds of experimentation are affordable. A TEC-oriented curriculum therefore needs to be more than a set of entrepreneurship topics plus a digital module. It must be a sequenced pathway aligned with agricultural calendars and compliance cycles. Without this alignment, education risks privileging platform-facing optimisation over the slower but more decisive capacities that support sustainable upgrading, including grading, quality evidence, cold-chain coordination, traceability routines and risk planning.

Research questions.

1. How can curricula be aligned with agricultural calendars and key decision windows?
2. Which TEC elements should form a core agri-industry curriculum, and which should remain context-specific?
3. How should TEC curricula vary across horticulture, livestock and aquaculture while retaining a coherent framework?

Methodological direction. Design-based research (DBR) is the most suitable starting point because it allows curriculum models to be designed, tested and refined in relation to real seasonal and sectoral constraints, while also generating transferable design principles.

Theme 2. Pedagogy: What pedagogies work in distributed AIIE learning environments?

Why this matters. AIIE is a distributed learning environment in which competence is enacted and judged across farms and facilities, cooperatives and service networks, platform-mediated market interactions, and compliance workflows. Pedagogy therefore becomes an orchestration problem: how to connect learning sites, actors and rhythms so that education supports sustained upgrading rather than short-term metric chasing. This challenge is intensified by a basic tension. Platform and metric regimes reward continuous responsiveness and rapid iteration, whereas agri-industry practice is shaped by seasonal windows and delayed feedback. A TEC-oriented pedagogy must therefore cultivate not only operational proficiency but also situated judgement about what to optimise, when, and at what cost.

Research questions.

1. How should platform coaching, farm-based learning and cooperative or extension support be combined to build TEC?
2. What pedagogical strategies help learners manage conflicts between platform tempo and agricultural tempo?
3. How should teaching roles be distributed across educators, extension agents, cooperative leaders and intermediaries without reproducing dependency?

Methodological direction. Multi-sited educational ethnography is especially well suited here because it can follow learning across classrooms, farms, cooperatives and online support environments, making visible how pedagogical coordination actually works and where it breaks down.

Theme 3. Assessment and credentials: How can TEC be assessed beyond skills tests?

Why this matters. What is assessed becomes what is pursued. Skills tests and attendance certificates tend to reward tool use and short-term outputs, whereas TEC requires evidence of coordination, compliance routines and upgrading decisions over time. Assessment is also an inclusion issue: credential systems can broaden recognition of competence, but they can also formalise gatekeeping. In AIIE, where legitimacy and access are often mediated through standards and evidence chains, assessment design becomes central to whether education supports sustainable transitions or reproduces exclusion through administrative burdens.

Research questions.

1. How can TEC rubrics capture agri-specific capacities rather than generic entrepreneurial confidence or digital tool use?
2. How can micro-credentials be made portable across ecosystem actors without excluding smallholders through documentation burdens?
3. What forms of evidence provide fair and valid indicators of TEC across seasons and compliance cycles?

Methodological direction. Longitudinal portfolio-based assessment research is the most appropriate approach because TEC is evidenced over time, through accumulated records, artefacts and decisions, rather than through one-off tests alone.

Theme 4. Delivery and governance: Who orchestrates entrepreneurship education in AIIE?

Why this matters. TEC formation requires sustained support, coordination and accountability across actors with unequal resources and influence. In AIIE, education is delivered through a mixed ecology that may include vocational colleges and universities, extension services, cooperatives, platform academies, local government programmes, incubators and intermediary service providers. This diversity can create innovation, but it can also produce fragmentation or capture. Treating education as part of ecosystem orchestration therefore brings governance questions to the foreground: who sets the agenda, who owns learning data, who bears compliance burdens, and how inclusion is protected.

Research questions.

1. What co-delivery models exist across universities or VET institutions, cooperatives, platforms and governments, and how do they differ?
2. How can delivery systems prevent benefits from concentrating among already-resourced actors?
3. Which institutional arrangements enable learning continuity beyond short project cycles?

Methodological direction. Comparative institutional case study is the strongest approach for this theme because it allows different governance arrangements to be

examined in relation to accountability, inclusion, continuity and upgrading outcomes across settings.

5. Conclusion

Taken together, these four themes reposition entrepreneurship education as a core lever in sustainable agri-industry transitions, but only under specific design and governance conditions. The key implication is that improving training, by itself, is not enough. What matters is whether education is organised as a seasonally sequenced capability pathway, delivered through hybrid architectures linking farm practice with cooperatives, intermediaries and platforms, assessed through credible evidence chains rather than narrow skills tests, and governed in ways that prevent credentials and compliance routines from becoming exclusionary gates. In practical terms, this shifts the centre of gravity of entrepreneurship education towards agri-specific domains that are often marginal in digital training programmes: quality grading and cold-chain coordination as forms of upgrading work; traceability and compliance as entrepreneurial assets rather than administrative burdens; and resilience-building as a core competence under climate, biological and market volatility. It also brings governance more fully into view. If platforms and data infrastructures increasingly define what counts as performance, educators and public institutions need strategies that cultivate critical metric literacy and protect learning from capture by short-term optimisation logics. Future progress will depend on comparative and mechanism-focused research across agri-industry sub-sectors, delivery models and standards regimes. The contribution of this agenda, however, is more specific: it shifts entrepreneurship education in agri-industry from a question of digital skills provision to a question of how educational design can build transformative entrepreneurial capacity for inclusive and sustainable upgrading.

References

- Azab, R., Mahmoud, R. S., Elbehery, R., & Gheith, M. (2023). A bi-objective mixed-integer linear programming model for a sustainable agro-food supply chain with product perishability and environmental considerations. *Logistics*, 7(3), 46.
- Boon, B., & Schifferstein, H. N. (2022). Seasonality as a consideration, inspiration and aspiration in food design. *International Journal of Food Design*, 7(1), 79-100.
- Daum, T. (2025). Digitalization and skills in agriculture. *Outlook on Agriculture*, 54(2), 171-181.
- Donaldson, A. (2022). Digital from farm to fork: Infrastructures of quality and control in food supply chains. *Journal of Rural Studies*, 91, 228-235.
- Komarudin, I., Duerawee, A., Santoso, A. P. A., & Lestari, R. D. (2025). The Digital Education based on Public Innovation in Developing a Sustainable Agribusiness Ecosystem. *Journal Governance Society*, 2(1), 38-47.

- Marchese, S., Gastaldi, L., & Corso, M. (2026). Orchestrating innovation ecosystems and digital technologies for dynamic capabilities development: the case of EdTech industry. *European Journal of Innovation Management*, 29(2), 429-463.
- Notarnicola, B., Sala, S., Anton, A., McLaren, S. J., Saouter, E., & Sonesson, U. (2017). The role of life cycle assessment in supporting sustainable agri-food systems: A review of the challenges. *Journal of cleaner production*, 140, 399-409.
- Petropoulos, D., Deirmentzoglou, G. A., Apostolopoulos, N., Paris, B., Michas, D., Balafoutis, A. T., ... & Moreira da Silva, J. F. (2025). Digital and entrepreneurial competencies for the bioeconomy: Perceptions and training needs of agricultural professionals in Greece, Italy, Portugal, and Sweden. *Agriculture*, 15(10), 1106.
- Qiu, R., Yu, P., Sadowski, B. M., & Shi, J. (2025). Value creation through complementary resource reconfiguration: complementor transition to innovation ecosystem orchestrator. *Management Decision*.
- Sanusi, M. S., Mayokun, O. M., Sunmonu, M. O., Yerima, S., Mobolaji, D., & Olaoye, J. O. (2025). Transformative trends: commercial platforms revolutionizing rice farming in Nigeria's agricultural value chain. *International Journal of Agricultural Sustainability*, 23(1), 2473757.
- Shi, J., Zhang, Z., Gao, R., & Chen, Z. (2025). Cultivating Talents at Tertiary Agricultural Institutions in China for Sustainable and Intelligent Development. *Sustainability*, 17(21), 9754.
- Silchenko, V., Pohorilyi, I., & Yarkov, V. (2025). DIGITAL TRANSFORMATION AND INNOVATIVE POTENTIAL OF AGRIBUSINESS IN UKRAINE. Publishing House "Baltija Publishing".
- Vahdanjoo, M., Sørensen, C. G., & Nørremark, M. (2025). Digital transformation of the agri-food system. *Current Opinion in Food Science*, 63, 101287.
- Wu, Q., Wu, Z., Zhang, W., & Wang, W. (2026). Is Interdisciplinary Research More Conducive to Knowledge Innovation? Evidence From Swiss National Science Foundation Projects. *European Journal of Education*, 61(2), e70530.
- Zhang, W., & Wang, C. (2026). Institutional Translations of Science Policy: How Global Collaboration Agendas are Practiced in a Leading Chinese University. *Minerva*, 1-27.