



Toward Smart Agrotourism: Co-Creating a Living Lab for Premium Melon Farming

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Abstract

Digital monitoring makes farm activity easier to observe, but adding technology does not by itself make a working farm an experiential learning setting. Smart agrotourism also depends on whether digital systems fit local governance and everyday cultivation. This paper examines the formation of a premium-melon Living Lab in Kebonagung, Bantul, Indonesia, during the pre-harvest and pre-tourism period. We used a qualitative, process-oriented single-case design and examined project documents, WhatsApp communications, field logs, digital monitoring records, and photographs collected from March to September 2026. The findings show that co-creation developed through adaptations prompted by field conditions. Physical, agronomic, and spatial constraints brought academic teams, students, village authorities, and local youth into shared decisions and changes in responsibility. Knowledge was brought together by repeatedly checking sensor readings against manual agronomic references and observed irrigation outcomes. The case offers a grounded pathway for rural initiatives by keeping pre-tourism formation separate from later tourism performance. It also shows why local caretaking arrangements and data-validation procedures need to be clear before project handover.

Keywords *Smart Agrotourism; Living Lab; Co-creation; Digital Agriculture; Premium Melon*

INTRODUCTION

A smart agrotourism approach could help to diversify rural areas as well as sustain farmers by blending genuine farming operations with digital aspects and experiential learning. However, in small-scale farming contexts, digital technologies must align with local capabilities and governance for these activities to work. Here, smart agrotourism means a system in which authentic production, IoT-enabled monitoring, multi-actor co-creation, and contextual interpretation turn routine farm data into learning resources. Digital tools make agricultural processes visible over time, especially when daily work cannot be observed continuously, but their usefulness still depends on cultivation practices, community knowledge, infrastructure, and daily care (Cascone et al., 2024; Gardezi et al., 2024; Idris et al., 2024). Living Labs are useful because experimentation takes place under real operating conditions, where actors can adjust technical arrangements when field problems arise.

In agritourism, farming is not simply the backdrop to a visit; it can be part of the experience. Studies emphasize authenticity, place, interaction, and learning, while community-based tourism research points to participation in creating the experience (Liang et al., 2023; Martinus et al., 2024). Tourism Living Lab research also examines how actors organize collaboration (Dickinger & Kolomojets, 2024). Much of this literature, however, concerns places where tourism is already operating. Kebonagung is at an earlier point: premium-melon production was running, but learning

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and visitor-oriented elements were only beginning to develop.

The analysis covers the pre-tourism formation period from March to September 2026. Visitor activities and final harvesting had not started, so the study does not assess visitor experience, tourism satisfaction, or crop-yield performance (Susenohaji et al., 2026; Teguh et al., 2025). Instead, Kebonagung provides a setting for examining how a multi-actor group—including the multidisciplinary academic team, project students, KKN students, village authorities, and community partners—responded to field constraints and brought different forms of knowledge together.

The case addresses a practical problem in rural smart agriculture: digital tools and governance arrangements have to fit local capacity before they can support visitor activities. The study therefore examines how the Living Lab supported multi-actor adaptation and connected agricultural, local, and digital knowledge in creating conditions for future agritourism functions (Idris et al., 2024; Teguh et al., 2025). To keep this formation stage separate from later tourism operations, we posed two research questions:

- RQ1. How does a Living Lab mediate multi-actor co-creation during the initial formation of a working premium-melon farm toward emerging smart agrotourism?
- RQ2. How does the Living Lab integrate agricultural, local, and digitally mediated knowledge, and how does this integration create prospective learning resources for future agritourism functions?

LITERATURE REVIEW

Living Labs and Co-Creation

Recent reviews describe agricultural Living Labs as collaborative settings where actor interaction and adaptation to farming conditions are central (Cascone et al., 2024; Gardezi et al., 2024; Toffolini et al., 2023). In practice, field conditions shape experiments: a proposed solution may change as it meets local constraints, and farmer knowledge must connect with interdisciplinary work. This case therefore treats adaptation as part of innovation rather than as a departure from a fixed plan (Cascone et al., 2024; Toffolini et al., 2023).

Learning in Living Labs can develop through contextualization, capacity building, co-creation, and reflection (Bhatta et al., 2025). But bringing several groups into one project does not itself establish co-creation. Roles, opportunities to influence decisions, and institutional conditions shape what collaboration produces. Here, co-creation was considered evident only when a change in interpretation, responsibility, decision-making, or Living Lab configuration could be linked to contributions from more than one actor group (Bhatta et al., 2025; James et al., 2025).

Agritourism Experience and Digital Interpretation

In agritourism, the farm is more than a place visitors arrive at; farming itself can become part of the experience. Recent studies highlight authenticity, location, interaction, and learning, while community-based tourism research emphasizes participation in co-creating experiences (Liang et al., 2023; Martinus et al., 2024). Tourism Living Lab research similarly considers how actors organize their collaboration (Dickinger & Kolomojets, 2024). Most of this literature, however, examines sites where tourism is already underway. Kebonagung differs because production was established first, while learning and visitor-oriented functions were only beginning to develop during the study period.

People working in the greenhouse can readily recognize signs produced by daily cultivation, but those signs may not be obvious to outsiders. In smallholder farming, IoT and sensor-based crop monitoring can provide continuous information on microclimate and soil conditions,

connecting established practices with data-driven agriculture ([Sharma et al., 2023](#); [Kumar et al., 2024](#)). Digital records retain sensor values, actuator states, and operating histories, yet they do not explain their own significance. Meaning comes from context. For Kebonagung, the issue is how production data can be interpreted beyond the technical team. Because the site was still primarily used for farming, the analysis will focus on how farming practices and internet data can support learning and experience before tourism begins. ([Gretzel et al., 2015](#); [Lyu et al., 2025](#); [Torabi et al., 2023](#)).

Working Concept

Here, smart agrotourism refers to a developing condition in which authentic agricultural production remains central, while digital systems make parts of that production visible and stakeholder knowledge helps others interpret the activities and records. Sensors and automation are part of the arrangement, but they are not sufficient on their own. The key question is whether agricultural processes can become observable, understandable, and meaningful to people outside the technical team, so they can later contribute to the visitor experience.

In Indonesia, the move toward smart agrotourism is closely connected to local institutional governance, particularly *Desa Wisata* (Tourism Village) frameworks and *Badan Usaha Milik Desa* (BUMDes). Indonesian studies show that BUMDes has an important role in planning, organizing, implementing, and supervising village tourism enterprises ([Reina-Usuga et al., 2024](#); [Srisontisuk, 2023](#); [Wijayanto et al., 2025](#)). Digital agricultural initiatives therefore need to connect with village governance arrangements to maintain operational continuity, clear caretaking responsibilities, and community involvement after temporary academic projects end.

RESEARCH METHOD

Design and Case

We studied the formation of the Kebonagung Living Lab as a qualitative, process-oriented single case. The unit of analysis was the changing co-creation and transformation process, rather than individual devices or participants. The chain of events was recreated chronologically using temporal bracketing to identify when changes occurred and reactions took place, and sources were then triangulated to trace how an input became a decision or action. The study covered the period before harvest and visitor operations, following exploration, implementation, reassessment, and adjustment without treating the process as fixed ([Langley, 1999](#)).

Actors and Evidence

The Kebonagung case involved actors with different responsibilities. The project team provided decision support, agronomic expertise, greenhouse management, digital and information technology implementation, and stakeholder communication. Project students handled installation, testing, troubleshooting, field verification, and reporting. KKN students later supported daily greenhouse activities, including planting, field reporting, and local coordination. Other actors included current and prospective plant managers, the village head and other Kalurahan officials, community and tourism-related organizations, and external institutional partners.

Figure 1 maps the connected roles in the Kebonagung Living Lab. The multidisciplinary academic team contributes agronomic expertise and IT infrastructure design; project students carry out technical installation. KKN students connect daily greenhouse work with community

coordination, while local actors and Kalurahan officials help maintain institutional continuity.

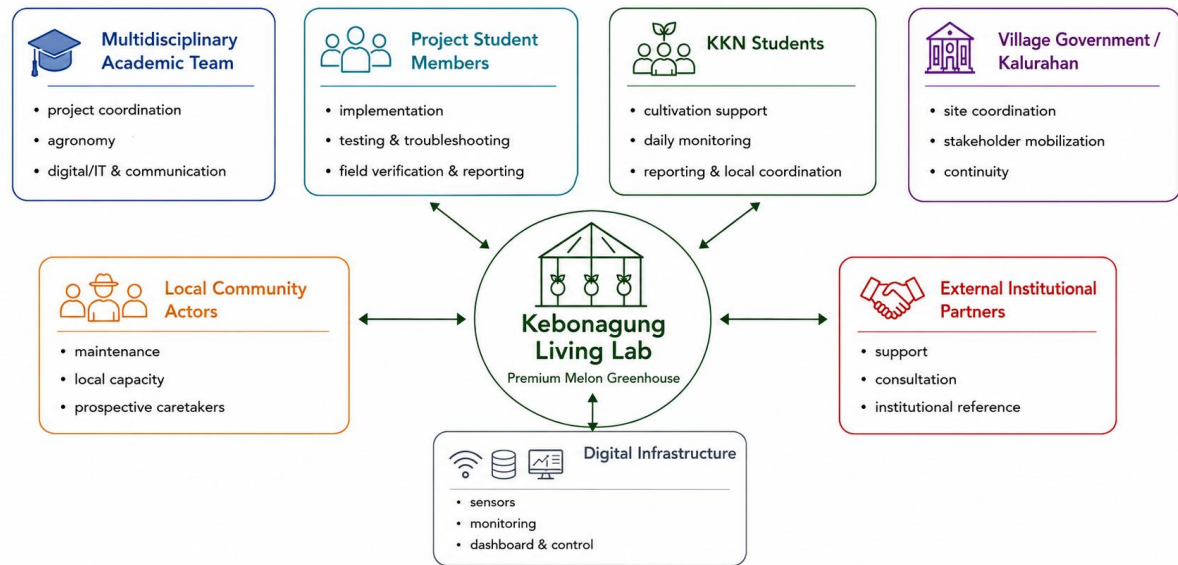


Figure 1. Actor and role ecosystem documented in the Kebonagung Living Lab; connections show participation but not equal intensity of contribution

The evidence consisted of project documents, WhatsApp coordination logs, field reports, digital monitoring logs, and photographs collected from March to September 2026. Table 1 lists the types, quantities, and date ranges of the materials analyzed. The analysis excluded personal content and identifying telephone numbers; participants were referred to by role, and no private opinions were inferred. No interviews or questionnaires were conducted.

Table 1. Summary of Analyzed Evidence Sources (March–September 2026)

Category	Source Type	Quantity / Volume	Date Range	Primary Focus / Contents
Project Documents	Proposals, MoAs, formal reports	6 documents	Mar–Sep 2026	Project scope, institutional permissions, budget, milestones
Communication Logs	WhatsApp group coordination chats	3 active channels (~1,450 messages)	Mar–Sep 2026	Daily operational decisions, field constraints, scheduling
Field and Operational Logs	KKN and project student field reports	28 weekly entries	May–Aug 2026	Cultivation steps, routine care, local coordination
Digital Monitoring Logs	Sensor/actuator dashboard records	182 daily log sets	Jun–Sep 2026	pH, EC/PPM, ambient temperature, pump status
Visual Documentation	High-resolution field photographs	210 photos	Mar–Sep 2026	Greenhouse construction, crop growth stages, verification

Process Reconstruction and Analysis

We analyzed the material using qualitative thematic coding. A priori codes were drawn from Living Lab literature, followed by inductive sub-coding and analytical memo-writing to capture issues emerging in the field. Records were arranged chronologically and examined through temporal bracketing to identify decision and adaptation episodes ([Langley, 1999](#)). An episode was retained only if the record linked an issue, constraint, or stakeholder input; an interpretation or response; and a later decision, adjustment, or operational consequence. Episodes were compared across evidence types, and co-creation was assigned only when contributions from more than one actor group could be traced to the resulting change. From 18 adaptation episodes, we selected five distinct, well-documented types for closer comparison (Table 2).

The two research questions were examined in different ways. For RQ1, we followed actors, inputs and interactions, decisions, adaptations, and consequences. For RQ2, we examined how knowledge sources and their representations were linked to operational meaning, how that meaning was interpreted, and how it might become a learning resource. Reconstructions were checked against contemporaneous coordination, agronomy and greenhouse-operation, digital/IT, and stakeholder-communication records. Cross-domain interpretations were reviewed again before retention.

A single primary coder conducted the analysis. No independent second-coder check or inter-rater reliability (IRR) test was carried out. Trustworthiness was supported through source triangulation, temporal traceability, and an audit trail documenting episode selection and interpretation to reduce potential interpretive bias ([Nowell et al., 2017](#)). Permission to use the setting was established through project collaboration arrangements. Communication records were treated as operational documents rather than interview data; personal content and telephone numbers were excluded, and participants are reported by role.

FINDINGS AND DISCUSSION

From Production Site to Living Lab

The physical configuration of the Kebonagung Living Lab changed several times, although Kebonagung remained the study setting. The first proposed site was too small, shaded, and structurally unsuitable for premium-melon cultivation, while other local options also had practical limitations. The team considered an institutional greenhouse outside Kebonagung, but moving there would have changed the village and stakeholder context. The search eventually led to a site near Bendung Tegal, still within Kebonagung. This location required a simpler greenhouse and renewed checks of water, electricity, connectivity, cultivation infrastructure, and equipment protection (Project implementation record, March–September 2026). The case boundary remained in place while the intervention was adjusted to local conditions. The greenhouse remained a production site but also became a place for experimentation, negotiation, and learning, consistent with agricultural Living Lab experimentation ([Gardezi et al., 2024](#); [Toffolini et al., 2023](#)).

Co-Creation Through Adaptation Episodes

Co-creation did not begin with a single, clearly identifiable episode. In the records, it became visible when a field problem brought several actors into discussion, and their interpretations affected the next action. Of the 18 field adaptations identified, Table 2 presents five episodes in which these collaborative links were documented most clearly.

The change in greenhouse location shows that a practical site decision also changed the project's social setting. The people expected to support the first location were not necessarily those closest to, or responsible for, the final site. Coordination therefore expanded beyond the local group initially anticipated. Kalurahan involvement became important not only for site access but also for

mobilizing actors and discussing how to maintain the greenhouse (Project implementation record, March–September 2026).

Table 2. Selected decision and adaptation episodes in the Kebonagung Living Lab

Episode	Actors	Field input	Response and Adaptation	Analytical insight
Site redesign	Research team, village actors	Proposed sites unsuitable or constrained	Kebonagung retained; greenhouse simplified	Local conditions override fixed physical plans
Stakeholder reconfiguration	Team, village actors, local youth	Final site changed the relevant local social environment	Coordination broadened to village level	Spatial change alters the stakeholder network
KKN-supported operation	Academic team, KKN students	Daily care required continuous field support	Students assisted cultivation, monitoring, reporting, coordination	Knowledge must be translated into everyday practice
Post-KKN continuity	Team, village government, community actors	Temporary student support ended; local participation was uneven	Caretaking responsibility and reporting were renegotiated	Continuity needs accountable local capacity
Digital–physical validation	Project student members, academic/field actors	Digital sensor/actuator states did not always correspond to manual or physical field conditions	pH/PPM values and pump/irrigation states were checked against manual references and physical outcomes	Digital visibility requires contextual and physical validation

Source: Reconstructed from project implementation, greenhouse/KKN field-coordination, stakeholder communication, and digital monitoring/field-verification records, March–September 2026.

During the KKN placement, students supported daily greenhouse work through cultivation, routine monitoring, reporting, and coordination with local actors. The importance of that support became clearer after the placement ended: the same day-to-day assistance was no longer available, and local youth did not immediately provide an equivalent replacement. The project team and village actors consequently had to revisit practical arrangements for caretaking, schedules, and progress reporting (Greenhouse/KKN field-coordination record, March–September 2026).

Earlier research notes that stakeholder presence does not itself constitute substantive co-production ([James et al., 2025](#)). The need to reorganize local responsibility in Kebonagung likewise shows why engagement structures matter in Living Lab co-creation. Participation became consequential when it changed responsibility, coordination, or routine practice ([Dickinger &](#)

[Kolomojets, 2024](#); [James et al., 2025](#)).

Site constraints simplified the greenhouse; the final site changed actors; KKN's end reopened caretaking and reporting.

When project students encountered unusual pH/PPM readings or pump and actuator states, they compared the digital record with manual readings and the actual irrigation outcome (Digital monitoring/field verification record, March–September 2026). Across the five episodes, adaptation involved more than technical problem-solving; it also affected cultivation practices, stakeholder arrangements, local governance, and responsibility for routine operations. Taken together, these episodes answer RQ1 by showing how the Living Lab supported co-creation through shared responses to field constraints and by redistributing technical, operational, and local responsibilities.

Knowledge Integration

Different forms of knowledge became most visible when a field problem could not be resolved from one perspective alone. Choosing the greenhouse site required agronomic judgment, attention to actual site conditions, and consideration of the local actors who would later operate it. A similar process occurred in digital monitoring: when pH/PPM readings or system states were uncertain, the team compared digital records with manual measurements and observed physical conditions before making subsequent decisions ([Bhatta et al., 2025](#); [Gardezi et al., 2024](#)).

The two student groups contributed in different ways. Project students worked mainly on the technical side through installation, testing, troubleshooting, field verification, and reporting. KKN students engaged with the Living Lab through cultivation, routine monitoring, reporting, and coordination with local actors. After the KKN placement ended, the issue was no longer only how the greenhouse would operate, but also who would take responsibility for daily care and reporting. These episodes brought technical, agronomic, and local knowledge into one implementation process. The case therefore points to a specific form of knowledge integration: repeated checks across digital representations, field conditions, and locally assigned operational responsibilities.

From Digital Visibility to Interpretive Resources

At Kebonagung, the digital system's value was not treated as a final account of field conditions. An unusual pH reading led to a comparison with a manual reference. The same principle applied to irrigation: although the system showed that a pump was running, the practical question was whether water had actually reached the plants. Field observations and manual checks therefore interpreted the digital records. The dashboard served as a trace of system activity, while its operational meaning came from relating that trace to the physical condition of the crop and irrigation system. Figure 2 shows the sequence from a field phenomenon through digital visibility and contextual validation to interpretation (Digital monitoring/field verification record, March–September 2026).

This distinction matters when the same records are later used outside routine operations. A pH value on its own may mean little to someone unfamiliar with melon cultivation; linked to an explanation of nutrient management, it can become an interpretive resource. An irrigation history can similarly help explain why an automated command still needs confirmation in the field. The records therefore provide a basis for explaining cultivation decisions after the event. Research on smart tourism also stresses that digital resources gain meaning when placed within suitable interpretive and governance contexts ([Gretzel et al., 2015](#); [Torabi et al., 2023](#)). In Kebonagung, this use remains prospective: the records supported operational interpretation and may later support learning, but visitor learning has not yet been observed empirically ([Lyu et al., 2025](#); [Susenohaji et al., 2026](#)).

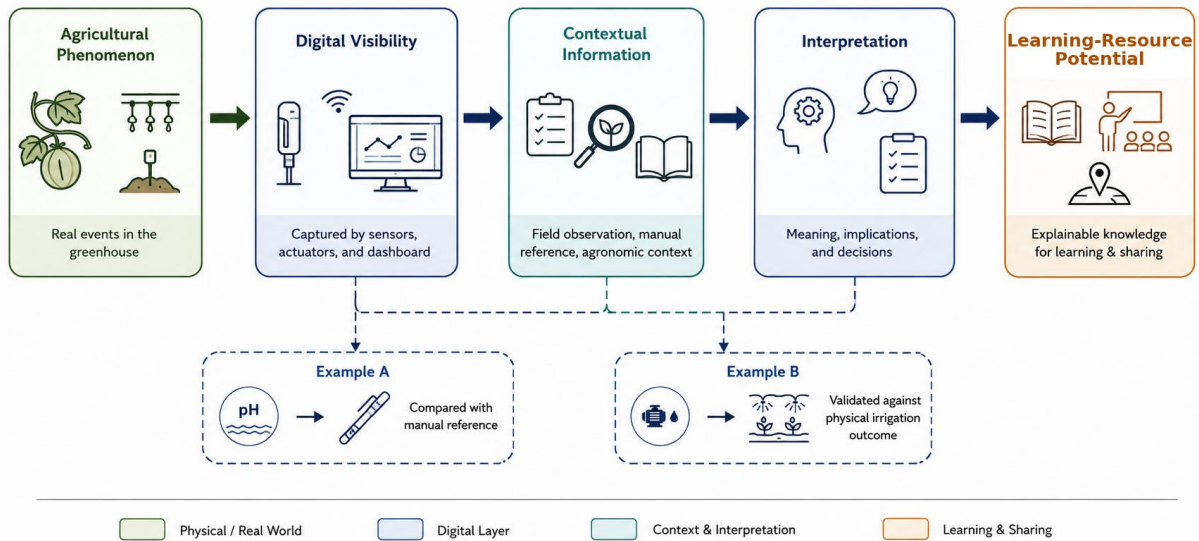


Figure 2. From agricultural phenomena and digital visibility to contextual interpretation and learning-resource potential

The RQ2 findings show that the Living Lab connected agricultural, local, and digital knowledge through contextual validation. Raw technical data were turned into practical explanations that may later serve as learning resources.

Toward Emerging Smart Agrotourism

During the study period, the greenhouse was still used mainly for premium-melon production. Harvest had not yet taken place, and the planned pick-your-own activity had not started, so visitor outcomes could not be assessed. Even so, the farming process already provided authentic material: cultivation decisions, field problems, and digital records came from an actual production setting rather than an activity staged for visitors. These materials could later help explain crop management and support experiential learning.

Village coordination on caretaking was also beginning to support continuity beyond temporary university involvement. Recent Indonesian rural-tourism studies likewise indicate that local leadership, multi-actor coordination, and digitalization influence the ability of tourism villages to sustain new initiatives (Martinus et al., 2024; Reina-Usuga et al., 2024; Srisontisuk, 2023; Susenohaji et al., 2026; Teguh et al., 2025; Wijayanto et al., 2025). Project communications recorded village-level discussions of the greenhouse within Kebonagung's Desa Wisata setting, including a formal maintenance coordination process involving BUMDes, the Jayan hamlet head (Dukuh Jayan), the head of RT 03 Tegal, and Karang Taruna Citra Kharisma in coordination with village tourism leadership (Project communication and stakeholder records, March–September 2026). This evidence indicates that the greenhouse was beginning to enter the local tourism governance setting before visitor operations started.

At this stage, pre-tourism formation and operational performance need to remain separate. The strongest evidence concerns agricultural production, Living Lab formation, contextual adaptation, knowledge integration, and digital visibility. Other elements were only beginning to develop. Interpretive learning resources, educational possibilities, and interaction potential had emerged, but visitor interaction, the pick-your-own experience, visitor satisfaction, and economic outcomes had not been tested. Figure 3 brings these observed and emerging elements together in a case-grounded analytical model.

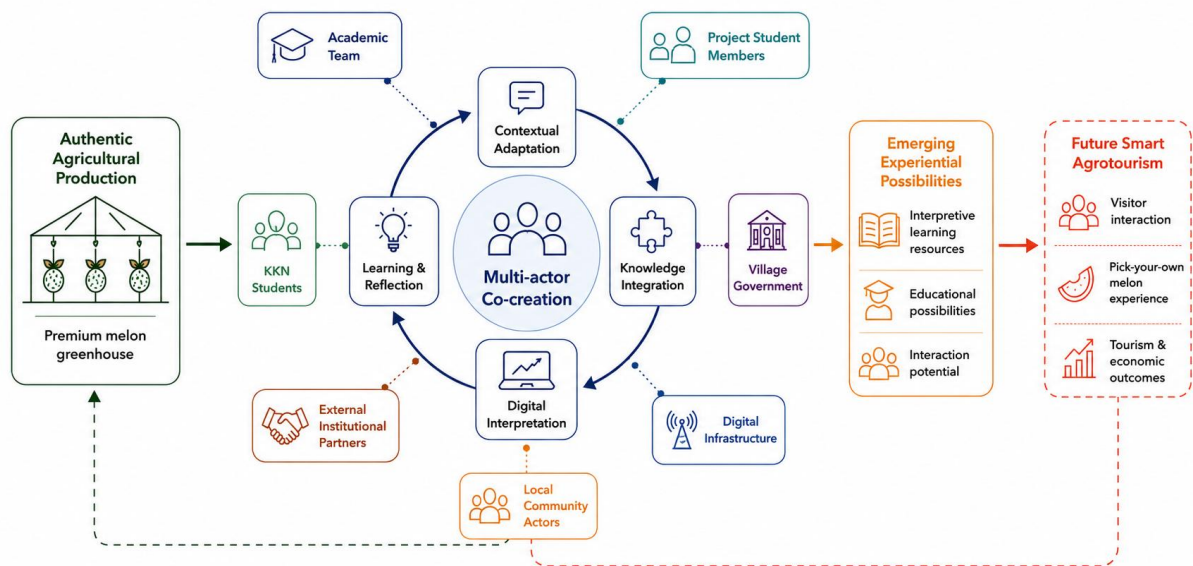


Figure 3. Case-grounded model of the iterative Living Lab transformation from authentic agricultural production toward emerging smart agrotourism

Figure 3 is not meant to show a fixed linear sequence. Contextual adaptation, knowledge integration, digital interpretation, and learning or reflection influence one another as the Living Lab develops. Visitor feedback could add another feedback loop once tourism begins, but that process is outside the evidence examined here. The model should therefore be read as an analytical proposition rather than a statistically generalizable result.

CONCLUSIONS

This study examined the pre-tourism formation of a smart agrotourism Living Lab in Kebonagung, Bantul, Indonesia. For RQ1, field-triggered adaptations—site constraints, operational support needs during and after student placements, governance integration, and digital monitoring anomalies—led to shared decisions, role changes, and cross-checking among actors. For RQ2, agricultural, local, and digital knowledge were brought together through contextual validation, including comparisons of sensor representations with manual checks and physical irrigation outcomes. This turned raw operational data into explanations that could later support learning. The main contribution is a case-grounded pathway distinguishing smart agrotourism formation before tourism from later tourism performance (Cascone et al., 2024; James et al., 2025).

Theoretically, the study extends Living Lab literature by showing that co-creation can be traced through the structural effects of field-level adaptations across physical, agronomic, digital, and governance domains, rather than inferred simply from stakeholder presence. It also contributes to agritourism research by highlighting the pre-tourism formation phase, which is less visible in studies focused on fully operating visitor sites.

Regarding practical implications, this study contributes to rural development initiatives and smart agriculture projects. Three key practical insights emerge:

1. **Governance Formalization:** Village institutions and local actors, including Desa Wisata committees and BUMDes, should agree on clear arrangements for caretaking and reporting before temporary university or project support ends.
2. **Sensor readings** should be treated as indicators requiring field and agronomic checks.
3. **Early Stakeholder Alignment:** Universities and project initiators should establish continuity

and handover arrangements with local actors from the beginning (Cascone et al., 2024; Dickinger & Kolomoyets, 2024; Martinus et al., 2024).

LIMITATIONS & FURTHER RESEARCH

Four limitations should be noted. First, the study ended before harvest and visitor operations, so it could not examine crop-yield performance, visitor learning, visitor satisfaction, or economic outcomes. Second, the single-case design limits statistical generalizability, and the proposed pathway needs testing in other rural agricultural settings. Third, the evidence came mainly from project-generated operational records, which document actions and institutional decisions more directly than stakeholder perceptions. Fourth, the study did not conduct primary interviews or surveys, limiting direct access to participants' reflections.

Future research should observe the site when visitor activities begin, collect primary data from local people and visitors, study the long-term sustainability of local governance and management systems, and conduct cross-case analysis to improve the smart agrotourism development model.

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