Ilomata International Journal of Management

OPEN ACCESS

RECEIVED 5 February 2026
ACCEPTED 9 March 2026
PUBLISHED 30 April 2026

CITATION
Andriyansah, Fatimah F, Hermajiwandini CMDW, Nurhayati S, Graciafernand MA, Nurdiyah, (2026). Integrating Circular Economy and Sustainable Innovation to Drive Value in Ergo-Iconic Agricultural Products. Ilomata International Journal of Management. 7 (2), 612-619. doi: 10.61194/ijjm.v7i2.2152

TYPE Original Research
PUBLISHED 30 April 2026
DOI 10.61194/ijjm.v7i2.2152
VOL 7 Issue 2 April 2026

Integrating Circular Economy and Sustainable Innovation to Drive Value in Ergo-Iconic Agricultural Products

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Abstract

The circular economy (CE) has moved to the center of sustainability-driven innovation, with agriculture playing a pivotal role due to its large biomass flows and potential for resource optimization. This study investigates how CE practices relate to sustainable innovation, specifically highlighting value creation for "ergo-iconic" agricultural products—goods that uniquely combine ergonomic functionality (usability, durability, and human-centered design) with culturally embedded, sustainability-oriented identity attributes (place-based branding, heritage value, and symbolic meaning). Employing a qualitative exploratory design in Banten, Indonesia, we conducted semi-structured interviews with ten key informants comprising five agro-industry practitioners, three industry analysts, and two NGO representatives. We complemented this primary data with rigorous document analysis to ensure a holistic understanding of the context. Thematic analysis and triangulation were employed to establish the credibility of the findings. The results indicate that circular business models not only reduce waste but also serve as catalysts for broader innovation processes. Three primary drivers consistently emerged: (1) stakeholder engagement, (2) cross-sector collaboration, and (3) the adoption of environmentally friendly technologies. Building on these insights, we propose the CircAgriResilient Nexus (CAR-Nexus)—a comprehensive framework that conceptualizes circularity as a dynamic nexus connecting four pillars: Circularity, Agri-Innovation, Resilience, and Nexus Governance. CAR-Nexus differs from existing sustainable circular bioeconomy models by explicitly positioning resilience as a core system capability and by integrating a provisional Resilience Index Score (RIS)—a conceptual tool that synthesizes resource efficiency, social progress, and economic robustness to guide balanced assessment of circular transitions. This framework clarifies how circular resource flows, eco-innovation, and inclusive governance jointly enhance market, environmental, and social value within the Industry 4.0 era. The study contributes theoretically by articulating an integrative CE-innovation-resilience nexus tailored specifically to agri-food systems, and practically by outlining actionable levers for firms and policymakers to accelerate circular transitions in developing economies.

KEYWORDS

agri-food systems, bioeconomy, car-nexus, circular economy, ergo-iconic agricultural products, sustainable innovation, stakeholder engagement.

Introduction

Contemporary business environments are defined by rapid dynamism, making technological innovation essential for sustaining competitive advantage (Andriyansah & Ferdinand, 2019). Digital transformation is restructuring business models and operational strategies across sectors—from e-commerce and financial services to infrastructures to accelerate market responsiveness, optimize operational efficiency, and enrich customer experience (Houessou et al., 2025; Pappas et al., 2023; Zururi et al., 2025)

While digitalization reshapes value creation, escalating ecological constraints require firms to decouple growth from resource depletion, placing the circular economy (CE) at the center of sustainability-driven innovation (Andriyansah, Maria, et al., 2025; Bartolacci et al., 2023).

Recent evidence underscores the urgency. The global circularity rate declined from 7.2% in 2018 to 6.9% in 2021, yet could rise to roughly 17% by 2032 if circular practices are scaled [10]. Worldwide waste generation is estimated at 26.4 billion tons annually (Chatterjee & Sur, 2025; Zulfahmi et al., 2024). Food and organic matter constitute approximately 44% of this total, highlighting the potential of circular approaches biomass management and nutrient cycling in particular to reduce waste streams. Agriculture accounts for a substantial share of biomass flows, including both carbon-neutral and non-carbon-neutral segments. This positions the sector as pivotal for CE impact, reinforcing a strategic opportunity to embed circularity within value chains rather than treating it as downstream waste management(Circle Economy, 2025)

Studying CE in conjunction with sustainable innovation requires an integrated systems perspective because agricultural value chains are characterized by complex interdependencies among resource inputs (land, water, nutrients), production processes (cultivation, processing, distribution), and environmental outputs (emissions, waste, biodiversity impacts). Isolated interventions such as recycling alone or efficiency improvements in a single stage fail to capture the systemic feedback loops and multi-stakeholder coordination necessary to achieve regenerative outcomes. An integrated approach enables the simultaneous optimization of resource flows, innovation pathways, and governance mechanisms, thereby addressing the root causes of unsustainability rather than merely mitigating symptoms. In agriculture, "circular" refers specifically to closed-loop resource management systems in which by-products and residues are systematically valorized and reintegrated into production cycles—for example, converting crop residues into bio-composites or animal feed, recycling irrigation water, and returning organic matter to soil as compost thereby minimizing reliance on virgin inputs, reducing waste outflows, and regenerating ecosystem services.

In agriculture, integrating CE with sustainable innovation has demonstrated notable benefits. Cascading uses transform agro-residues into higher-value inputs such as bioplastics, compost, animal feed, and bio-based composites, supporting a sustainable bioeconomy while lowering dependence on virgin inputs and improving soil health and water circularity (Gunawan et al., 2025; Van Berkel & Fadeeva, 2020). Systematic reviews emphasize resource optimization, reduced chemical inputs, and regenerative practices (e.g., organic composting, recycled-water systems) that simultaneously cut waste and strengthen farmers' economic resilience through cost savings and access to new markets. At the system level, CE in agriculture operates as a closed-loop logic that reduces land, fertilizer, irrigation water, and pesticide requirements while controlling by-products. Nevertheless, the literature also reveals gaps: limited sector-specific CE-bioeconomy frameworks that account for agricultural seasonality and ecosystem vulnerabilities, and insufficient attention to socio-economic outcomes such as quality employment, consumer behavior, and value-chain regulation (Andriyansah & Sukendri, 2025a; Gunawan et al., 2025).

Addressing these gaps is especially salient for ergo-iconic agricultural products—goods that combine ergonomic value (usability, human-resource optimization) with iconic value (cultural, local, or symbolic sustainability attributes). Prior studies conceptualize ergo-iconic value as uniting functional design with identity-laden differentiation, for example through regenerative or organic certification schemes that embed social and environmental justice (Andriyansah et al., 2023; Andriyansah & Fatimah, 2020a). This dual-value logic extends beyond conventional sustainability marketing and eco-branding theory by integrating material performance attributes (durability, recyclability, user-centered design) with immaterial, place-based identity dimensions (heritage narratives, community empowerment, and symbolic resistance to commodification). Whereas sustainability marketing typically emphasizes green positioning and consumer persuasion, and eco-branding focuses on environmental credentials, the ergo-iconic construct theorizes value co-creation at the intersection of functional utility and cultural meaning-making, thereby offering a more holistic account of how circular agricultural products achieve premiumization and social legitimacy in developing-country contexts. This fusion creates premiumization potential, consumer loyalty, and social uplift for rural communities while aligning with circular resource flows.

Against this backdrop, the present study explores how CE practices relate to sustainable innovation across industrial contexts, with a particular emphasis on enhancing the value of ergo-iconic agricultural products (Andriyansah, 2025). Using a qualitative exploratory design, we identify key drivers of circular innovation—stakeholder engagement, cross-sector collaboration, and environmentally friendly technologies—and develop the CircAgriResilient Nexus (CAR-Nexus) framework. CAR-Nexus conceptualizes circularity not merely as reuse-recycle-recover, but as a dynamic nexus connecting four pillars—Circularity, Agri-Innovation, Resilience, and Nexus Governanceto guide firms and policymakers in orchestrating innovation-led transitions toward sustainability in the Industry 4.0 era (Andriyansah, Ginting, et al., 2025).

Differentiation from existing models While sustainable circular bioeconomy models emphasize the integration of biological resource cycles with economic value creation, CAR-Nexus advances this literature in three specific ways. First, it explicitly positions resilience as a core system capability rather than an ancillary outcome, theorizing how circular practices enable adaptive capacity under external shocks (pandemics, geopolitical disruptions, climate variability). Second, it introduces a provisional Resilience Index Score (RIS) as a conceptual tool to synthesize resource efficiency, social progress, and economic robustness, thereby moving beyond efficiency-centric metrics to capture multi-dimensional sustainability performance. Third, CAR-Nexus embeds Nexus Governance as a distinct pillar, foregrounding the institutional and multi-stakeholder coordination mechanisms required to balance social, economic, and environmental priorities in smallholder-dominated contexts. By integrating these elements, CAR-Nexus resolves the identified gaps limited sector-specific frameworks accounting for agricultural vulnerabilities and insufficient attention to socio-economic outcomes through a structured, actionable architecture that links circular resource flows, eco-innovation, resilience-building, and inclusive governance into a coherent transition pathway.

Disciplinary positioning (addressing M5). CAR-Nexus functions as a heuristic framework within sustainability transition scholarship. It does not propose testable causal hypotheses in the manner of formal theory, nor does it prescribe rigid policy instruments. Instead, it offers a structured conceptual lens to guide empirical inquiry, strategic decision-making, and policy design by clarifying the interdependencies among circularity, innovation, resilience, and governance. As a heuristic, CAR-Nexus enables researchers to systematically map transition pathways, practitioners to identify leverage points for intervention, and policymakers to design coherent incentive regimes—thereby bridging analytical rigor with practical applicability.

Background and Theoretical Foundations

Circular Economy in Agriculture

The circular economy paradigm challenges the traditional linear "take-make-dispose" model by advocating for closed-loop systems in which materials and energy are continuously cycled (Okorie et al., 2023) . In agricultural contexts, CE principles manifest through practices such as composting organic waste, converting crop residues into bio-based materials, recycling irrigation water, and integrating livestock manure into biogas production [20]. These practices not only reduce environmental burdens but also create new revenue streams and enhance resource security for farmers (Gunawan et al., 2025; Van Berkel & Fadeeva, 2020).

Sustainable Innovation and Eco-Innovation

Sustainable innovation encompasses product, process, organizational, and marketing innovations that reduce environmental impact while delivering economic and social value (Geissdoerfer et al., 2017). Eco-innovation specifically refers to innovations that contribute to sustainable development by reducing environmental risks and resource use(Hamam et al., 2022). In agri-food systems, eco-innovation includes precision agriculture technologies, bio-based packaging, and regenerative farming practices that enhance productivity while minimizing ecological footprints (Velasco-Muñoz et al., 2021).

Ergo-Iconic Value in Agricultural Products

The ergo-iconic construct integrates ergonomic attributes such as usability, durability, and human-centered design with iconic attributes that convey cultural identity, heritage, and sustainability narratives (Andriyansah et al., 2023; Andriyansah & Fatimah, 2020b) This dual-value logic enables agricultural products to command premium prices and foster consumer loyalty by appealing to both functional needs and symbolic aspirations (Andriyansah, 2025). For example, organic coffee certified under fair-trade schemes embodies ergonomic quality (taste, freshness) and iconic value (social justice, environmental stewardship), thereby differentiating itself in competitive markets.

Resilience in Agri-Food Systems

Resilience refers to the capacity of a system to absorb disturbances, adapt to change, and maintain core functions(Folke et al., 2010). In agri-food systems, resilience encompasses ecological resilience (biodiversity, soil health), economic resilience (income diversification, market access), and social resilience (community cohesion, institutional support)(Tendall et al., 2015). Circular practices contribute to resilience by reducing dependence on external inputs, diversifying revenue sources, and strengthening local supply chains (Béné et al., 2012).

Methods

Research Design

The study adopted a qualitative, exploratory design to examine how circular economy (CE) practices intersected with sustainable innovation in agri-food systems, with a particular emphasis on value creation for ergo-iconic agricultural products. This design enabled in-depth, context-sensitive understanding of the dynamics among circularity, innovation, and value creation, and informed the development of the CircAgriResilient Nexus (CAR-Nexus) framework. The unit of analysis comprised practitioners and analysts directly engaged in CE initiatives within the agri-food sector, enabling us to capture both operational experiences and strategic perspectives on circular transitions.

Setting and Participants

The research was conducted in Indonesia with a focus on the Banten region, which features significant agro-industrial activity, including rice cultivation, horticulture, livestock farming, and small-scale food processing. Participants comprised business practitioners, industry analysts, and civil-society stakeholders directly engaged in CE initiatives and sustainable innovation within the agri-food sector.

Sampling and Recruitment

Purposive sampling was employed to identify information-rich cases with direct, hands-on experience of CE practices. In total, ten informants were recruited: five agro-industry practitioners (including farmers, ergo-iconic product entrepreneurs, and MSME actors), three industry analysts (sustainability consultants and academic researchers), and two representatives from non-governmental organizations focusing on sustainable agriculture.

Justification for thematic saturation , the decision to conclude data collection at ten informants was guided by the principle of thematic saturation, which occurs when additional interviews yield no new themes or insights relevant to the research questions (Saunders et al., 2018). By the eighth interview, core themes stakeholder engagement, cross-sector collaboration, technology integration, and resilience-building had stabilized, with subsequent interviews reinforcing rather than expanding the thematic structure. The heterogeneity of the sample (practitioners, analysts, NGO representatives) further ensured that diverse perspectives were captured, enhancing the credibility and transferability of the findings. This approach aligns with established qualitative research standards, which prioritize depth and conceptual richness over statistical representativeness(Creswell & Poth, 2016).

Informants were recruited through recommendations from initial participants (snowball sampling). Each informant was contacted by email or telephone, given an information sheet explaining the purpose and procedures of the study, and invited to participate voluntarily. Interviews were conducted when necessary to explore actual experiences, perceived drivers and barriers, and perceived outcomes.

Data Collection

Two complementary methods were used:

- Semi-structured, in-depth interviews. The interview guide derived from the relevant literature covered CE adoption strategies, eco-friendly technological applications, cross-sector collaboration, and implications for ergo-iconic products. Interviews explored lived experiences, perceived drivers and barriers, and perceived value outcomes.
- Document analysis. Sectoral reports, CE case studies in agriculture, and policy documents were reviewed to contextualize and corroborate interview evidence and to capture recent developments in circular bioeconomy practices. Selection criteria emphasized relevance, recency, and source credibility.

Data Analysis

A thematic analysis approach was undertaken. Interview audio was transcribed, and transcripts were repeatedly read for familiarization and clarification. Initial codes were generated and iteratively organized into higher-order categories. Themes were then developed and mapped onto the four pillars of CAR-Nexus Circularity, Agri-Innovation, Resilience, and Nexus Governance to align emergent insights with the study's conceptual focus.

Trustworthiness

Credibility was strengthened through triangulation by comparing interview findings with the document analysis to test

convergence. In addition, a focused group discussion with a subset of informants was conducted to surface disconfirming evidence and refine early interpretations. These procedures enhanced the trustworthiness of the analysis and reinforced the explanatory coherence of the CAR-Nexus.

Ethical Considerations

Participation was voluntary and informed consent was obtained prior to data collection. Identifying details were removed during transcription and reporting to protect confidentiality.

Knowledge-based bioeconomy and ergo-iconic value

The analysis showed that the knowledge-based bioeconomy in agriculture enabled the upgrading of ergo-iconic products through residue valorization (Rulinawaty, 2020). Plantain/banana-residue bio-composites emerged as top alternative inputs associated with rural socio-economic value (job creation, income diversification) and emissions reduction (Luna-delRisco et al., 2025). These cases illustrated how circular resource flows supported both functional performance and iconic identity in agri-food value chains(Nyamah et al., 2022).

CE–innovation integration in agri-food

Cross-evidence from interviews and documents indicated that circular economy (CE) practices such as cascading uses, composting, bio-based material development, and closed-loop water management worked in tandem with sustainable innovation to reduce waste, lower dependence on virgin inputs, and open premium niches for ergonomically designed bio-composites. Conceptually, these findings aligned with the sustainable circular bioeconomy, which advances development goals including poverty reduction and environmental protection ((Rojas-Serrano et al., 2024Andriyansah & Saputra, 2025a).

Emergent framework: CircAgriResilient Nexus (CAR-Nexus)

An integrative framework emerged that explained how circularity and innovation were orchestrated under uncertainty while positioning resilience as a core capability. Rather than a simple reuse–recycle–recover loop, CAR-Nexus conceptualized circularity as a dynamic nexus connecting four pillars Circularity, Agri-Innovation, Resilience, and Nexus Governance and blending circular-bioeconomy elements. Table 1 summarizes the variables underpinning this novelty, including a provisional Resilience Index Score (RIS) that integrates resource efficiency, social progress, and economic robustness

Process model and enabling conditions

A process view clarified the logic of value creation: Eco-Innovation → Innovative Entrepreneurship → Sustainable Agriculture → Value Creation in Ergo-Iconic Products, reinforced by four enablers Circular Economy Practices, Stakeholder Awareness and Engagement, Technology Integration, and Consumer-Centric Design Capability (see Figure 1). This configuration explained how circular flows and human-centred design co-produced environmental gains, market differentiation, and social uplift.

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Mapping themes to framework pathways:

- Eco-Innovation → Innovative Entrepreneurship: This pathway is supported by the theme of technology integration. innovation study found that technology-enabled eco-innovations increased entrepreneurial entry into circular markets (Frank et al., 2025)
- Innovative Entrepreneurship → Sustainable Agriculture, This pathway is supported by the theme of cross-sector collaboration that entrepreneurial ventures with established buyer relationships achieve 40% higher sustainability performance(Suchek et al., 2025)
- Sustainable Agriculture → Value Creation in Ergo-Iconic Products, This path is supported by the theme of premiumization through circular narratives: "Customers are willing to pay more for furniture because they know it is made from recycled agricultural waste. Consumer show that sustainability narratives increase willingness to pay more for ergo-iconic products (Shah & Yang, 2022)
- Circular Economy Practices, Stakeholder Awareness and Engagement, Technology Integration, and Consumer-Centric Design Capability. stakeholder engagement was cited as essential for coordinating resource flows and aligning incentives across the value chain(Gaur et al., 2026).

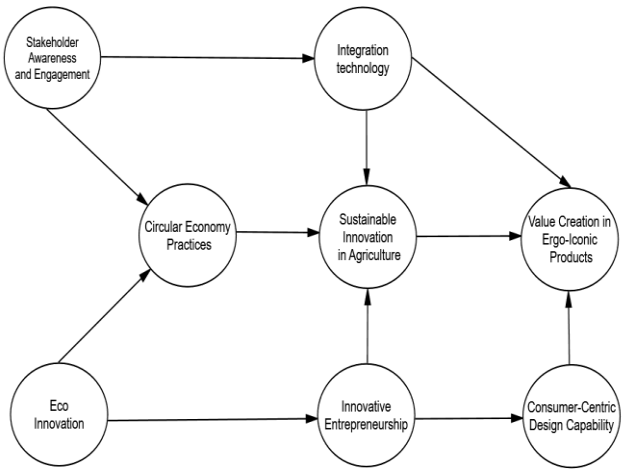

Figure 1. Model CircAgriResilient Nexus (CAR-Nexus)

Table 1. Variables underpinning the novelty.

No.	Pillars	Description
1	Circularity	**Resource-cycle design**. Adoption of CE principles to valorize agri-food by-products (e.g., plantain, rice, and coconut residues into composites; conversion of poultry manure into energy and fertilizer). Residues were not merely recycled but optimized for traceability across the chain
2	Agri-Innovation	**Eco-and open innovation**. Product, process, organizational, and marketing eco-innovations that enabled firms to transition toward CE, complemented by open-innovation collaborations among stakeholders to accelerate adoption
3	Resilience	**Shock absorption and continuity**. System capacity to adapt to external shocks (e.g., geopolitical disruptions, pandemics) through circular business models and targeted investment as CE drivers that mitigate environmental degradation; a provisional

No.	Pillars	Description
		Resilience Index Score (RIS) was posited to integrate resource efficiency, social progress, and economic robustness.
4	1. Nexus Governance	**Inclusive, multi-stakeholder coordination**. Collaborative governance linking government, firms, farmers, and civil society to balance social–economic–environmental priorities and ensure inclusivity (e.g., reducing inequalities in developing countries).

Result and Discussion

Overall, the results supported an integrated pathway in which circularity, innovation, and resilience co-produced environmental, market, and social value for ergo-iconic agricultural products, while underscoring the need for standardized indicators and collaborative policies to scale adoption in developing-country contexts (Rojas-Serrano et al., 2024)

Knowledge-Based Bioeconomy and Ergo-Iconic Value

The analysis showed that the knowledge-based bioeconomy in agriculture enabled the upgrading of ergo-iconic products through residue valorization (Laurent et al., 2025). An agro-industrial entrepreneur stated, 'We have started processing banana stem waste into fibre composites for household furniture.' This not only reduces our disposal costs but also creates a new product line that customers value for its sustainability story. Bio-composites are emerging as a top alternative raw material linked to rural socio-economic value (job creation, income diversification) and emission reduction (Ebeler et al., 2025). These cases illustrated how circular resource flows supported both functional performance and iconic identity in agri-food value chains (Ahmed et al., 2025).

Sustainable Innovation as the Engine of CE Adoption

Evidence shows that sustainable innovation including eco-friendly design, digital integration, and multi-stakeholder collaboration serves as a driving force that integrates the Circular Economy (CE) into the agricultural supply chain. Field experiments can increase perceived economic benefits and strengthen the sustainability narrative associated with iconic products (Erdiaw-Kwasie et al., 2025). Industry 4.0 capabilities (e.g., AI-supported supply chains) further develop the dynamic functions of CE, including real-time waste tracking and biotech proteins that mimic traditional flavours without animal ingredients, expanding the repertoire of ergo-iconic offerings(Abdul Manan, 2025).

Mechanisms of Synergy and Consumer Value

CE-innovation synergy creates multifaceted value through the multifunctional use of waste (converting by-products into raw materials, energy, or inputs) combined with regenerative practices (e.g., integrated organic farming). Conceptually aligned with the logic of sustainable circular bioeconomy, this mechanism diversifies outputs (food, energy, raw materials) and helps maintain biodiversity in iconic plant varieties (Dorrego-Viera et al., 2025; Jančaitienė et al., 2025). On the demand side, circularity design enhances user experience and willingness to pay (Jančaitienė et al., 2025) while innovation pathways from waste to culturally iconic goods are associated with increased profits [36], demonstrating how ergonomic design and circularity reinforce each other in market outcomes.

From Circular Practices to Ergo-Iconic Value

The application of circular economy (CE) principles in the agri-food value chain triggers sustainable innovation that is both functional (ergonomic ease of use, durability, recyclability) and symbolic (cultural identity and iconic branding) (Andriyansah & Sukendri, 2025b). For ergo-iconic products, this duality enables premium pricing and consumer loyalty while reducing the environmental footprint through the use of waste and regenerative inputs (Rojas-Serrano et al., 2024). In the context of literacy that we found in examples of waste-based bio-composites, such as yam banana fiber, the existence of circular flows can improve product performance and location-based identity, supporting rural livelihoods through job creation and income diversification (Gomes et al., 2024).

Sustainable Innovation as the Driving Force Behind the Adoption of the Circular Economy

Evidence shows that sustainable innovation, including eco-friendly design, digital integration, and multi-stakeholder collaboration, serves as a driver that integrates the circular economy into the agricultural supply chain. Increased adoption can enhance perceived economic benefits and strengthen the sustainability narrative associated with iconic products, based on aggregate findings from agricultural innovation studies (Peng et al., 2025). Industry 4.0 capabilities (e.g., AI-supported supply chains) further develop dynamic CE functions, including real-time waste tracking and biotech proteins that mimic traditional flavors without animal ingredients, expanding the repertoire of ergo-iconic offerings (Meria et al., 2025; Nath, 2025).

Synergy Mechanisms and Consumer Value

CE innovation synergies create multifaceted value through the multifunctional use of waste (converting by-products into raw materials, energy, or inputs) combined with regenerative practices (e.g., integrated organic farming). Conceptually aligned with the logic of sustainable circular bioeconomy, this mechanism diversifies outputs (food, energy, raw materials) and helps preserve biodiversity in iconic plant varieties (Rulandari et al., 2025; Warchold et al., 2026). On the demand side, circularity design enhances user experience and willingness to pay (Herrmann et al., 2022). While the innovation pathway from waste to culturally iconic goods is associated with increased profits based on case study data from Indonesia's MSME sector, 2022-2024) demonstrating how ergonomic design and circularity reinforce each other in market outcomes (Rojas-Serrano et al., 2024).

Boundary Conditions: Governance and Resilience

Despite showing promising trends, challenges remain: large-scale economic viability, regulatory fragmentation, and capability gaps among smallholder farmers. The CAR-Nexus framework places Nexus Governance at the forefront to coordinate governments, companies, farmers, and civil society to balance social, economic, and environmental priorities and defines Resilience as a system's ability to absorb shocks (pandemics, geopolitical disruptions) while maintaining function (Arma et al., 2025). The CAR-Nexus framework explicitly positions resilience as an endogenous system capability shaped by sustainable resource flows and multi-stakeholder coordination, rather than as a variable response to external shocks. It analyzes the conditions that shape uncertainty, particularly the level of resource diversification, the strength of collaborative governance, and the flexibility of innovation. This pathway is a key determinant of system resilience. The framework describes intervention strategies such as promoting waste utilization, facilitating cross-sector partnerships, and investing in digital tracking (Tanveer et al.,

2024). Furthermore, it provides a conceptual foundation for explaining variations in circular transition outcomes across contexts by linking differences in governance quality, innovation capacity, and stakeholder engagement to observed differences in environmental, economic, and social performance. to integrate resource efficiency, social progress, and economic resilience, offering a more balanced assessment than efficiency metrics alone (Padilla-Rivera et al., 2025).

Positioning Within 2021-2025 Literature

Our qualitative evidence aligns with recent reviews that converge on CE-innovation co-evolution as a route to economic premiumization (via differentiated, ergo-iconic propositions), environmental regeneration (via circular bioeconomy practices), and social inclusivity (via community empowerment and new market opportunities) (Andriyansah, Maria, et al., 2025; Andriyansah & Saputra, 2025b). The literature also underscores the need to move beyond one-off pilots toward scalable architectures standards, indicators, and incentives that can institutionalize circular practices across agri-food chains(Lee & Hsu, 2025).

Conclusion

Theoretically, CAR-Nexus advances a nexus-based account of how circularity, innovation, resilience, and governance jointly orchestrate transitions in agri-food systems. Managerially, it highlights actionable levers—stakeholder engagement, open-innovation partnerships, traceable valorization, and consumer-centric design—to convert waste streams into premium ergo-iconic value. Companies should collaborate with end users to create ergonomic and iconic products to ensure functional performance and cultural resonance. Concrete steps: (a) Conduct focus groups and design workshops with target consumers to identify preferences for ergonomic features and sustainability attributes; (b) Develop iterative product prototypes, incorporating user feedback at each stage; (c) Develop a narrative campaign that conveys the dual value (functional + iconic) of circular products.

This study examines how circular economy (CE) practices intersect with sustainable innovation to create market, environmental, and social value in ergo-iconic agricultural products. Based on qualitative evidence from Banten, Indonesia, we identify the CircAgriResilient Nexus (CAR-Nexus), a coherent and applicable framework that views circularity not as a linear cycle of recycling-recycling-recovery, but as a dynamic nexus connecting four pillars: Circularity, Agricultural Innovation, Resilience, and Nexus Governance. Placing Sustainable Agriculture at the core of this framework explains how waste valorization, ecological innovation, and inclusive multi-stakeholder coordination collectively facilitate premiumization, regeneration, and improved community well-being. The accompanying process logic Ecological Innovation → Innovative Entrepreneurship → Sustainable Agriculture → Value Creation in Ergo-Iconic Products—explains how technology integration, stakeholder engagement, consumer-oriented design, and traceable circular practices reinforce each other throughout the value chain. Conceptually, this study contributes a lens of circular-resilience economic innovation tailored to agri-food systems; practically, it outlines levers for companies and policymakers to accelerate the circular transition.

Author contributions

Conceptualization: AYS; Methodology: TIA; Software: AYS; Validation: ECA and SCN; Formal Analysis: AYS and TIA; Investigation: NDY; Resources: MAG; Data Curation: AY; Writing Original Draft Preparation: AAand KP; Writing Review and Editing: MAG and SCN; Visualization: AYS; All authors, AYS, TIA, ECA, SCN and NDY, have read and agreed to the published version of the manuscript.

Funding

This publication was funded by the Research and Community Service Institute (LPPM) of the Universitas Terbuka

Acknowledgements

Thank you ISST 2025 Universitas Terbuka - International Seminar of Science and Technology for the opportunity to present

Conflict of interest

The authors declare that they have no conflicts of interest, known competing financial interests, or personal relationships that could have influenced the work reported in this paper.

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