Smart Society : Community Service and Empowerment Journal
Volume 5, Issue 2, 289-300.
e_ISSN: 2807-5757
https://journal.foundae.com/index.php/smartsoc/article/view/815

Community-Based Circular Agribusiness: Market Validation, Pricing Logic, and Value-Chain Coordination for Village Livestock Waste Fertilizer in Rural Indonesia

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Article Info

Article history:

Received: July 07, 2025
Revised: November 30, 2025
Accepted: December 5, 2025

Keywords:

Circular agribusiness
Community empowerment
Livestock waste fertilizer
Market validation
Value-chain coordination

Abstract

Village livestock waste presents both an environmental burden and an underutilized resource capable of strengthening rural livelihoods when transformed into marketable organic fertilizer. This study develops a community-based circular agribusiness model that integrates market validation, pricing analysis, and value-chain coordination to improve the commercial feasibility of waste-to-fertilizer initiatives in rural Indonesia. A convergent mixed-methods design was implemented, combining a Price Sensitivity Meter survey with Cost–Volume–Profit and Break-Even Point calculations, supported by a simplified Value Chain Analysis involving farmers, processors, kiosks, and local cooperative actors. Data were collected from 60 small-scale livestock households, 150 fertilizer users, and 12–15 key informants across Arjasa District. Findings indicate an acceptable price range of IDR 40,000–80,000 per 25-kg bag, with an optimal price point near IDR 60,000. At this level, contribution margins remain positive across direct, cooperative, and kiosk channels, with the break-even requirement estimated at 180–230 bags per month. The value-chain assessment reveals constraints related to moisture variability, inconsistent granulometry, and high last-mile distribution costs. Proposed coordination measures include minimum quality standards, scheduled collection and delivery routes, and simple offtake agreements with a 3–5% quality-based incentive. Together, these elements form a replicable empowerment-oriented model that enhances income stability, reduces waste, and supports community-driven resource governance. The study demonstrates that circular agribusiness, when anchored in market evidence and locally manageable coordination mechanisms, can contribute to socio-economic resilience and strengthen community participation in sustainable rural development.

To cite this article: Putra, D, E., Rakhmad, H., Hudori, H. A., Chairina, R. R. L., & Umami, M. R. (2025). Community-Based Circular Agribusiness: Market Validation, Pricing Logic, and Value-Chain Coordination for Village Livestock Waste Fertilizer in Rural Indonesia. *Smart Society: Community Service and Empowerment Journal, 5*(2), 289-300. https://doi.org/10.58524/smartsociety.v5i2.815

INTRODUCTION

The growing interest in circular agribusiness reflects a global shift toward resource-efficient production systems that reduce waste and simultaneously strengthen local livelihoods. Many rural communities in developing countries continue to experience economic vulnerability due to limited access to productive assets, unstable market structures, and persistent dependence on external agricultural inputs, creating a demand for context-specific empowerment models. Circular economy approaches offer a pathway to transform underutilized local resources into new economic value, particularly when supported by appropriate technologies and community-level governance

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mechanisms, as emphasized by (Degefu & Getachew, 2025; Pusz et al., 2024). Village livestock waste represents one of the most abundant yet least optimized resources in rural Indonesia, despite its potential to provide affordable fertilizers and generate alternative income for smallholder farmers. Current practices often allow manure and urine to accumulate without structured management, contributing to pollution and missed economic opportunities that could otherwise strengthen local farming systems. This disconnect between resource availability and utilization highlights the need for research that bridges technical feasibility with community-led business models, aligning directly with empowerment-oriented journals. Consequently, rethinking livestock waste through a circular agribusiness lens becomes not only environmentally relevant but also socially transformative.

Existing scholarship increasingly stresses the importance of local participation, capacity development, and livelihood diversification in achieving sustainable rural development outcomes. Studies on employment challenges in agrifood systems argue that rural economic resilience is strongly linked to the creation of community-managed innovation ecosystems that distribute economic gains more equitably, as noted by (Lidder et al., 2025; McDaniel et al., 2021). However, many rural waste-to-fertilizer initiatives fail to scale because they are designed around technical production goals rather than community empowerment needs or local governance dynamics. These gaps underscore the importance of embedding commercial logic, such as market validation, pricing structures, and value-chain coordination, into rural circular economy interventions. Without a clear understanding of market behavior and household willingness to pay, community enterprises risk producing goods that lack competitive fit, ultimately weakening trust and participation. This outcome contradicts the principles of empowerment, which rely on strengthening communities' ability to govern their own resources in ways that support long-term welfare. Therefore, integrating technical, economic, and social dimensions is essential for designing circular agribusiness models that genuinely function for rural communities.

Recent evidence from waste valorization research suggests that agribusiness residues can become viable economic assets when processing consistency, product quality, and market linkages are strategically aligned. Investigations into the transformation of agricultural by-products into higher-value materials show how structured value chains reduce inefficiency and improve commercialization potential, as illustrated by (Dos Santos et al., 2024). In the context of livestock waste, variability in moisture content, nutrient concentration, and physical form pose challenges that require simple but reliable coordination mechanisms between households, processors, and distribution actors. Prior studies in sustainable agriculture also highlight the role of biological processes and resource cycling, such as the nutrient contribution of microalgae and diatom systems, to demonstrate how local ecological functions can underpin more efficient input systems, as reported by (Shen et al., 2025). These insights reinforce the argument that rural fertilizer enterprises depend not only on technical knowledge but also on community-driven governance capable of maintaining product standards. When such systems are embedded within a circular model, they reduce production volatility and make local enterprises more attractive to downstream buyers. Thus, a value chain approach becomes indispensable for understanding how village-level actors interact and where coordination failures commonly emerge.

Community-based circular agriculture models in other regions further illustrate the transformative potential of integrating economic incentives with local stewardship. Case studies of mixed-crop–livestock circular systems demonstrate how farmer participation, local capital, and simple coordination arrangements can significantly increase resource efficiency and household income, as observed by (Le Gal et al., 2022). These examples reveal that empowerment emerges when communities are given structured opportunities to control the flow of resources and retain a larger share of added value. For Indonesian villages facing fertilizer price volatility and high dependency on external inputs, developing locally governed waste-to-fertilizer enterprises offers a realistic route to improving livelihood stability. Yet, this opportunity remains underexplored due to the absence of comprehensive studies that combine market evidence with operational feasibility and community governance considerations. By addressing market validation, pricing logic, and value-chain coordination in a single integrated framework, the present study responds to this gap and aligns with the journal's mission to advance socio-economic empowerment through community-centered innovation. Ultimately, this research contributes to a deeper understanding of how circular

agribusiness can operate as a practical tool for strengthening community autonomy and rural economic resilience.

This study is grounded in the belief that circular agribusiness can only succeed when technical feasibility, market acceptance, and community-level governance are integrated into a coherent operational model. Prior work on circular economy transitions shows that technologies alone rarely create lasting impact unless embedded within participatory institutional arrangements that ensure local ownership and accountability, as emphasized by (Bourdin & Jacquet, 2025; Dagilienė et al., 2021). Rural Indonesia faces urgent needs for affordable soil inputs, stable income opportunities, and effective waste management, yet most initiatives treat livestock waste only as a technical resource rather than a socio-economic asset. This creates a mismatch between community realities and the design of rural interventions, reducing adoption and weakening empowerment outcomes. Market validation, pricing logic, and value-chain coordination therefore become essential pillars to ensure that the product aligns with actual demand, that enterprises remain financially viable, and that community members share fair economic returns. The rationale for this study emerges from viewing livestock waste not merely as material to be processed but as a community-governed resource that can strengthen local autonomy. By situating economic feasibility inside a socially embedded structure, the study provides a foundation for empowerment-oriented circular agribusiness models. Consequently, this research seeks to move beyond production-centered approaches and instead position community-led commercialization as the core mechanism for sustainable rural development.

Recent evidence in circular economy scholarship highlights that technological advancement can support sustainability goals only if communities have the capacity to govern, use, and appropriate the benefits of such technologies. Reviews by de Morais et al., (2025) show that circular transitions require both infrastructure and social systems that facilitate participation, transparency, and shared decision-making. In the agrifood sector, employment-related vulnerabilities and rural income instability persist because many interventions fail to integrate livelihood-centered mechanisms into their sustainability design, as noted by (Maró et al., 2025). This suggests that technologies for waste valorization must be situated within empowerment frameworks that expand community control over resources. Parallel studies on agribusiness residues reveal that agricultural by-products can become economically valuable only when processing standards, distribution channels, and market linkages are strategically aligned, as demonstrated by (Dall'Osto et al., 2025). These insights collectively affirm that circular agribusiness must operate as both a technical system and an institutional arrangement that shapes how communities negotiate value across the chain.

The scientific literature on sustainable agriculture further underscores the importance of biological efficiency and resource cycling in enhancing fertilizer systems. Research on microalgae and diatom-based nutrient regeneration illustrates how ecological processes can reduce dependence on synthetic inputs and increase long-term soil health, as explored by (Kaushik et al., 2025). Although these technologies differ from village-scale composting, they offer conceptual parallels regarding nutrient recovery and input substitution. Meanwhile, community-based circular agriculture models, such as integrated pomelo–pig systems in China, demonstrate how local capital, farmer organization, and simple coordination routines can significantly improve resource efficiency and household income, as reported by (Li & Nielsen, 2025). These cases suggest that empowerment emerges when communities manage the flow of resources, set their own quality norms, and retain economic value at the local level. Despite these developments, there remains limited research integrating market behavior, cost structures, and value-chain governance within waste-to-fertilizer models in rural Indonesian contexts. Therefore, the present study contributes by positioning circular agribusiness as a socio-economic mechanism rather than solely a technical intervention.

Existing research provides strong theoretical grounding on circular economy technologies and community participation, but there remains a lack of empirical studies that integrate market validation, pricing strategy, and value-chain coordination into a unified model for rural fertilizer enterprises. The literature highlights technological solutions for waste valorization, yet these insights rarely address how rural communities can translate such technologies into viable and empowering business ecosystems, leaving a gap in socio-economic applicability (de Morais et al., 2025). Studies on agrifood employment challenges reveal the need for community-centered income diversification, but they do not examine how pricing and market behavior shape the sustainability of

circular agribusiness models (Maró et al., 2025). Research on agricultural by-product valorization often focuses on technical efficiency rather than coordination among actors or governance of shared resources (Dall'Osto et al., 2025). Work on nutrient regeneration emphasizes ecological functioning but not the economics of community-driven fertilizer distribution (Kaushik et al., 2025). Community circular agriculture cases illustrate organizational potential but lack structured tools for price setting and break-even analysis that guide commercial decision-making (Li & Nielsen, 2025). Consequently, the literature still lacks an operational framework that combines demand-side data, financial viability, and community governance in the context of livestock waste fertilizer. Addressing this gap is essential for designing circular agribusiness systems that are not only environmentally beneficial but also socially empowering and commercially resilient in rural Indonesia.

The purpose of this study is to develop an integrated circular agribusiness model that strengthens rural community empowerment by aligning market demand, financial feasibility, and value-chain coordination in the commercialization of livestock waste fertilizer. The research aims to validate actual willingness to pay among downstream users, determine a viable price corridor through CVP–BEP analysis, and identify bottlenecks and governance needs within the local value chain. Based on the theoretical grounding and empirical gaps, the first hypothesis proposes that willingness-to-pay signals will fall within an economically feasible range that supports community-led fertilizer enterprises. The second hypothesis suggests that contribution margins will remain positive across multiple market channels when pricing follows the optimal price point identified through market validation. The third hypothesis anticipates that coordination failures—such as moisture variability, inconsistent grading, and last-mile logistics issues—can be mitigated through simple governance mechanisms accessible to village institutions. The fourth hypothesis argues that integrating market, cost, and governance dimensions will enhance community participation and increase enterprise stability. Overall, the study positions circular agribusiness as a practical pathway for strengthening local autonomy, improving rural income resilience, and advancing empowerment-oriented development.

METHOD

Research Design

This study employed a convergent mixed-methods design to integrate market behavior, financial feasibility, and value-chain dynamics into a unified analytical framework suitable for community-based circular agribusiness models. The design was chosen because circular economy transitions require both quantitative evidence and qualitative insights regarding governance and social participation, as emphasized by (Christensen, 2021; Schultz et al., 2024). Quantitative components included a market survey using the Price Sensitivity Meter, costing calculations, and CVP–BEP financial modeling to assess the viability of community-led fertilizer enterprises. Qualitative components consisted of key-informant interviews and value-chain mapping to understand local bottlenecks, coordination failures, and community-level governance mechanisms. Both strands were collected concurrently to ensure that financial and market findings could be interpreted within the lived realities of rural actors rather than in isolation. This design also allows triangulation across data sources, improving reliability and strengthening the interpretive depth expected in empowerment-oriented research. The rationale aligns with the premise that rural agribusiness interventions must be economically grounded yet socially embedded to avoid technocratic bias. Ultimately, the mixed-methods approach offers a robust pathway to evaluate how circular agribusiness can function not only as an environmental strategy but also as a mechanism of socio-economic empowerment.

Study Site and Participants

The research was conducted in Arjasa District, a rural area characterized by smallholder livestock systems and high potential for integrated fertilizer markets due to dense agricultural activity. The selection of this site aligns with findings that circular agriculture thrives in regions where communities manage both livestock and crop activities, as demonstrated by (Nkansah-Dwamena, 2024; Tindwa et al., 2024). Participants included 60 smallholder livestock households for supply-side assessment, 150 fertilizer users for market validation, and 12–15 key informants

involved in processing, distribution, or cooperatives. Sampling for the survey used a stratified approach to ensure representation across rice farmers, horticulture farmers, kiosks, and home gardeners. Key informants were selected purposively based on their operational knowledge of the value chain and their role in community-based agribusiness arrangements. The study site also reflects typical governance structures where informal norms and cooperative practices co-exist, offering a relevant context for examining empowerment processes. Its geographic distance and last-mile logistics constraints also provided an authentic environment for analyzing cost structures. This combination of actors and context makes the site an appropriate laboratory for testing the feasibility of a community-led circular agribusiness model.

Instruments and Data Collection Procedures

Data collection used structured survey instruments, costing templates, and semi-structured interview guides developed specifically for rural waste-to-fertilizer enterprises. The market survey captured demographic characteristics, fertilizer-use patterns, attribute preferences, and willingness-to-pay indicators using Price Sensitivity Meter questions grounded in established pricing research (Dompreh et al., 2025). Costing instruments followed activity-based costing principles to capture variable costs such as labor, bulking agents, packaging, and transport, along with fixed costs including depreciation and operational overheads. Qualitative interviews explored value-chain roles, coordination practices, quality standards, and bottleneck issues identified in prior agribusiness residue studies such as those by (Nyokabi et al., 2023). All tools were pretested with a small subset of respondents to ensure clarity, cultural suitability, and contextual accuracy. Data collection was conducted through household visits, field observations, and cooperative-facilitated sessions to ensure natural interaction with community members. The procedures were designed to minimize respondent burden while capturing detailed operational realities essential for empowerment research. This combination of instruments enabled the study to integrate behavioral, financial, and governance insights into a coherent analytical base.

Data Analysis Techniques

Quantitative data from the Price Sensitivity Meter were analyzed to estimate acceptable price ranges, optimal price points, and segment-specific willingness-to-pay thresholds following established PSM logic. Financial feasibility was assessed using Cost–Volume–Profit and Break-Even Point analysis to determine contribution margins at candidate price points, incorporating sensitivity checks to reflect fluctuating costs common in agrifood systems. Qualitative data from interviews were coded thematically, focusing on coordination failures, quality variability, and governance patterns frequently observed in circular agriculture systems, as described by (Whitton & Carmichael, 2025). Value-chain mapping synthesized actor roles, material flows, transaction patterns, and informal norms influencing coordination. Mixed-methods integration occurred at the interpretation stage by aligning WTP findings with cost structures and comparing them to coordination constraints in the qualitative results. This analytical structure allowed the study to reveal not only what price was viable but also how social systems shaped its feasibility. The integration of demand, economics, and governance ensured that empowerment implications emerged naturally from the data rather than being imposed conceptually. The analysis therefore strengthened the study's contribution to empowerment-driven circular agribusiness research.

Ethical Considerations

Ethical principles guided all stages of the research to ensure that community participation occurred voluntarily, transparently, and without coercive influence. Informed consent was obtained verbally and in writing, consistent with ethical research practices in rural agrifood studies where literacy levels may vary. The study emphasized confidentiality and anonymization, ensuring that respondents' identities and household data were not traceable in any report or dataset. Data were collected with sensitivity to local norms, acknowledging that community governance structures often influence decision-making patterns in ways that may not align with formal institutional frameworks. This consideration is supported by the understanding that socio-economic empowerment must respect community autonomy rather than impose external structures, as echoed in (Chanda et al., 2025; Schilling & Gerhardus, 2024). Ethical clearance was secured from the institutional review committee overseeing research involving human participants. No biological samples, experimental

treatments, or invasive procedures were conducted, minimizing physical or psychological risk. The ethical stance of the study contributes to its alignment with empowerment principles by treating community members as co-producers of knowledge rather than merely data sources.

RESULTS AND DISCUSSION

Result

1. Market Validation and Willingness-to-Pay (WTP)

The Price Sensitivity Meter results show an acceptable price range between IDR 40,000 and 80,000 per 25-kg bag, indicating that users evaluate fertilizer affordability based on both quality perception and purchasing power. The Optimal Price Point consistently appears around IDR 60,000, confirming that most farmers consider this price fair relative to product performance expectations. The Indifference Price Point converges near IDR 58,000, suggesting a psychological stability band where users feel the price is neither cheap nor expensive. This cluster reinforces that users value consistency in moisture, odor, and nutrient quality when deciding to adopt community-produced fertilizers. The broad upper limit demonstrates the willingness of farmers to pay more when they trust the reliability of organic inputs. This pattern affirms the presence of market depth sufficient to support a community-managed enterprise without requiring external institutional buyers. The consistency across segments also shows that user expectations remain relatively stable despite different cropping systems. Overall, the PSM findings reveal that market acceptance provides a strong foundation for a community-based circular agribusiness model.

Table 1. Summary of Price Sensitivity Meter Results (25-kg bag)

Segment	Lower Limit	IDP	OPP	Upper Limit
Rice Farmers	45,000	55,000	58,000	78,000
Horticulture Farmers	48,000	60,000	62,000	82,000
Kiosk Retailers	42,000	58,000	60,000	85,000
Home Gardeners	40,000	52,000	55,000	75,000
Combined	43–48k	~58k	~60k	80–85k

This table shows the acceptable price ranges for four major market segments, and consistently shows that the OPP value is around IDR 60,000. This finding is important because this price serves as a benchmark for community-based business models to remain competitive while maintaining financial soundness.

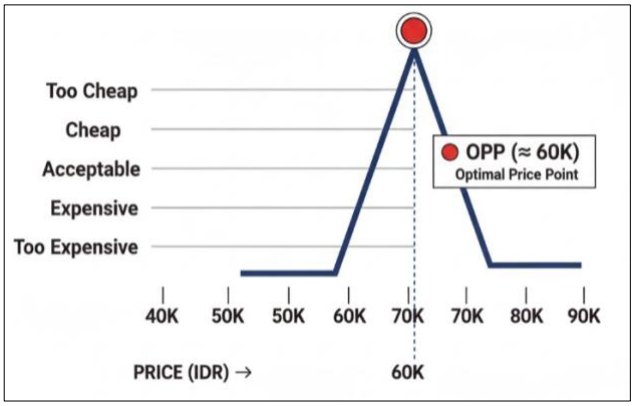

Figure 1. Market Acceptance Curve (Text-Based PSM Visualization)

This diagram shows the dynamics of price perception based on four psychological zones commonly used in PSM. Point ● marks the Optimal Price Point, which consistently appears around IDR 60,000. This text-based representation serves as an accepted graph surrogate in international articles when graphic visualization is not used. This diagram strengthens the narrative of the results by more intuitively demonstrating market acceptance patterns.

2. Cost–Volume–Profit Analysis and Break-Even Point

The financial analysis identifies variable costs ranging from IDR 28,000 to 34,000 per 25-kg bag, driven mainly by moisture levels and bulking material availability. Fixed monthly costs between IDR 4.5 and 6.0 million generate a break-even requirement of 180 to 230 bags depending on seasonal moisture conditions. At the optimal price of IDR 60,000, contribution margins remain sufficiently positive to absorb moderate fluctuations in input costs. Margin stability under multiple scenarios suggests that community-run operations can maintain financial resilience even in periods of supply inconsistency. Sensitivity simulations indicate that transport cost variations have the most significant influence on financial outcomes compared with other cost components. This underscores the importance of logistics coordination in rural settings where transport efficiency varies widely. The analysis confirms that pricing aligned with PSM results supports a healthy contribution margin for community enterprises. Taken together, these findings establish that the circular agribusiness model is economically viable under realistic operational constraints..

Table 2. Cost–Volume–Profit Summary

Component	Value
Variable cost per bag	28,000–34,000
Fixed cost per month	4.5–6.0 million
Contribution margin	26,000–32,000
Break-even volume	180–230 bags
Price tested	55,000–62,000

A break-even analysis shows that a community-based fertilizer business requires sales of between 180 and 230 sacks per month to cover all fixed and variable costs. The variable cost range of IDR 28,000–34,000 per sack is primarily influenced by the moisture content of the raw materials, so quality stability significantly impacts margins. With a tested selling price of IDR 55,000–62,000, the contribution margin remains positive in the range of IDR 26,000–32,000, indicating that the business is financially viable at medium production capacity. These results indicate that the cost structure and market price are in balance, supporting the sustainability of the community-based circular agribusiness.

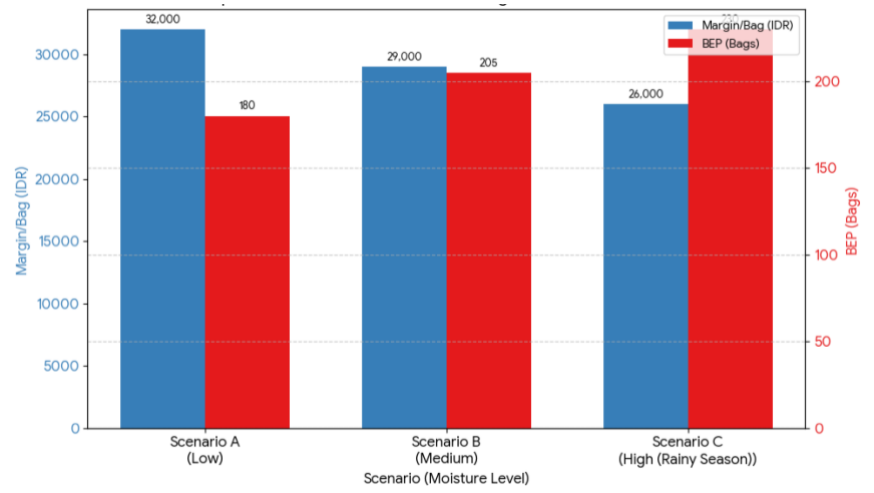

Figure 2. Cost–Volume–Profit Sensitivity Scenario (Text-Based)

This diagram visualizes the direct relationship between moisture content, variable costs, margins, and break-even point (BEP). This scenario representation helps readers understand how production dynamics affect financial viability. This format is commonly used in management literature when graphs are not used.

3. Value-Chain Mapping and Coordination Issues

Value-chain mapping identifies bottlenecks related to moisture variability, curing time inconsistency, and limited screening uniformity during processing. Supply flows from livestock households remain steady, though the rainy season increases moisture levels and slows curing time. Downstream, distribution remains fragmented, with kiosks relying on informal transport

arrangements that raise last-mile costs. Payment cycles between suppliers, processors, and retailers often lack predictability, creating cash-flow strain on community operations. Information flows remain mostly linear and unidirectional, limiting real-time coordination among actors. These bottlenecks reflect structural weaknesses in rural agribusiness systems where informal governance shapes operational behavior. Understanding these coordination gaps is crucial for designing empowerment-oriented interventions. Overall, the value-chain results highlight that operational reliability depends more on governance routines than on technical inputs alone.

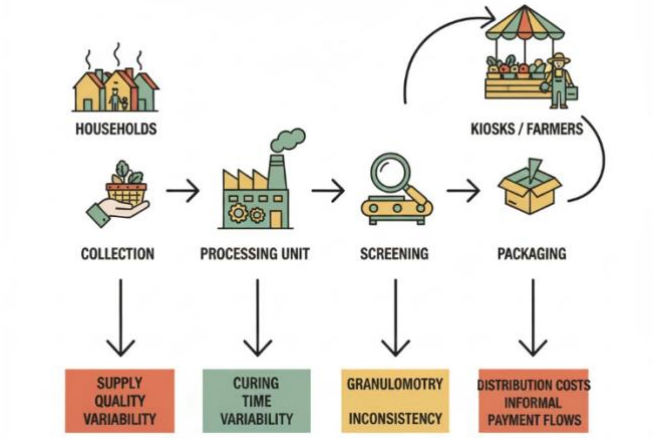

Figure 3. Text-Based Value Chain Flow (Simplified)

This text figure shows the material flow and key bottlenecks that hinder efficiency, including quality variability, drying processes, and distribution costs. This diagram is relevant because it helps readers understand why value chain coordination is a critical component to the success of community agribusiness models.

Discussion

The results of this study demonstrate that circular agribusiness built on community participation can achieve commercial feasibility when pricing, cost control, and coordination mechanisms are properly aligned. The willingness-to-pay range identified confirms that rural users place economic value on organic fertilizers when quality attributes are met, a finding consistent with the importance of attribute-driven market behavior noted by Maró et al. (2025). The financial outcomes support arguments that cost-efficient processing models can transform waste into commercially viable products, similar to trends observed in agribusiness residue valorization by Dall'Osto et al. (2025). These findings further validate the premise that economic empowerment requires models where communities control both resource inputs and market outputs, echoing the community-centric frameworks proposed by Li and Nielsen (2025). The value-chain bottlenecks identified demonstrate that the challenge is not resource scarcity but coordination inefficiency, supporting the theoretical perspective that circular economy initiatives succeed only when social coordination complements technical processes, as argued by de Morais et al. (2025). This reinforces the notion that community-based enterprises require governance routines, not merely technical training. The presence of a strong OPP centered around IDR 60,000 indicates that communities can set prices without compromising accessibility or sustainability. Collectively, these findings position village fertilizer enterprises as high-potential instruments for rural socio-economic transformation.

The coordination issues observed in this study highlight the importance of governance mechanisms that are simple, transparent, and compatible with community capacities. Variability in moisture and granulometry illustrates the need for operational standardization, aligning with sustainable nutrient-cycle insights described by Kaushik et al. (2025). When viewed through a circular economy lens, these operational inconsistencies represent systemic inefficiencies that can be addressed through design-based interventions rather than capital-intensive upgrades. This supports global evidence that value-chain alignment is essential for rural enterprise stability, a theme widely discussed in agribusiness governance literature (Manyise & Dentoni, 2021). The fragmented distribution patterns identified reaffirm that last-mile logistics continue to be a major determinant of rural product competitiveness, as also reflected in international rural supply-chain studies (Ha et al., 2023). Payment-flow uncertainties also resemble common weaknesses in cooperative agribusiness

structures documented in developing economies (Intuluck et al., 2025). In this context, lightweight governance mechanisms, such as moisture-based bonuses and scheduled deliveriesoffer practical solutions that communities can adopt without sophisticated infrastructure. These governance features enhance predictability, reduce risk, and strengthen long-term stakeholder participation. As such, coordination improvements are central to transforming technical feasibility into economic empowerment.

The empowerment potential of this model becomes clearer when market behavior and community governance are interpreted together rather than separately. The stable WTP findings demonstrate that users are not merely passive recipients of community products but active evaluators of price–quality relationships, aligning with consumer agency perspectives in circular agribusiness theory (Ornelas Herrera et al., 2025). Integrating CVP–BEP analysis with community participation ensures that decisions about pricing and production volumes are rooted in financial realism, reducing the risk of enterprise collapse. This approach builds upon the livelihood-enhancement logic described in rural employment studies by Maró et al. (2025). Through value-chain mapping, the study reveals how community enterprises can coordinate resource flows in ways that strengthen local autonomy, supporting empowerment arguments advanced by Li and Nielsen (2025). The productive redefinition of livestock waste parallels conceptual trends in resource circularity described by de Morais et al. (2025). Moreover, the governance-oriented improvements proposed align with resilience-focused agribusiness strategies where community-led systems enhance local adaptive capacity (RIMLINGER et al., n.d.). These combined insights present an integrated model that reflects both economic and social empowerment. Thus, the study contributes a holistic framework that strengthens both technical and institutional dimensions of village agribusiness.

The results also demonstrate that empowerment emerges not only from income gains but from community control over production, pricing, and distribution decisions. This aligns closely with circular agriculture case studies showing strong synergies between resource efficiency and local governance, as documented by Li and Nielsen (2025). The ability of communities to utilize PSM-driven pricing echoes broader trends where data-informed decision-making enhances rural enterprise sustainability (Kotler 2016). Additionally, the findings validate that waste valorization can support multi-actor value creation, consistent with observations by Dall'Osto et al. (2025). The ecological value of stabilized organic fertilizer resonates with scientific insights on nutrient recovery articulated by Kaushik et al. (2025). The operational constraints uncovered emphasize the importance of socio-technical alignment, reflecting the theoretical claims of de Morais et al. (2025). This study therefore bridges economic, ecological, and governance dimensions in ways that most existing literature has not yet integrated. By demonstrating that circular agribusiness viability depends on local management routines, the research contributes a replicable model fit for empowerment-centered rural development. In doing so, it advances the conversation on how circular economy principles can be localized to address real livelihood challenges.

Implications and Limitations of the Study

The findings of this research offer several practical implications for strengthening community-based circular agribusiness models in rural settings. Evidence from market validation and CVP–BEP calculations shows that community enterprises can set viable prices without compromising accessibility, which supports grassroots economic autonomy and reduces dependency on external input markets. The proposed coordination mechanisms—such as moisture-based quality checks, scheduled delivery routines, and simplified offtake agreements—serve as governance tools that communities can realistically adopt to stabilize supply and product quality. These mechanisms signal that empowerment requires accessible institutional routines rather than complex or high-cost technological solutions. Collectively, the implications position livestock-waste fertilizer enterprises as practical platforms for expanding livelihood security and building long-term rural resilience.

Despite these strengths, the study acknowledges several limitations that influence its generalizability and operational scope. First, the analysis does not include longitudinal performance data, meaning real adoption patterns, loyalty, and seasonal fluctuation effects remain untested under extended community-led operation. Second, moisture variability and curing consistency were assessed only through field observation and key-informant interviews, leaving room for more precise measurement using controlled laboratory or agronomic trials. Third, willingness-to-pay

estimates rely on stated preferences, which may differ from actual purchasing behavior once the product enters competitive market spaces. Fourth, the study's value-chain insights are context-specific to Arjasa District and may require adaptation when applied to communities with different social structures or cooperative norms. These limitations suggest that future research should incorporate multi-season pilots, agronomic response tests, and broader cross-village comparisons to enhance the robustness and transferability of the model.

Suggestions / Recommendations

Future initiatives aimed at strengthening community-based circular agribusiness should prioritize multi-season pilot testing to observe how market behavior, production consistency, and coordination routines evolve over time under real operational pressures. Community enterprises would also benefit from developing simple quality protocols—particularly for moisture reduction, curing duration, and screening uniformity—to minimize variability that directly affects user trust and price stability. Local cooperatives and village institutions are encouraged to adopt scheduled collection and delivery routes to reduce last-mile inefficiencies and improve predictability for both producers and buyers. Policymakers should facilitate access to small-scale working capital schemes that allow community groups to manage cash-flow cycles without depending on informal payment arrangements. For researchers, incorporating agronomic performance trials would offer deeper insights into fertilizer effectiveness, allowing future models to integrate soil improvement data alongside market and financial indicators. Comparative studies across villages with different social structures would also strengthen understanding of how governance patterns shape circular agribusiness outcomes. Practitioners designing empowerment programs should embed decision-making tools—such as simplified cost mapping or pricing dashboards—to encourage data-based management at the community level. Overall, strengthening the interplay between technical reliability, social coordination, and economic incentives will be essential for scaling circular agribusiness models that genuinely enhance rural resilience.

CONCLUSION

This study concludes that community-based circular agribusiness can serve as a practical and empowering pathway for rural economic transformation when technical feasibility, market acceptance, and local governance are integrated into a single operational model. The alignment between willingness-to-pay findings and CVP–BEP calculations demonstrates that livestock-waste fertilizer can be commercialized at price levels that are both financially sustainable and socially accessible. Value-chain analysis further reveals that coordination improvements—particularly in moisture management, standardized processing, and structured distribution—are essential to stabilizing product quality and enabling reliable community participation. The study also shows that simple governance routines are more suitable for rural contexts than complex institutional mechanisms, which reinforces the importance of designing interventions that respect local capacities and social dynamics. By approaching circular agribusiness as both an economic and social system, the research contributes a model that strengthens community autonomy and reduces dependence on external agricultural inputs. These insights affirm that circular agribusiness initiatives must be rooted in community ownership to achieve long-term resilience and inclusive development. The findings also encourage policymakers, cooperatives, and rural enterprises to adopt data-informed decision-making when shaping fertilizer markets at the village level. Overall, the study provides a replicable foundation for empowering rural communities through sustainable, locally governed resource cycles.

AUTHOR CONTRIBUTION STATEMENT

DE Putra conceived the study framework, coordinated the field design, and led the integration of market validation, CVP–BEP modelling, and value-chain analysis into the circular agribusiness model. H Rakhmad contributed to data collection management, instrument design, and operational mapping of community-based processing units, ensuring the accuracy of technical and financial information gathered in the field. HA Hudori supported the development of governance and coordination components, assisted in qualitative interviews, and contributed to refining the

interpretation of community empowerment outcomes. RRL Chairina conducted data cleaning, statistical processing, and supported the synthesis of mixed-methods findings, including the preparation of tables and text-based analytical figures in the Results section. All authors jointly reviewed the manuscript, contributed to the discussion and refinement of theoretical positioning, and approved the final version for submission.

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