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EDITED BY

Francesco Bozzo,
University of Bari Aldo Moro, Italy

REVIEWED BY

Caterina Contini,
University of Florence, Italy
Antonio Seccia,
Policlinico Riuniti, Italy

*CORRESPONDENCE

I Made Supartha Utama
✉ supartha_utama@unud.ac.id

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From farm to HORECA: advancing sustainable value chains for tourism-driven agribusiness in Indonesia

I Made Supartha Utama^{1*}, I Wayan Widia¹,
I Gusti Ketut Arya Arthawan¹, Jeremy Badgery Parker²,
Nyoman Ngurah Arya³, Bambang Sayaka³, Sri Widyastuti⁴,
Dahlanuddin⁵, Gregoria S. Suhartati Djarkasi⁶,
Maria Fransisca Sumual⁶ and Andreas Leonardo Sumendap⁶

¹Department of Agricultural Engineering and Biosystem, Faculty of Agricultural Technology, The University of Udayana, Denpasar, Indonesia, ²Centre for Global Food and Resources, The University of Adelaide, Adelaide, SA, Australia, ³National Research and Innovation Agency of Indonesia, Jakarta, Indonesia, ⁴Department of Food Science, Faculty of Food Technology and Agroindustry, The University of Mataram, Mataram, Indonesia, ⁵Department of Animal Nutrition, Faculty of Animal Science, The University of Mataram, Mataram, Indonesia, ⁶Department of Agricultural Technology, Faculty of Agriculture, The University of Sam Ratulangi, Manado, Indonesia

Agri-food value chains in Indonesia's tourism economies offer strategic opportunities for inclusive rural-urban linkages but remain hindered by persistent constraints in finance, logistics, and digital innovation. This study investigates the conditions that enable or constrain sustainable, inclusive, and efficient farm-to-HORECA (Hotels, Restaurants, and Catering) value chains across three provinces in Indonesia—Bali, Lombok-West Nusa Tenggara (WNT), and North Sulawesi—using a mixed-methods design comprising structured surveys ($n = 370$), in-depth interviews ($n = 60$), and participatory workshops. Results reveal critical bottlenecks: 91.1% of farmers rely on personal savings, only 16.9% of in-chain actors adopted new technologies in the past 5 years, and formal collaboration remains extremely limited. HORECA actors demonstrate operational resilience and support inclusive principles, yet upstream engagement is weak and perceptions of regulatory benefit are low across sectors (farmers 13.3%, in-chain 8.5%). Nonetheless, significant correlations were found between inclusivity, organizational innovation ($r \geq 0.6$), and perceptions of regional development. These findings underscore the need for integrated interventions—combining localized policy support, financial inclusion tools, digital platforms, and cooperative governance models—to strengthen value chain connectivity and performance. By identifying leverage points across farm, midstream, and market segments, this study contributes to the literature on inclusive agri-food systems and offers actionable insights for achieving SDGs 2 (Zero Hunger), 12 (Responsible Consumption and Production), and 17 (Partnerships for the Goals) in middle-income, tourism-dependent economies.

KEYWORDS

sustainable value chains, agri-food systems, tourism economies, SDGs, digital agriculture, innovation diffusion

1 Introduction

The transformation of agri-food systems has become a global imperative, as these systems are increasingly recognized both as contributors to and potential solutions for challenges related to poverty, inequality, malnutrition, and climate change (Nguyen et al., 2020; HLPE, 2020). International frameworks, such as the UN Food Systems Summit (UNFSS, 2021) and the Sustainable Development Goals (SDGs), emphasize the importance of building sustainable, inclusive, and resilient food value chains that support smallholder livelihoods while minimizing environmental harm (Mangnus et al., 2019; FAO et al., 2023). A key emerging priority is the integration of small-scale producers into higher-value markets through enhanced connectivity, digitalization, and governance reforms (Reardon et al., 2015; Barrett et al., 2022).

Tourism-driven economies in the Global South present a distinctive context for evaluating inclusive agri-food strategies, particularly through the HORECA sector (Hotels, Restaurants, and Catering), which is exhibiting a growing demand for locally sourced, traceable, and high-quality agricultural products (Nedumaran et al., 2020; Amin, 2020). In Indonesia, tourism constitutes a substantial share of GDP and employment, creating significant potential to enhance rural–urban market linkages. Nonetheless, agricultural value chains remain largely fragmented and informal, hindered by systemic constraints such as inadequate logistics, insufficient cold chain infrastructure, high price volatility, and limited bargaining power among producers (Dwiartama et al., 2023). Additionally, the spatial disconnect between rural production areas and urban consumption centers exacerbates coordination costs, further impeding effective value chain integration (Huang, 2023).

Simultaneously, digital tools and inclusive business models are increasingly advocated as mechanisms to enhance coordination, transparency, and market access across food systems (Xie et al., 2025). Technological innovations—such as blockchain-enabled traceability, e-commerce platforms, and fintech-based agricultural financing—demonstrate potential to reduce transaction costs and promote inclusivity within value chains (Ros-Tonen et al., 2018; Suri and Jack, 2016). However, the effectiveness of these interventions is contingent upon institutional preparedness, capacity development, and supportive regulatory frameworks. In the Indonesian context, where digital literacy and infrastructure exhibit considerable regional disparities, a nuanced understanding of adoption barriers and incentive structures is essential for the design and implementation of scalable, sustainable solutions (Wahida et al., 2022).

Despite increasing scholarly attention to food system transformation, existing literature remains largely fragmented—tending to analyse production, processing, or consumption in isolation (Devaux et al., 2018). There is a notable absence of integrated, value chain–level analyses that encompass actors across the farm, midstream (in-chain), and downstream (HORECA) segments, particularly within tourism-driven contexts. As Gereffi (2018) emphasizes, fostering inclusivity within global value chains necessitates a critical focus on power asymmetries and institutional dynamics—factors frequently neglected in disjointed food systems. This fragmentation contributes to a persistent knowledge gap

regarding the interactions among policies, business models, and technological innovations across the entire chain, and how these interactions can be leveraged to promote equitable livelihoods and food security (Nguyen et al., 2020; UNFSS, 2021).

To contribute to this evolving discourse, this study examines the enabling and constraining conditions for developing sustainable, inclusive, and efficient agri-food value chains within Indonesia's tourism-oriented economies. Employing a mixed-methods approach—including structured surveys, in-depth interviews, and participatory workshops—it investigates the farm, midstream (in-chain), and downstream (HORECA) segments across three key provinces: Bali, Lombok-West Nusa Tenggara (WNT), and North Sulawesi. The research aims to generate actionable insights for policymakers, agribusinesses, and civil society stakeholders seeking to enhance agri-food governance, foster digital adoption, and promote equitable access in tourism-driven supply chains. In doing so, it contributes to the broader agenda of sustainable food system transformation in middle-income contexts.

2 Methods

This study adopts a mixed-methods approach to investigate the sustainability, inclusivity, and efficiency of agri-food value chains in tourism-dependent regions of Indonesia. By combining quantitative and qualitative methodologies, this study offers a comprehensive analysis that bridges macro- and micro-level perspectives across the farm, in-chain, and Hotels, Restaurants, and Catering (HORECA) sectors.

- The quantitative component provides measurable insights into systemic dynamics such as resource constraints, logistical efficiency, innovation adoption, and market demand.
- The qualitative component, including in-depth interviews and participatory workshops, complements quantitative findings by capturing stakeholder perspectives and exploring contextual challenges and opportunities.

This dual approach ensures that the research accounts for both broad trends and localized complexities, contributing to a holistic understanding of agri-food value chains in diverse regional contexts.

2.1 Data collection

Structured surveys were conducted with 370 respondents, comprised of:

- 180 Farmers, focusing on resource availability, market access, and sustainability practices.
- 58 In-chain actors, including aggregators, processors, and distributors, assessing certification standards and logistical barriers.
- 132 HORECA operators, covering market demand, sourcing preferences, and compliance with sustainable practices.

Survey instruments were administered using the Kobo Toolbox digital platform, with enumerator support provided where digital access was limited. Surveys were conducted between June and November 2024, with stratification based on actor type, region, and gender.

Survey themes included:

- Resource constraints and availability.
- Supply chain logistics and efficiency.
- Adoption of sustainable practices and relevant technologies.
- Market demands, including certification and traceability compliance.

To deepen the analysis, 60 semi-structured interviews were conducted with:

- Farmer leaders representing local communities,
- Agribusiness intermediaries such as processors and traders,
- HORECA managers,
- Policymakers in agriculture and tourism sectors.

Additionally, six participatory stakeholders focus group discussions (FGDs) and workshops were organized, each comprising 10–15 participants. The FGDs and workshops aimed to:

- Identify localized challenges and opportunities,
- Explore cross-sector collaboration strategies,
- Capture regional insights into supply chain coordination and value chain integration.

All qualitative sessions were recorded, transcribed, and analyzed systematically.

2.2 Sampling strategy

To ensure robust representation across actor categories and regional contexts, the study employed a stratified sampling strategy, disaggregated by actor type (farmers, in-chain actors, and HORECA actors), province (Bali, Lombok–West Nusa Tenggara, and North Sulawesi), and gender.

The final dataset consists of 370 structured survey respondents, strategically distributed across the three provinces: Bali (128 respondents), Lombok–West Nusa Tenggara (121), and North Sulawesi (121). These participants were further categorized by actor type—Farmers (180), In-chain actors (58), and HORECA actors (132)—and by gender, with 254 male and 116 female respondents. As shown in [Table 1](#), this detailed stratification by actor group, province, and gender supports robust, disaggregated analysis across multiple dimensions.

The sampling frame was developed in collaboration with Extension Services from the Departments of Agriculture and Food Security and Departments of Tourism in each province. These institutional partnerships facilitated access to diverse stakeholder groups. A two-stage approach was used: initial lists were developed through institutional referral, and then snowball sampling was

TABLE 1 Respondent profile by gender, region, and sector.

Region	Sector	Male	Female	Total
Bali	Farmer	57	23	80
	In-Chain	13	9	22
	HORECA	24	20	44
Lombok-WNT	Farmer	36	11	47
	In-Chain	10	5	15
	HORECA	28	15	43
North Sulawesi	Farmer	42	11	53
	In-Chain	13	8	21
	HORECA	31	14	45

employed to reach additional participants, particularly in in-chain and HORECA segments where formal registries were less complete.

Surveys were administered using KoboToolbox, as introduced in Section 2.1. Specifically, data were collected through self-administered tablet-based questionnaires using the KoboCollect app. Trained field assistants were present during data collection to provide clarification as needed. This method enabled respondent autonomy, improved data reliability, and reduced interviewer bias.

This combined strategy ensured sectoral diversity, regional balance, and gender inclusivity—critical for capturing cross-sectional dynamics within the agri-food-tourism value chain.

2.3 Data analysis

Quantitative data were analyzed using SPSS v27 and Python v3.11. The analysis involved:

- Descriptive statistics to summarize trends in market engagement, logistics, innovation, and sustainability behavior.
- Pearson correlation analysis to explore associations between training, innovation adoption, profitability, and market access.
- *P*-values and confidence intervals were reported to validate the significance and precision of observed relationships.
- Stratified analyses were conducted by actor type, gender, and province.

Qualitative data from interviews and workshops were analyzed thematically using NVivo 14, combining inductive coding with theory-guided categorization. Analytical framing was based on:

- Inclusive Value Chain Theory, emphasizing governance and power dynamics.
- Innovation Diffusion Theory, examining adoption patterns of technologies and practices.

Themes were cross-validated by the research team and integrated with quantitative insights to capture both systemic trends and region-specific challenges.

2.4 Ethical considerations

All participants provided informed consent after being briefed on the study's objectives and their rights, including the option to withdraw at any time. Data were anonymized and securely stored to ensure confidentiality.

Ethics approval was obtained from the National Agency of Research and Innovation of Indonesia. To ensure equitable participation, respondents received incentive fees, covering transportation and food expenses, particularly beneficial in remote and rural areas.

2.5 Limitations

This study acknowledges several limitations:

- Regional focus: findings may not be generalizable to agri-food systems outside Indonesia.
- Self-Reported data: responses may be influenced by recall or social desirability bias.
- Logistical barriers: geographical dispersion posed challenges for workshop coordination and consistent attendance.

Nonetheless, the integration of multiple data sources, use of validated tools, and alignment with theoretical frameworks strengthen the reliability and relevance of the findings.

2.6 Alignment with the sustainable development goals (SDGs)

This research directly addresses the following SDGs:

- SDG 2 (Zero Hunger): identifying barriers and opportunities to enhance agrifood systems and improve food security.
- SDG 12 (Responsible consumption and production): promote sustainable practices throughout the value chain.
- SDG 17 (Partnerships for the goals): by fostering multi-stakeholder collaboration to align agri-food practices with sustainability goals.

3 Result

3.1 Challenges in agrifood value chains across farm, in-chain, and HORECA sectors

3.1.1 Farm-level challenges

Smallholder farmers in Indonesia's agri-food systems face a series of interconnected challenges affecting their value chain participation and resilience. These include barriers in financial access, postharvest handling, and logistics—identified through structured surveys, interviews, and participatory workshops conducted across Bali, Lombok (WNT), and North Sulawesi.

3.1.1.1 Financial exclusion and credit access gaps

Pearson correlation analysis (survey data) reveals a negative association between reliance on savings and profitability ($r = -0.11$), while formal credit usage shows a positive correlation with profitability ($r = 0.18$) (Table 2). A strong inverse correlation between use of savings and access to formal finance ($r = -0.53$) indicates systemic exclusion from formal banking mechanisms.

Furthermore, a notable pattern emerged in the survey: farmers who reported receiving training were more likely to cite banking challenges ($r = 0.27$), suggesting a mismatch between awareness and institutional responsiveness. Workshop discussions supported this interpretation, with participants citing low trust in rural financial systems and inconsistent access to loan officers.

3.1.1.2 Postharvest labor burden and efficiency loss

Survey results show that farmers spend an average of 4.11 h per week on postharvest tasks like cleaning, sorting, and packing, with a standard deviation of 4.50 h. This variability likely reflects inconsistent equipment access and market-specific demands.

Interview data emphasized that labor intensity discourages quality control when buyer incentives are unclear. As one farmer from Lombok stated during an interview, *"If buyers don't pay more, we don't spend more time."* This was echoed in a workshop where participants linked buyer reliability to sorting efforts and willingness to meet quality standards.

3.1.1.3 Market access and transport limitations

Survey findings show that only 46.1% of farmers consistently transport goods to markets, while others face obstacles such as high transport costs, poor infrastructure, and lack of vehicle access.

Regional analysis indicates that these challenges are especially acute in North Sulawesi, where a higher share of farmers report difficulty reaching buyers. Without reliable transport, many resort to selling at the farm gate, often at a loss. Interviews and workshop dialogues underscored this reality, with participants noting that poor logistics directly discourage improvements in quality and scale.

3.1.2 In-chain actor challenges

In-chain actors—aggregators, traders, and processors—serve as the crucial link between primary producers and consumer markets. Yet, both survey results (Figure 1) and correlation analysis (Table 3) reveal a mix of persistent operational barriers and untapped opportunities.

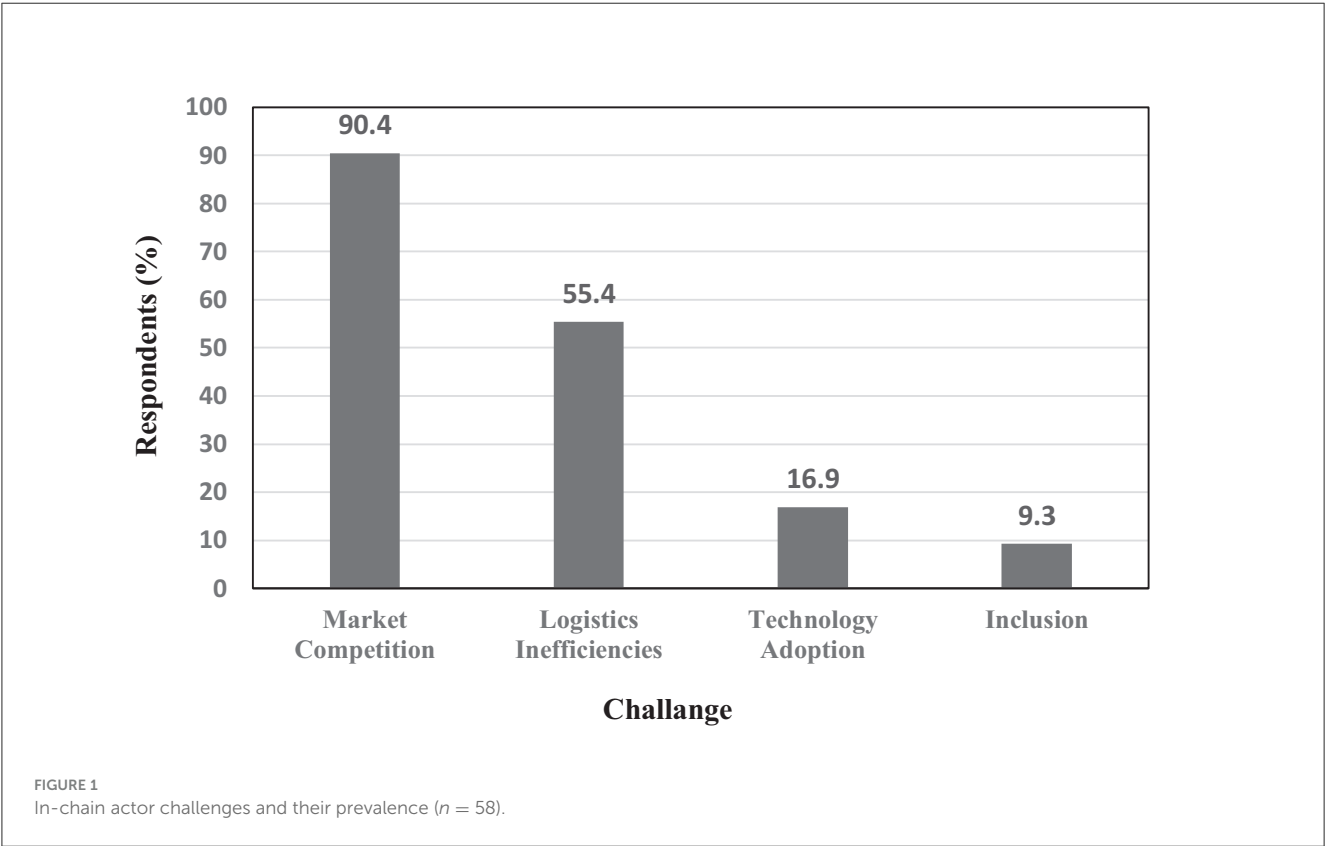
3.1.2.1 Logistical inefficiencies

Figure 1 shows that 55.4% of in-chain actors face significant logistical bottlenecks, including sourcing delays and inadequate transport infrastructure. Interviews indicate that these inefficiencies stem from fragmented supply chains and a lack of consolidation hubs, leading to high spoilage rates and inconsistent deliveries.

TABLE 2 Farm-level opportunities indicators.

Indicator	Value	Interpretation
No Training Received	61.1%	Majority of farmers have not received training in past 2 years.
Training vs. Profitability	$r = 0.16$	Training is positively associated with profitability.
Agriculture Training vs. Profitability	$r = 0.10$	Agricultural training shows a positive, but weaker, link to profitability.
Credit Use vs. Profitability	$r = 0.18$	Use of credit for input purchase correlates with higher profit.
Savings Use vs. Profitability	$r = -0.11$	Savings reliance shows negative correlation with profit.
Finance Agreement vs. Savings Use	$r = -0.53$	Strong inverse relation between using savings and access to finance.
Written Specs vs. Credit Use	$r = 0.26$	Use of written product specifications is higher among credit users.
Banking Issues vs. Training	$r = 0.27$	Trained farmers report more barriers accessing banking services.

Data are based on survey responses from farmers in Bali, Lombok (WNT), and North Sulawesi (n = 180). Percentages represent the share of respondents reporting each condition. Correlation coefficients (r) indicate the strength and direction of the association between two variables, with positive values showing a direct relationship and negative values showing an inverse relationship.



3.1.2.2 Market competition and price pressure

According to Figure 1, 90.4% of respondents cite market competition and price volatility as critical concerns. Qualitative responses highlight that smaller enterprises have limited bargaining power in both procurement and sales, often facing inflexible contract terms that restrict innovation and profitability.

3.1.2.3 Technology adoption gaps

Despite potential efficiency gains, Figure 1 indicates that only 16.9% of actors have adopted digital tools in the last five years. Cost barriers, low digital literacy, and poor alignment of available technologies with local needs are primary obstacles. While Table 3 does not directly measure technology uptake, it shows that 62.7%

of actors believe in the positive impact of inclusive business practices—an attitude correlated with valuing workforce diversity ($r = 0.62$) and regional development ($r = 0.61$). This suggests that fostering inclusive mindsets could also increase openness to adopting innovative technologies.

3.1.2.4 Inclusion and workforce diversification

Figure 1 shows only 9.3% of respondents reporting workforce inclusion as an immediate challenge. However, Table 3 reveals that 57.6% value workforce diversity and 59.3% actively promote community development, both positively correlated ($r \geq 0.50$) with inclusive business beliefs. Interviews further highlight that inclusive hiring practices are linked to higher performance confidence (r

TABLE 3 In-chain opportunity indicators.

Indicator	% of respondents	Correlated themes ($r \geq 0.5$)
Belief in Inclusive Business Impact	62.7%	Staff Diversity ($r = 0.62$), Regional Development ($r = 0.61$)
Promotion of Community Development & Equality	59.3%	Inclusive Business Impact ($r = 0.50$)
Value of Workforce Diversity	57.6%	Inclusive Business Impact ($r = 0.62$), Dev. Perception ($r = 0.62$)
Belief in Inclusive Supply Chain Development	44.1%	Staff Diversity ($r = 0.62$), Inclusive Business Impact ($r = 0.61$)
Structured Collaboration with Farmers	Not Available	No quantifiable data recorded

= 0.50), suggesting that strengthening diversity efforts—especially in hiring women, youth, and underrepresented groups—could reinforce business resilience.

3.1.3 HORECA sector challenges

The HORECA (Hotels, Restaurants, and Catering) sector serves as a vital endpoint within Indonesia’s agri-food value chain, particularly in tourism-dependent provinces such as Bali, Lombok–WNT, and North Sulawesi. Drawing on 132 structured survey responses, stakeholder interviews, and participatory workshop findings, this section identifies five dominant challenges impacting sectoral resilience: supply volatility, external disruptions, low institutional collaboration, innovation barriers, and limited support networks.

3.1.3.1 Supply reliability vs. price volatility

Survey results show that a strong majority (89%) of HORECA respondents reported reliable access to agricultural products (Table 4). However, only 11% expressed confidence in pricing stability or transparency. In interviews, many HORECA managers emphasized that despite availability, pricing unpredictability—largely due to fluctuating transport costs, supplier markups, and inconsistent tourism-driven demand—significantly impacts profitability. One restaurant owner in Bali shared, “Even if I get the vegetables I need, I have no idea if next week the price will triple.” Survey correlations further showed a moderate link ($r = 0.21$) between pricing concerns and innovation reluctance, suggesting that financial strain may suppress technology adoption.

3.1.3.2 Exposure to environmental and economic disruptions

Approximately 28% of survey respondents cited macro-level shocks—such as the COVID-19 pandemic or natural disasters—as key disruptors. In workshop discussions, HORECA actors noted that these events caused unpredictable swings in supply and demand, staff shortages, and abrupt cancellations from buyers and tourists. A hotel manager from North Sulawesi stated, “We lost both supply and customers overnight.” Quantitative data also revealed a significant correlation ($r = 0.45$) between disruption exposure and hesitancy to innovate, underscoring how uncertainty dampens the motivation to modernize operations.

3.1.3.3 Low participation in business cooperatives

Only 3% of HORECA businesses surveyed reported participating in cooperatives or formal business networks. Interviews confirmed this lack of engagement, attributing it to

TABLE 4 Prevalence and interrelationships of HORECA sector challenges ($n = 132$).

% of respondents	Correlation with innovation barrier [®]	Correlation with environmental/national risk [®]
89%	0.14	0.28
11%	0.21	0.10
28%	0.45	—
14%	—	0.45
3%	0.15	0.12

Summary of thematic challenges in the HORECA sector based on survey data ($n = 132$). The table presents the percentage of respondents indicating each challenge, along with Pearson correlation coefficients (r) between variables. Bolded values indicate moderate positive correlations ($r \geq 0.20$), suggesting interconnected systemic barriers.

perceived irrelevance, low trust, or lack of awareness. A café owner in Lombok–WNT remarked, “We don’t have time for meetings that don’t help us get products faster or cheaper.” Workshop participants noted that without group procurement or shared delivery platforms, most actors remain operationally isolated. Compared to farmers who often leverage cooperatives for input access, HORECA businesses lack these collaborative safety nets—reducing resilience and negotiation capacity.

3.1.3.4 Barriers to innovation and technological adoption

Only 14% of survey respondents identified innovation as a significant challenge; however, qualitative data reveal that many HORECA businesses face systemic barriers. Interviews indicated that cost concerns, risk aversion, and lack of technical skills hinder the uptake of tools like digital inventory systems or e-procurement platforms. A manager from a mid-sized hotel explained, “We can’t afford trial-and-error. If an app fails, we lose customers.” Notably, survey data showed a strong positive correlation ($r = 0.45$) between environmental disruption and innovation reluctance, suggesting a cyclical dynamic in which shocks reinforce conservatism.

3.1.3.5 Weak institutional and social networks

Survey and interview data both highlight a pervasive lack of institutional engagement. Most respondents described their operations as “independent” or “isolated,” with limited input from local government, farmer groups, or tourism boards. One workshop participant remarked, “We’re on our own when problems hit.” This weak connectivity translates into missed opportunities for strategic planning, innovation-sharing, and

collective problem-solving. Even informal supply ties are often reactive rather than strategic. These gaps inhibit resilience, especially in times of crisis.

In combination, these findings underscore that while supply reliability in the HORECA sector is relatively high, other pillars of resilience—such as affordability, innovation capacity, and institutional connectivity—remain underdeveloped. Targeted interventions to build cooperative models, strengthen peer learning, and de-risk innovation could significantly improve HORECA's ability to act as a robust intermediary in Indonesia's agri-food system.

3.2 Opportunities for advancing sustainable agrifood value chains

3.2.1 Farm-level opportunities

The farm-level analysis reveals several actionable opportunities to enhance the sustainability, resilience, and inclusivity of smallholder farming systems. These findings are grounded in data from structured surveys ($n = 180$ farmers), semi-structured interviews, and participatory workshops conducted across Bali, Lombok–WNT, and North Sulawesi. Key opportunity areas include targeted agricultural training, financial inclusion, and improved market engagement—all critical for integrating smallholders into higher-value supply chains.

3.2.1.1 Agricultural training and knowledge transfer

According to survey responses, 61.1% of farmers reported not receiving any agricultural training or extension support within the past 2 years. However, for those who did receive training, a positive correlation was observed with improved outcomes: training participation was modestly associated with increased profitability ($r = 0.16$) and the use of written product specifications ($r = 0.26$).

These quantitative results were reinforced by interview narratives, where trained farmers described improvements in planting schedules, pest management, and recordkeeping. One respondent from Lombok–WNT explained, “After training, I started keeping a log of sales and quality checks, which helped me negotiate better prices.” These insights suggest that knowledge access supports both operational performance and market readiness.

3.2.1.2 Access to finance and credit constraints

Survey data show that financial access is a pivotal determinant of farm success. Farmers who accessed formal credit reported higher profitability ($r = 0.18$), while reliance on personal savings correlated negatively with profit outcomes ($r = -0.11$). Additionally, a strong inverse relationship was observed between savings reliance and access to finance ($r = -0.53$), indicating that self-financing may entrench exclusion from formal banking systems.

Interviews added qualitative depth, with farmers noting documentation, collateral, and institutional mistrust as common barriers. A participant from a workshop in North Sulawesi stated, “Even when I have contracts, the bank still hesitates because I'm not officially registered.” Interestingly, survey data also indicated

that farmers using written specifications—often a prerequisite for formal contracts—were more likely to access credit ($r = 0.26$), further emphasizing the role of institutional legitimacy.

However, challenges persist: trained farmers were actually more likely to report difficulties in accessing finance ($r = 0.27$), a paradox that suggests rising expectations but stagnant institutional delivery. These results underscore the need for better-aligned financial products and services for the smallholder segment.

3.2.1.3 Regional disparities in opportunity access

Cross-regional comparison of survey responses (Table 5) reveals disparities in opportunity access. Credit access difficulty was highest in North Sulawesi (77.9%), followed by Lombok–WNT (65.0%) and Bali (63.2%). Educational attainment also differed, with 67.8% of Bali-based farmers completing secondary education—potentially enabling greater participation in training programs and technical documentation.

Workshop discussions mirrored these statistics. Participants from North Sulawesi emphasized infrastructure deficits and poor connectivity with extension services. One farmer stated, “Our training center is 2 h away, and no one from the government has visited in over a year.” These regional differences call for tailored, locally grounded interventions.

3.2.1.4 Pathways to market-oriented transformation

In synthesis, both quantitative and qualitative data point to three critical leverage points:

- Expanding localized training and extension services to close the knowledge gap and improve production practices.
- Improving financial inclusion through banking products adapted for smallholders, coupled with financial literacy programs.
- Formalizing engagement mechanisms, such as cooperatives and contract farming, which enhance traceability and creditworthiness.

3.2.2 In-chain opportunities

Inclusive business models and organizational diversity offer critical pathways for strengthening Indonesia's agri-food value chains, particularly among in-chain actors such as aggregators, traders, and processors. This section draws on structured survey data from 58 respondents, semi-structured interviews, and supplementary open responses to identify statistically significant patterns and operational gaps relevant to inclusive practice and collaboration.

3.2.2.1 Inclusive practices and organizational performance

Based on survey responses, 62.7% of in-chain actors agreed that inclusive business and supply chain practices enhance both performance and innovation capacity. Additionally, 59.3% of respondents indicated that their organizations actively promote community development and equality, and 57.6% affirmed the positive impact of workforce diversity.

These quantitative results are internally consistent, with strong correlations between inclusive beliefs and key organizational values: belief in the performance benefits of inclusivity correlates

TABLE 5 Regional comparison of key indicators across sectors.

Farm sector						
Region	Secondary education	Vocational/ tertiary	Credit use	Financial issues	Input supply issues	Sees regulation beneficial
Bali	67.8%	14.2%	35.5%	63.2%	71.1%	21.0%
Lombok-WNT	65.0%	14.2%	31.7%	65.0%	74.2%	8.3%
North Sulawesi	63.9%	7.8%	29.5%	77.9%	70.6%	15.2%
In-chain sector						
Region	Supports inclusivity		Inclusive dev. Support		Sees regulation beneficial	
Bali	84.7%		84.7%		40.5%	
Lombok-WNT	77.9%		77.9%		24.6%	
North Sulawesi	74.6%		74.6%		21.3%	
HORECA sector						
Region	Farmer inclusivity		Inclusive dev. Support		Sees regulation beneficial	
Bali	72.7%		93.2%		31.8%	
Lombok-WNT	23.3%		46.5%		4.7%	
North Sulawesi	80.0%		84.4%		17.8%	

positively with valuing staff diversity ($r = 0.62$) and promoting equality ($r = 0.50$). Interviews reinforced these perceptions, with one processor from Bali stating, “When we hire locally and diversify, our team feels more committed and we get fewer operational disruptions.”

These findings suggest that inclusivity is seen not just as a social imperative but as a concrete driver of innovation and operational reliability—aligning with the literature (Pingali and Sunder, 2017) that underscores the link between inclusive culture and adaptive capacity in agrifood systems.

3.2.2.2 Regional development and ethical supply chains

Survey results also show that 44.1% of respondents believe that inclusive supply chains—characterized by ethical sourcing, fair employment, and community-based procurement—can meaningfully support regional development goals. These beliefs are correlated with valuing staff diversity ($r = 0.62$) and linking inclusivity to performance ($r = 0.61$), reinforcing the broader perception that inclusivity can catalyze both internal effectiveness and external impact.

Qualitative interviews supported this, with in-chain actors frequently pointing to local job creation and stable supply relationships as key drivers of their community involvement. However, regional variability was observed, revealing stronger support in Bali (84.7%) compared to Lombok-WNT (77.9%) and North Sulawesi (74.6%). This points to uneven institutional capacity and highlights the need for localized support mechanisms to bolster inclusive practice.

3.2.2.3 Collaboration gaps with producers

While inclusive intentions are widely expressed, survey data revealed a major gap in structured collaboration with upstream producers. Despite including a survey variable to track these

TABLE 6 Policy perceptions and collaboration (% of respondents).

Indicator	Farm sector	In-chain sector	HORECA sector
Sees regulation as beneficial	13.3%	8.5%	18.0%
Participates in cooperative	52.8%	0.0%	0.0%

linkages, no quantifiable responses were recorded—suggesting that such partnerships are either informal or absent.

Open-ended survey comments and workshop insights further confirm this. One respondent from Lombok-WNT noted, “We do buy from farmers, but there’s no formal contract—just trust.” This informal engagement limits accountability and joint planning, weakening the resilience of the supply chain.

Moreover 13.3% of respondents (Table 6) explicitly cited “lack of trust” as a major barrier to farmer collaboration, highlighting systemic distrust and low institutional linkage. These findings underscore a clear disjunction between internal inclusive practice and external producer engagement.

3.2.2.4 Pathways forward

To capitalize on the inclusive potential of in-chain actors, the following strategies are recommended:

- Formalize engagement with farmer groups through contracts, shared training, and inclusive sourcing schemes.
- Promote inclusive procurement via government or industry incentives linked to sustainability benchmarks.
- Improve monitoring tools in future studies to capture collaboration depth and identify best practices.

TABLE 7 HORECA sector opportunity indicators.

Indicator	% of respondents agreeing	Correlated variables ($r \geq 0.2$)
Currently has supply	93.2%	—
Views regulations as beneficial	18.0%	Inclusivity ($r = 0.24$), Development ($r = 0.27$)
Perceives suppliers as influential	36.8%	Inclusivity ($r = 0.45$), Development ($r = 0.23$)
Believes farmers promote inclusivity	46.0%	Supplier Influence ($r = 0.45$)
Believes inclusive chains promote sustainable development	44.0%	Regulations ($r = 0.27$), Supplier Influence ($r = 0.23$)

Together, survey data, interview responses, and workshop discussions reveal that while inclusive practices are internally valued and regionally supported, they are not yet systematically extended upstream. Bridging this gap through formal structures is essential to building resilient, inclusive agri-food value chains across Indonesia.

3.2.3 HORECA sector opportunities

Survey data from 132 HORECA respondents—including hotels, restaurants, and catering businesses—reveal promising foundations and actionable opportunities for embedding sustainability, inclusion, and local integration into Indonesia's agri-food value chains. Drawing on both structured responses and qualitative inputs, this section outlines five focal areas for advancing HORECA sector engagement in inclusive value chains (Table 7).

3.2.3.1 Reliable supply but unclear local sourcing patterns

A high proportion (93.2%) of respondents indicated consistent access to food supply (Table 7), affirming operational stability across all three regions surveyed. However, open-ended responses to “source type” and “sourcing geography” were not codified in the dataset, limiting the ability to confirm whether these supply chains are locally embedded or dependent on external sources.

During interviews, several respondents alluded to “longstanding relationships” with key vendors but often could not specify if these vendors sourced directly from regional farms. This suggests that while supply reliability is strong, the traceability and localization of sourcing remain ambiguous—an area where improved documentation and sourcing registries could enhance agri-tourism linkages.

3.2.3.2 Emerging norms around inclusivity and regional development

Survey results show that 46.0% of respondents believe their suppliers contribute to inclusive practices—such as ethical labor or fair pricing. Similarly, 44.0% agreed that inclusive supply chains can support long-term regional development (Table 7). These attitudes suggest that while inclusive values are gaining normative traction, they are not yet consistently translated into business models.

Importantly, a moderate correlation ($r = 0.45$) between supplier inclusivity beliefs and perceived supplier influence indicates that inclusive procurement is more likely when suppliers are seen as partners rather than passive vendors. Interview comments reinforced this: one hotelier from Bali noted, “We

appreciate when suppliers go beyond just delivery—when they care about worker conditions, it shows.”

3.2.3.3 Weak supplier influence and cooperative gaps

Only 36.8% of HORECA actors viewed suppliers as having meaningful influence on their business practices (Table 7). This points to a transactional nature of relationships that prioritize logistics over collaboration. Additionally, consistent with earlier findings in Section 3.1.3, only 3% reported active membership in business cooperatives.

Workshop participants identified a lack of formal structures—such as joint training or sustainability standards—as a key reason for limited supplier collaboration. One restaurant manager from North Sulawesi noted, “We work with the same vendors, but there's no system for innovation or feedback.” These gaps suggest that mutual learning and co-investment in innovation are not institutionalized within current supply relationships.

3.2.3.4 Limited regulatory support for inclusive practices

Survey data show that only 18.0% of respondents agreed that current government policies support the agricultural sector (Table 7). This low figure signals a regulatory misalignment with sustainable sourcing aspirations. However, correlation analysis reveals that respondents who viewed policies positively were also more likely to value supplier engagement ($r = 0.17$) and believe in inclusive value chains as development tools ($r = 0.27$).

This finding underscores the potential for enabling policy environments to incentivize inclusive procurement—yet the current policy context is perceived as fragmented or underresponsive by most HORECA actors.

3.2.3.5 Strategic opportunities for sector advancement

Building from these insights, the following actions can help bridge the gap between inclusive intentions and tangible practice:

- Codify Local Sourcing through structured supplier databases, traceability systems, and digital procurement platforms. These systems could be implemented via platforms like Kobo Toolbox, which was successfully used for data collection in this study.
- Strengthen Supplier Engagement by facilitating joint planning forums, supplier development programs, and multi-year performance-based contracts.
- Bridge Regulatory Disconnects by aligning local government initiatives with sustainability incentives—such as tax relief or certification schemes for HORECA actors sourcing from inclusive supply chains.

- Foster Peer Learning and Innovation Networks by establishing cross-regional platforms where HORECA businesses share best practices and pilot inclusive models.

Taken together, the HORECA sector demonstrates a strong base of operational continuity and an emerging commitment to inclusive values. However, the institutionalization of supplier engagement and the formalization of local sourcing remain underdeveloped. Strengthening these linkages—through systems, policy alignment, and peer collaboration—will be essential for maximizing the sector's contribution to sustainable and equitable agri-food value chains within Indonesia's tourism economy.

3.3 Comparative analysis of regional dynamics

A regional comparison across Bali, Lombok–West Nusa Tenggara (WNT), and North Sulawesi highlights context-specific barriers and opportunities influencing the sustainability and inclusiveness of agri-food value chains. Drawing on structured survey data, open-ended survey responses, and qualitative interviews, the section underscores the critical importance of context-aware policy, tailored capacity-building, and infrastructure alignment.

3.3.1 Educational attainment and innovation potential

Survey data show that the majority of farmers in all regions have completed secondary education, with the highest rates observed in Bali (67.8%), followed by Lombok–WNT (65.0%), and North Sulawesi (63.9%). However, access to vocational or tertiary education remains limited, especially in North Sulawesi (7.8%) compared to Bali and Lombok–WNT (both 14.2%).

This disparity affects farmers' ability to engage in formal market contracts, certification schemes, and the adoption of new technologies, as confirmed by both survey trends and interview insights. In workshops, North Sulawesi participants emphasized challenges in comprehending digital platforms and regulatory requirements—reinforcing that literacy and vocational training are prerequisites for innovation readiness.

3.3.2 Divergent financial access and credit gaps

Access to credit remains one of the most regionally divided constraints. According to survey responses, 77.9% of farmers in North Sulawesi face credit access challenges, higher than in Lombok–WNT (65.0%) and Bali (63.2%). Interviewees in North Sulawesi reported that financial institutions are “physically and administratively distant,” and that even when products exist, “we don't qualify.”

The correlation between reliance on personal savings and lower profitability is most evident in North Sulawesi. This points to a pressing need for community-tailored financial instruments, such as rotating savings groups, cooperatively managed micro-credit, and loan programs designed around agricultural cycles.

3.3.3 Market access and logistics: a regional imbalance

Farmers in different parts of the country face unequal access to markets, with those in more remote provinces bearing the heaviest burdens. In North Sulawesi, more than two-thirds of farmers reported difficulty in reaching buyers, a figure only slightly lower in Lombok–WNT. By contrast, fewer than half of farmers in Bali described market access as a major challenge. These disparities reflect not only geographical distance from urban centers but also deep gaps in infrastructure. Producers in eastern regions spoke of long and costly transport routes, a shortage of consolidation hubs, and the absence of cold storage facilities that could extend product shelf life.

On the buyer side, only a minority of HORECA actors reported sourcing directly from smallholder farmers, and many lacked formal supply agreements. This structural disconnect means that even when rural producers have goods available, they struggle to integrate into stable, higher-value markets. Both farmers and buyers pointed to the need for improved logistics systems, better road networks, and more structured supplier partnerships as essential steps toward a more equitable and efficient value chain.

3.3.4 Inclusivity norms: strong beliefs, variable implementation

Support for inclusive supply chains is high across all regions but inconsistently reflected in practice. Among in-chain actors, the survey shows that Bali leads with 84.7% agreement on inclusive business practices, followed by Lombok–WNT (77.9%) and North Sulawesi (74.6%).

Interestingly, in the HORECA sector, support for inclusivity was highest in North Sulawesi (80.0%), exceeding both Bali (72.7%) and Lombok–WNT (23.3%). These findings, drawn from structured responses and echoed in workshops, suggest that cultural context and local social norms heavily influence perceptions and operational realities of inclusion.

For example, a North Sulawesi hotel owner emphasized, “We hire from nearby villages—it's our way of giving back,” whereas a Lombok–WNT respondent noted, “We prefer experienced staff from other provinces.” This variation underscores the need for region-specific behavioral nudges and incentive systems to bridge intention and action.

3.3.5 Regulatory trust and policy perception gaps

Only 14.8% of surveyed farmers nationwide view current policies as beneficial, and 83.9% raised concerns about regulatory clarity. This distrust is most pronounced in Lombok–WNT (4.7%), with North Sulawesi (17.8%) and Bali (31.8%) showing slightly more optimism.

Meanwhile, HORECA expressed slightly more favorable views, with 18% nationally finding policy support adequate (Table 8). Interviews suggest that regulations are often perceived as “urban-focused” or “non-applicable to tourism-linked food sectors.” This reinforces the need for co-designed local regulations, clear implementation guidance, and communication strategies tailored to rural and tourism-linked contexts.

TABLE 8 Technology adoption across sectors (% respondents).

Indicator	Farm sector	In-chain sector	HORECA sector
Digital confidence	60.0%	89.8%	94.7%
Adopted new tech	30.6%	16.9%	72.2%
Continued use	26.1%	—	—

3.3.6 Policy implications and strategic priorities

These regional findings collectively dismantle the assumption that uniform interventions can effectively address the complexity of Indonesia's agri-food value chain. They instead highlight four region-sensitive priorities:

- Expand localized financial services, including co-managed microfinance and seasonal credit schemes.
- Enhance targeted training programs with attention to literacy, gender, and vocational needs in low-education regions.
- Modernize rural infrastructure, particularly cold chains and transport for perishable goods.
- Promote inclusive policy co-design using digital platforms and trusted local intermediaries to enhance transparency and uptake.

3.4 Key technological opportunities for agri-food value chains (revised)

Technological advancement holds transformative potential for improving efficiency, transparency, and resilience across Indonesia's agri-food value chains. However, adoption remains inconsistent across actors—namely farmers, in-chain intermediaries, and the HORECA sector—driven by a combination of structural, economic, and informational barriers. Data from the structured survey (Table 8), combined with open-ended responses and qualitative interviews, illustrate both readiness and resistance within and across segments.

3.4.1 Farm-level: readiness without reinforcement

Among farmers, 60.0% identified themselves as digitally capable (Table 8), indicating moderate awareness of technological applications. However, only 30.6% reported adopting new agricultural technologies or practices in the past 5 years, and sustained post-adoption use dropped to 26.1%. This disconnect was echoed in interviews, where several farmers cited lack of training and “apps that no one explains how to use.”

Structural constraints—including limited access to training programs, unaffordability of digital tools, and insufficient rural infrastructure—remain key barriers. The positive correlation between training and profitability suggests that digital readiness must be reinforced through capacity-building and support systems to ensure continuity and effectiveness in practice.

3.4.2 In-chain: high awareness, low adoption

In-chain actors—aggregators, traders, and processors—reported the second-highest digital confidence (89.8%; Table 8),

largely reflecting the presence of operational awareness, particularly among urban-based enterprises. Yet, only 16.9% had adopted new digital systems, including logistics platforms and inventory management tools, in the past 5 years.

Survey and interview data indicate a key constraint: cost. Respondents noted the prohibitively high prices of digital traceability systems and a lack of shared infrastructure. One processor in Lombok-WNT shared: “Even if we wanted to try a digital tool, we'd have to build it ourselves, and it's not affordable.”

The absence of cooperative data systems or shared procurement platforms results in fragmented information flows, reducing the sector's ability to engage in real-time coordination and supply forecasting.

3.4.3 HORECA sector: digitally enabled but isolated

The HORECA sector demonstrated both the highest digital confidence (94.7%) and the most substantial technology adoption rate (72.2%; Table 8). Businesses reported extensive use of customer interface platforms, dynamic inventory systems, and predictive procurement tools—technologies driven by consumer-facing demands for speed, accuracy, and service quality.

However, despite this internal digitalization, upstream connectivity with producers and in-chain actors remains limited. Interviews confirm that traceability systems are rarely integrated, and sourcing decisions often remain informal. This lack of connectivity reduces the potential for closed-loop feedback—critical for monitoring quality, ensuring sustainability claims, and mitigating operational risk.

3.4.4 Cross-sectoral gaps: capacity vs. implementation

Comparative analysis reveals a growing disconnect between digital capability and systemic implementation. While actors across all segments report technological confidence, actual adoption rates diverge sharply due to misaligned enabling conditions.

- For farmers, barriers include affordability, tool complexity, and inconsistent training.
- For in-chain actors, the constraint lies in interoperability and capital requirements.
- For HORECA actors, the issue is weak integration with upstream suppliers, limiting full supply chain digitalization.

This misalignment hampers traceability, transparency, and inclusive growth—key goals in Indonesia's evolving food system.

3.4.5 Strategic recommendations

To unlock the transformative potential of technology, context-specific interventions are needed:

- Farmer-focused digital literacy campaigns and mobile extension services should address gaps in functional usage and confidence.

- Shared digital platforms—led by cooperatives or value chain alliances—should reduce tech access costs and build real-time data interoperability.
- Incentivize innovation through subsidies, sustainability-linked certification discounts, or public-private innovation funds.
- Expand tools already in circulation, such as Kobo Toolbox, for traceable and user-friendly monitoring of adoption trends.

Collectively, these strategies can strengthen digital equity and position all actors—regardless of scale or region—for success in a more connected, efficient, and resilient agri-food value chain.

3.5 Policy and stakeholder collaboration for sustainability (revised)

The transition to sustainable agri-food systems in Indonesia hinges on both enabling policy environments and multi-level stakeholder coordination. Yet, as evidenced by the survey and qualitative interview data, a persistent implementation gap exists between policy design and grassroots realities, limiting the scalability of inclusive and climate-resilient innovations across the food system.

3.5.1 Weak regulatory confidence across value chain actors

Survey results show consistently low trust in regulatory frameworks:

- Only 13.3% of farmers believed existing regulations effectively supported their work;
- Among in-chain actors, the approval rate dropped further to 8.5%;
- HORECA actors expressed slightly higher, but still limited, confidence (18.0% [Table 8](#)).

Interviewees from all regions cited unclear eligibility criteria, limited access to certification tools, and poor alignment between policy and operational constraints as critical barriers. A farmer from Lombok noted: “Policies often come from Jakarta, but they don’t speak our language—or meet our timing.” This disconnect underscores a core weakness: top-down regulatory instruments have struggled to enable bottom-up adaptation, particularly among small-scale actors.

3.5.2 Fragmented collaboration mechanisms

Patterns of inter-actor collaboration remain uneven across the system:

- Farmers reported the most structured engagement, with 52.8% participating in cooperatives, producer groups, or associations. These institutions provide access to extension services, group marketing, and collective input procurement, albeit with regional disparities in effectiveness and inclusivity.

- Patterns of collaboration among in-chain actors remain inconsistent, revealing both strengths and gaps. The majority of respondents recognize the value of inclusive business practices, 62.7% believe such approaches have a positive impact, strongly correlating with support for staff diversity ($r = 0.62$) and regional development ($r = 0.61$). Similarly, 59.3% promote community development and equality, and 57.6% value workforce diversity, each closely linked to perceptions of inclusivity and development outcomes ($r \geq 0.50$).
- HORECA respondents showed strong operational stability, with 93.2% reporting a steady supply. However, only 18.0% saw regulations as beneficial, though this view was linked to inclusivity ($r = 0.24$) and development ($r = 0.27$). Just over a third (36.8%) viewed suppliers as influential, closely tied to inclusivity ($r = 0.45$) and development ($r = 0.23$), while 46.0% believed farmers promote inclusivity and 44.0% associated inclusive supply chains with sustainable development. These findings suggest that, despite stable supply, stronger use of regulatory and supplier influence could enhance inclusivity and sustainability.

The cumulative effect is a fragmented network of disconnected actors, limiting shared learning, contract stability, and collective response to external shocks.

3.5.3 Toward systemic realignment: strategic levers for change

To bridge these structural and institutional gaps, a multi-pronged, actor-sensitive approach is required:

- Regulatory harmonization: clarify and simplify certification programs, subsidy eligibility, and compliance procedures. This should include integrated policymaking across ministries (agriculture, trade, tourism), with regionally embedded communication mechanisms tailored to local literacy and timing patterns.
- Inclusive platform development: expand investment in cooperative development infrastructure—especially among in-chain and HORECA actors. These platforms should support cost sharing, data interoperability, and joint risk mitigation, building collective capacity beyond isolated efforts.
- Public-private innovation compacts: launch multi-stakeholder coalitions aligned to sustainability and inclusion targets. Such alliances could pool expertise, reduce transaction costs, and institutionalize trust-building through co-developed frameworks for traceability, fair sourcing, and environmental stewardship.
- Digital tools for regulatory accessibility: leverage platforms like Kobo Toolbox—already used in field data collection—to disseminate policy updates, register cooperative activities, and gather real-time feedback from field actors.

In sum, policy recalibration and strengthened stakeholder collaboration must move beyond rhetorical alignment and into institutional redesign that reflects on-the-ground complexity. Only then can Indonesia realize a resilient, inclusive, and regionally embedded agri-food system capable of withstanding future shocks while delivering shared prosperity.

4 Discussion

4.1 Farm-level dynamics: strengthening inclusive support systems

Smallholder farmers across Indonesia continue to face structural constraints that limit their ability to adopt sustainable practices and engage meaningfully in higher-value markets. The survey revealed significant gaps in both agricultural training and financial access. A substantial 61.1% of farmers had not received any formal agricultural training in the past two years, a critical barrier to innovation and productivity. This aligns with global findings highlighting the role of knowledge gaps and weak extension systems in impeding technology adoption (Nguyen et al., 2020; Glendenning et al., 2010).

Financial exclusion remains a persistent challenge. With over 80% of farmers relying primarily on personal savings and only a minority accessing credit, capital constraints continue to limit investments in inputs, equipment, and climate-smart practices. This mirrors broader evidence from the Global South, where access to financial tools has been shown to significantly influence the sustainability of smallholder operations (Gauchan and Shrestha, 2021).

Notably, farmers who had received training were more likely to encounter difficulties accessing financial services, suggesting a paradox: increased awareness does not necessarily translate to inclusion. This highlights the need for integrated interventions that combine capacity building with financial literacy and institutional reform. As Chinsinga and Matita (2021) argue, effective engagement requires targeting “hanging-in” farmers who are struggling to move beyond subsistence-level activity.

These findings reinforce the relevance of inclusive value chain theory, which posits that smallholders require both horizontal (peer-based) and vertical (market-based) coordination mechanisms to achieve equitable outcomes (Reardon et al., 2025). At the same time, the innovation adoption framework emphasizes that perceived risk, resource constraints, and institutional voids inhibit farmers from implementing improved practices (Rogers et al., 2014). Without supportive networks and formalized pathways to markets, sustainable transformation remains elusive.

In response, future strategies must prioritize farmer-centric systems that integrate training, credit access, and inclusive governance. Cooperative models, digital extension tools, and incentive-based certification programs can serve as pathways for empowering smallholders while aligning with Sustainable Development Goal 2 on zero hunger and smallholder productivity.

4.2 In-chain sector: untapped potential through collaboration

The in-chain segment of Indonesia's agri-food value chains exhibits significant digital readiness but struggles with actual technology deployment and collaboration mechanisms. While 89.8% of in-chain respondents expressed confidence in using digital tools, only 16.9% reported adopting new technologies in the past 5 years. This discrepancy suggests that structural barriers—primarily financial constraints and infrastructural gaps—are limiting the

sector's capacity to act on its digital potential (Fischer et al., 2020; World Bank, 2021).

Studies on agri-food system transformation indicate that access alone is insufficient; without affordable platforms, shared investment models, and supportive institutional frameworks, digital transformation remains aspirational rather than operational (Ansell and Gash, 2018; Abebaw and Haile, 2013). In other contexts, cooperative digital hubs have been shown to reduce costs, foster traceability, and improve logistics efficiency—outcomes that are equally relevant for Indonesia's fragmented midstream sector (Amend et al., 2024).

Equally concerning is the weakness of vertical coordination between in-chain actors and producers. Although nearly one-third (28.9%) of respondents acknowledged the challenge of trust in upstream relationships, only 24.5% reported engaging in formal collaboration with farmers. This limited interaction reflects broader institutional voids in contract enforcement, pricing transparency, and data sharing—elements essential for effective integration (Reardon et al., 2025; Nedumaran et al., 2020).

The findings align with inclusive value chain theory, which emphasizes that resilient supply chains require embedded trust, transparency, and equitable governance among actors at different nodes of the chain (Riisgaard et al., 2010). Without these elements, power asymmetries persist, undermining collective innovation and reinforcing fragmentation.

Policy and development interventions should therefore focus on enabling multi-stakeholder governance platforms that build trust and formalize cooperation. This includes standardized contract templates, certification schemes, and traceability systems co-developed by public agencies, cooperatives, and agri-business associations. Investing in these coordination mechanisms would not only bridge the adoption gap but also catalyze inclusive innovation and risk-sharing—both of which are essential for long-term supply chain resilience.

4.3 HORECA sector: high digital capacity, low upstream engagement

The HORECA sector—comprising hotels, restaurants, and catering businesses—emerges as the most technologically advanced segment of Indonesia's agri-food value chain. With 94.7% of respondents reporting digital proficiency and 86.2% having implemented new technologies (Table 7), this sector demonstrates strong digital integration in downstream operations. These tools include demand forecasting, inventory optimization, and digital procurement systems, positioning HORECA actors as frontrunners in consumer-oriented innovation (Rabadán et al., 2019).

However, this digital maturity does not extend upstream. Only 32.4% of HORECA businesses source directly from smallholder farmers, indicating a significant disconnect between digital adoption and inclusive value chain engagement. This gap aligns with global evidence showing that downstream actors often prioritize efficiency and consumer responsiveness over supply-side integration (Reardon et al., 2015; de Vries et al., 2023). The lack of formalized sourcing frameworks suggests a missed opportunity to leverage digital tools for inclusive procurement and traceability—a cornerstone of sustainable food systems (HLPE, 2020).

Community engagement is relatively strong (79.8%), reflecting localized corporate social responsibility (CSR) practices and community-based initiatives. Yet, the absence of cooperative participation (0%) and weak supplier relationships highlight fragmented governance and a lack of institutionalized collaboration mechanisms. Research underscores that without structured linkages—such as contract farming, inclusive procurement policies, or digital traceability systems—the HORECA sector's potential to drive inclusive development remains underutilized (Gereffi, 2018; Da Silva and Rankin, 2013).

From a theoretical standpoint, this pattern reflects the pitfalls of *selective modernization*—where downstream nodes of value chains innovate rapidly, while upstream actors remain marginalized (Kaplinsky and Morris, 2000). Inclusive value chain frameworks emphasize the importance of *vertical coordination*, especially in market-driven sectors like tourism and hospitality (Bolwig et al., 2010). Tools such as blockchain for traceability, supplier certification schemes, and embedded service models have been shown to enhance trust and inclusivity in fragmented agri-food networks (Osei et al., 2021).

To address this, disconnect, policy frameworks should promote structured collaboration between HORECA businesses and upstream actors. Public–private partnerships, sustainability certifications (e.g., Rainforest Alliance, Fair Trade), and digital platforms can facilitate trust, transparency, and inclusion (Kiran et al., 2023). Furthermore, targeted incentives—such as procurement subsidies or tax benefits for inclusive sourcing—can shift procurement behaviors toward socially embedded models of supply chain governance (Vellema et al., 2021).

In sum, the HORECA sector's digital capacity provides a strong foundation for innovation, yet its exclusion of smallholder farmers and weak supplier institutionalization limits its contribution to inclusive value chain transformation. Embedding inclusive sourcing strategies within regulatory and digital frameworks is essential for aligning consumer-driven growth with broader goals of rural development, environmental sustainability, and SDG 12 (Responsible Consumption and Production).

4.4 Regional variation and the role of contextual policy

Regional disparities across Indonesia's agri-food value chains underscore the urgent need for spatially differentiated interventions. The data reveal critical variations in market access, education, infrastructure, and perceptions of regulatory effectiveness, highlighting how geographical context fundamentally shapes the capacity for inclusive transformation.

For instance, 67.5% of farmers in North Sulawesi report severe market access challenges, compared to just 41.7% in Bali, where institutional networks and tourism-driven demand offer more robust value chain linkages. Educational disparities further compound these differences, with vocational and tertiary education levels remaining below 15% in all surveyed regions, limiting knowledge transfer and adoption of advanced agronomic practices. These inequalities mirror findings from similar decentralized economies where regional development gaps hinder national-level

food system transformation (Christiaensen and Todo, 2014; HLPE, 2020).

This evidence reinforces the importance of localized policy frameworks that are sensitive to region-specific socio-economic and infrastructural conditions. One-size-fits-all strategies risk exacerbating existing inequalities by failing to respond to the nuanced challenges of underserved regions such as Lombok–WNT and North Sulawesi. Studies on adaptive governance and place-based development consistently argue that successful agricultural innovation depends on aligning interventions with local institutional capacities, cultural preferences, and ecological constraints (Rodríguez-Pose, 2013; Scoones et al., 2020).

Localized policy instruments—such as decentralized agricultural training, targeted credit schemes, and investment in rural infrastructure—can play a transformative role when paired with inclusive governance mechanisms. For example, regional innovation platforms and participatory planning processes have shown success in aligning stakeholder priorities in fragmented systems, improving both accountability and implementation (Hall and Clark, 2010; Klerkx et al., 2012).

Moreover, tailored interventions should emphasize regional value chain integration, especially in areas with weaker private sector engagement. Public–private partnerships focused on logistics, cold chain infrastructure, and digital inclusion could help elevate the competitiveness of rural producers. These approaches also resonate with the principle of “territorial development” advocated in recent food systems literature, which prioritizes endogenous growth and community-level resilience over centralized solutions (Kiran et al., 2023; HLPE, 2020).

Ultimately, advancing food system equity and sustainability in Indonesia requires governance that is not only inclusive, but also place-responsive. Regional variation must be seen not as a challenge to be managed uniformly, but as a strategic entry point for differentiated, context-aware interventions that amplify the strengths and address the constraints of each locality.

4.5 Cross-cutting insights on policy and cooperation

System-wide analysis reveals a recurring concern: the perceived ineffectiveness of regulatory frameworks and the fragmentation of cooperative engagement across Indonesia's agri-food value chains. Regulatory support is viewed as insufficient across all sectors—only 13.3% of farmers, 8.5% of in-chain actors, and 18.0% of HORECA businesses report benefiting from current policies. These figures indicate a systemic disconnect between policy design and stakeholder realities, echoing broader critiques of top-down regulatory regimes in developing agri-food systems (Vorley et al., 2012; HLPE, 2020).

Compounding this issue is the uneven adoption of cooperative models. While farm-level cooperative participation remains relatively strong at 52.8%, the in-chain and HORECA sectors exhibit near-total absence of structured collaboration. This lack of horizontal and vertical integration reflects institutional voids—spaces where formal coordination mechanisms are absent, creating inefficiencies and weakening the potential for collective action (Khanna and Palepu, 1997; Reardon et al., 2019).

Strengthening governance across the value chain requires an ecosystem approach to cooperation—where public policy, market incentives, and social norms are aligned to promote sustainable and equitable practices. Embedding inclusive governance principles within cooperative platforms and multi-stakeholder forums can help bridge sectoral silos and improve coordination. Empirical studies show that such platforms enhance transparency, foster innovation, and reduce transaction costs, especially in fragmented systems (Ansell and Gash, 2018; Klerkx and Aarts, 2013).

Moreover, trust and mutual accountability must be central to upstream and downstream interactions. Transactional relationships—based solely on price or volume—are insufficient for building resilient food systems. Instead, value-based collaborations rooted in shared risk and benefit can yield longer-term stability and innovation diffusion. These insights align with inclusive value chain theory, which advocates for joint investments in capacity building, equitable contract mechanisms, and participatory governance (Donovan et al., 2015; Ros-Tonen et al., 2018).

From a policy perspective, this calls for harmonized regulatory environments that prioritize not only compliance, but also enablement—through accessible certification systems, fiscal incentives, and institutional support for network development. In particular, linking sustainability certifications (e.g., fair trade, organic, local origin) with cooperative-led traceability systems could incentivize both performance and inclusion, aligning with Sustainable Development Goals such as SDG 12 (Responsible Consumption and Production) and SDG 17 (Partnerships for the Goals).

In sum, addressing regulatory fragmentation and cooperative gaps is not merely a technical challenge—it is a structural imperative. Empowering stakeholders through integrated platforms, supportive policies, and trust-based collaboration can transform disconnected value chain actors into coordinated agents of sustainable food system change.

5 Conclusion

This study provides an integrated analysis of sustainability dynamics within Indonesia's agri-food value chains, encompassing the farm, in-chain, and HORECA sectors. The findings expose structural barriers that inhibit innovation, inclusive growth, and regulatory alignment, while also revealing significant opportunities for transformation through targeted collaboration, technological innovation, and institutional reform. Framing the results within inclusive value chain theory and the innovation adoption framework enables a holistic understanding of sector-specific and cross-cutting constraints, while identifying actionable pathways to achieve more equitable, resilient, and sustainable food systems.

5.1 Farm-level dynamics: advancing equity and capacity

Smallholder farmers face persistent exclusion from formal training systems and financial services, with most relying on personal savings and informal knowledge networks. These constraints reinforce limited market engagement and restrict the adoption of sustainable innovations. Despite relatively

strong participation in farmer cooperatives, weak enabling environments and fragmented policy support diminish their efficacy. Strengthening farmer inclusion will require bundled interventions—including access to credit, capacity-building, and enabling policy frameworks—to bridge systemic gaps and improve market orientation. These findings support the inclusive value chain model, which emphasizes capacity development, institutional linkage, and vertical coordination as levers to enhance rural livelihoods and achieve SDG 2 (Zero Hunger).

5.2 In-chain sector: unlocking collaborative digitalization

While nearly 90% of in-chain actors demonstrate digital confidence, fewer than one in five have implemented technological innovations in recent years. This disparity reflects constraints in capital access, infrastructure, and coordinated investment models. Fragmented relationships with producers and a lack of formalized partnerships—despite stated interest—suggest that trust deficits and governance voids limit the sector's contribution to inclusive development. Multi-stakeholder platforms, digital cooperatives, and contractual frameworks could bridge these gaps, facilitating cost-sharing and co-investment in traceability and inventory systems. Such collaborative mechanisms align with SDG 17 (Partnerships for the Goals) by enabling digital transformation while supporting equitable value distribution.

5.3 HORECA sector: aligning innovation with inclusivity

The HORECA sector stands out for its advanced digital engagement, with nearly 95% of businesses confident in technology use and over 86% adopting new systems. However, this downstream progress has not translated into stronger upstream linkages, with only 32.4% of businesses sourcing from smallholder farmers and no reported participation in cooperatives. While community engagement is relatively high, supplier relationships remain informal and unstructured. Embedding digital platforms within formal sustainability frameworks—such as fair trade certifications, digital traceability, and contract farming—could bridge the divide between consumer-side innovation and inclusive procurement. These actions would enhance the sector's contribution to SDG 12 (Responsible Consumption and Production).

5.4 Regional dynamics: toward contextualized policy interventions

Subnational comparisons underscore stark disparities in market access, education, and financial inclusion. Bali exhibits stronger institutional engagement, while North Sulawesi and Lombok–WNT face pronounced constraints in logistics, education, and credit access. These findings affirm that a one-size-fits-all policy is ill-suited for Indonesia's diverse agro-ecological landscape. Effective food system transformation must be rooted in regional governance models that reflect local needs, capacities,

and infrastructure realities. Institutionalizing adaptive policy frameworks and decentralized innovation systems will be essential to fostering equitable development across regions and building resilience into local agri-food ecosystems.

5.5 Building a resilient and inclusive value chain model

Across all sectors, perceived regulatory support remains low, with only 13.3% of farmers, 8.5% of in-chain actors, and 18.0% of HORECA businesses viewing current frameworks as beneficial. Similarly, cooperative engagement beyond the farm level is absent, revealing systemic fragmentation in value chain governance. These challenges highlight the need for harmonized policy environments, cross-sector coordination, and inclusive multi-actor platforms. A national food system strategy that promotes transparent governance, public-private alignment, and shared infrastructure will be vital to drive long-term value creation, ensure food security, and support environmental sustainability.

Altogether, this study offers timely insights into Indonesia's food system transformation, showcasing how inclusive value chain frameworks and innovation adoption theories can guide evidence-based interventions. The sectoral and regional disparities uncovered underscore the urgency of aligning national strategies with localized realities and inclusive governance mechanisms. The results align with key global targets—specifically SDGs 2, 12, and 17—and reinforce recommendations from the High Level Panel of Experts (HLPE) advocating for equitable, transparent, and resilient agri-food systems. Future efforts must prioritize integrated, participatory approaches that foster digital integration, multi-level cooperation, and shared prosperity across the entire value chain.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

IU: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Validation, Visualization, Writing – original draft. IW: Data curation, Formal analysis, Investigation, Methodology, Writing – review & editing. IA: Formal analysis, Investigation, Writing – review & editing. JBP: Conceptualization, Formal analysis, Funding acquisition, Methodology, Supervision, Validation, Writing – review & editing. NA: Formal analysis,

Investigation, Writing – review & editing. BS: Formal analysis, Investigation, Methodology, Writing – review & editing. SW: Formal analysis, Investigation, Methodology, Writing – review & editing. D: Formal analysis, Investigation, Methodology, Writing – review & editing. GD: Formal analysis, Investigation, Methodology, Writing – review & editing. MS: Formal analysis, Investigation, Methodology, Writing – review & editing. AS: Writing – review & editing, Data curation, Methodology, Project administration, Investigation.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The author(s) declare that no Gen AI was used in the creation of this manuscript.

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