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Utilising Agricultural Downstreaming as a Method to Enhance Food Security for Rural Populations

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Abstract

Agricultural downstreaming in Buru Regency improves food security and rural economies. Farmers receive low value-added returns and are vulnerable to market price fluctuations because agricultural produce is mostly sold raw. Downstreaming transforms agricultural products into higher-value goods, expanding market access and job opportunities. This study is qualitative and phenomenological. This method was chosen because it can deeply examine the Buru community's worldview, traditions, and relationships with value systems and their environment. The study included farming and fishing households in Parbulu, Seith, Waegeren, Waitele, Hatawano, Wamlana, and Waeperang villages in Buru Regency, Maluku. Following in-depth interviews and participant observation, the researchers used MAXQDA 24 to thematically analyse data from 22 purposively selected informants. The findings show that the community's survival strategies depend on local knowledge about ecologically balanced food processing and crop diversification. Technology adoption is driving downstream processes to add value to products, but success depends on village government policies, social capital, and women's traditional wisdom, forming a holistic food security model resilient to environmental and economic challenges. Limited collective awareness of the long-term effects of environmental change and a lack of innovations to create more competitive, value-added products limit this study. Thus, future research should develop climate change adaptation models with appropriate technology and strengthen coastal women's entrepreneurship strategies to move from subsistence to economic independence.

Keywords: adaptation; downstreaming; agriculture; village; culture

Introduction

Food security remains a complex global challenge, particularly for archipelagic regions highly vulnerable to fluctuations in food distribution and prices. Buru Regency (Jamaludin et al., 2026), a potential food production hub in Maluku, faces the challenge of shifting from a supplier of raw materials to a centre for value-added processing (Fesanrey et al., 2025). Agricultural downstreaming strategies have emerged as a crucial instrument for strengthening rural economic structures. Consistent with Blanchard's Value-Added

Theory (Blanchard et al., 2026), downstreaming is not merely a technical processing activity but a strategy to extend the commodity value chain, directly impacting improved farmer welfare and local food stability (Reardon & Timmer, 2012).

Theoretically, the success of downstream processing in rural areas relies heavily on integrating technology and traditional ecological knowledge. Berkes (2012) argues that intergenerationally transmitted local knowledge underpins sustainable cultivation practices (Fei et al., 2026). In Buru Regency, local wisdom regarding food processing and crop diversification serves not merely as a cultural heritage but as an adaptive mechanism ensuring food availability amidst limited modern infrastructure. Pattinama's research reinforces the argument that integrating downstream processing technologies without disregarding local cultural roots builds greater resilience to both ecosystem and economic shocks (Pattinama, 2009).

However, downstream processing cannot operate in a vacuum. Douglass North's New Institutionalism theory emphasises that local institutions, specifically village-level institutions, act as key drivers by providing the framework for regulation and community collaboration (North, 2016). In Buru Regency, the synergy between government support and community social capital is a decisive factor in the effective adoption of downstream processing technologies. As Ostrom argues, robust collective resource governance at the village level is a prerequisite for the sustainability of community-based economic development programs (Ostrom, 2000).

Despite the significant potential for downstream processing in Buru Regency, a gap persists between policy and implementation, particularly in value-added innovation and adaptation to environmental change. While most prior studies have focused on increasing upstream production, few have examined how local knowledge structures and the resilience of village institutions interact to support downstream processing. Therefore, this study aims to analyse the strategic roles of local knowledge and institutional support in accelerating agricultural downstream processing in Buru Regency. This study is expected to provide a holistic food security strategy model, in which downstream processing technology acts as the economic engine, while local wisdom and village institutions serve as the anchors for its sustainability.

Materials and Methods

This study uses a qualitative, phenomenological approach. This approach was selected because it can deeply explore the lived experiences of the Buru people, including how they perceive the world, interpret traditions, and connect their daily lives with value systems and their environment (Williams, 2021). Phenomenology seeks to understand

reality from the informants' perspectives, thereby yielding more authentic and contextual research findings (Milevsky, 2026). Consequently, this study goes beyond merely describing phenomena; it aims to capture the underlying meanings embedded in the cultural and ecological practices of the Buru community.

The research was conducted among farming and fishing households across seven villages (Parbulu, Seith, Waegeren, Waitele, Hatawano, Wamlana, and Waeperang) in Buru Regency, Maluku, focusing on characteristics typical of rural communities. The selection of these locations was based on the villages' integral role in the lives of the Buru people, particularly regarding the relevance of downstream processing activities to food security, encompassing subsistence, sustainability, and social systems.

Furthermore, the selection of these villages considered accessibility, the presence of women, and the availability of relevant informants. Given the broad geographical scope, this study highlights downstream processing as a strategy for community food security.

Informants were selected using purposive sampling, a deliberate selection process based on specific criteria (Gill, 2020). The primary criterion was that individuals possess experience and a deep understanding of food systems and the village economy. Key informants included: 1) village heads, 2) housewives, 3) female fish traders, 4) female farm labourers, and 5) women's farmer and fisher groups. Based on these criteria, the study selected 22 informants. Data were collected through in-depth interviews using a semi-structured guide, allowing informants to speak freely while remaining focused on the research objectives (García-Jurado et al., 2021; Johansson et al., 2024). Questions centred on life experiences, food security practices, and the meanings the informants attributed to agricultural downstream activities. Researchers also used participant observation; they engaged in farmers' economic activities, such as processing the catch, sales revenue-sharing systems, and subsistence activities, to gain firsthand insight into the role of agricultural downstream processing. Before interviews, researchers explained the study's purpose and obtained informed consent. Researchers built rapport to create a comfortable atmosphere and encourage informants to speak openly. Researchers also used local languages or interpreters when necessary to ensure effective communication.

This study upholds ethical principles, including informant consent (all interviews were recorded with permission), data confidentiality (protecting informant identities to prevent negative repercussions), and cultural respect (adhering to local customary norms, including ritual protocols and social interactions). Regarding non-intervention, researchers sought not to disrupt customary activities but rather to observe and document them. By applying these ethical principles, the study aims not only to generate valid data but also to build trust with the Buru community.

The analysis followed a four-stage naturalistic analysis pattern: category collection (identifying key themes from interviews and observations, such as community network structures, natural resource utilisation, individual and community awareness, and need-fulfilment actions); direct interpretation (understanding the meaning of informants' statements without excessive reduction); pattern formation (discovering inter-category connections, such as the relationship between network structures and need-fulfilment actions); and naturalistic generalisation (formulating conclusions relevant to the context of coastal women that also allow for comparison with women's communities in other regions). For data processing and analysis, the author utilised MAXQDA 24 software developed by VERBI GmbH, which enables researchers to code text, identify themes, analyse inter-category relationships, and generate comprehensive data visualisations (De Lerma & de las Mercedes Botija Yagüe, 2022).

Results

This study generated data on the role of coastal women in supporting food security, utilising interview results systematically organised in a tabular format. The interview data were processed using MAXQDA 24 software developed by VERBI GmbH, which enables researchers to code text, identify themes, analyse relationships between categories, and generate data visualisations, as illustrated in the following figure.

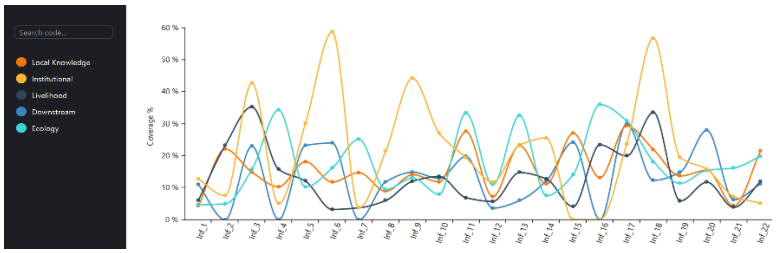


Figure 1. Code Trends Multiple Documents
Source: Field Data Processing with MAXQDA 24 Software

This study shows that the institutional narrative is the most dominant discourse among informants, comprising 124 data segments. This indicates that institutional capacity building, particularly through the "community collaboration" sub-theme, which appeared most frequently (102 segments), is viewed as a primary pillar within the ecosystem under study. This dominance is further confirmed by the percentage coverage graph, where the institutional category frequently shows extreme spikes compared to other categories, reflecting that policy issues and community collaboration are the main focus for most research subjects.

Regarding the "local knowledge" dimension, the knowledge structure is proportionally divided between value preservation and technical practices. The "inheritance of knowledge" sub-theme (41 segments) highlights efforts to transmit values across generations, with Inf_17 emerging as a key figure, or "knowledge guardian," who contributed the most information. Meanwhile, the "local wisdom in food processing" sub-theme (33 segments) shows how local knowledge manifests in practical food-processing actions, supported by informants such as Inf_3 and Inf_9. This indicates a division of roles or knowledge specialisation within the community, where some informants focus on upholding the underlying philosophy of the knowledge, while others concentrate on its technical application.

Qualitatively, dynamic interconnections between categories are evident in the fluctuating, intersecting line patterns. The relationship between Ecology, Livelihood, and Local Knowledge reveals an integration of environmental understanding with community survival strategies. However, gaps exist in certain areas such as "environmental changes" and "value-added" which show very low coverage; this suggests that awareness of long-term environmental changes or product value-added innovation is not yet a top priority in the informants' current collective memory. Overall, the data depicts a social system heavily reliant on community collaboration and the heritage of local knowledge, yet one that still needs strengthening in technology and environmental adaptation.

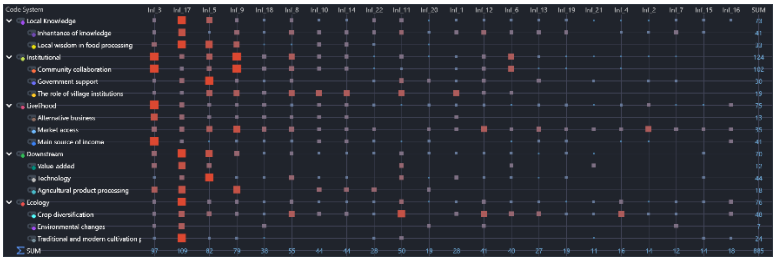


Figure 2. Code Matrix Browser
Source: Field Data Processing with MAXQDA 24 Software

Based on the visual data, this qualitative analysis shows that the narrative on institutional aspects is the most dominant discourse among informants, comprising 124 data segments. This phenomenon indicates that strengthening institutional capacity, particularly through the "community collaboration" sub-theme, which appeared most frequently with 102 segments, is viewed as a primary pillar within the social ecosystem under study. This dominance is confirmed by the percentage coverage charts, where the institutional category frequently exhibits extreme spikes compared to other categories,

notably for informants Inf_6 and Inf_18, reflecting that policy issues and community partnerships are the central focus of attention.

Within the "Local Knowledge" dimension, comprising 73 data segments, the knowledge structure is proportionally divided between the preservation of values and practical manifestations. The sub-theme "Inheritance of knowledge" (41 segments) stands out as an effort to transmit values across generations; notably, Inf_17 emerges as a key figure, or "knowledge keeper," contributing the most information (11 segments). Meanwhile, the sub-theme "Local wisdom in food processing" (33 segments) shows how local wisdom is implemented through practical food-processing activities, supported by a group of informants including Inf_3, Inf_5, and Inf_9. This division reveals a specialisation of roles within the community: some informants act as guardians of the knowledge's historical philosophy, while others focus more on technical, on-the-ground applications.

Qualitatively, a dynamic interconnection exists between categories, evidenced by the fluctuating, intersecting line patterns on the coverage graph. The close relationship among "Ecology" (76 segments), "Livelihood" (75 segments), and "Local Knowledge" demonstrates that the community's understanding of the environment and local heritage is deeply linked to their survival strategies. However, the study also identifies gaps in certain areas; specifically, the sub-themes "Environmental changes" (7 segments) and "Value-added" (12 segments) show very low coverage. These findings strongly suggest that awareness regarding long-term environmental changes and product value-added innovation has not yet become a primary priority, nor has it been widely internalised within the informants' current collective memory.

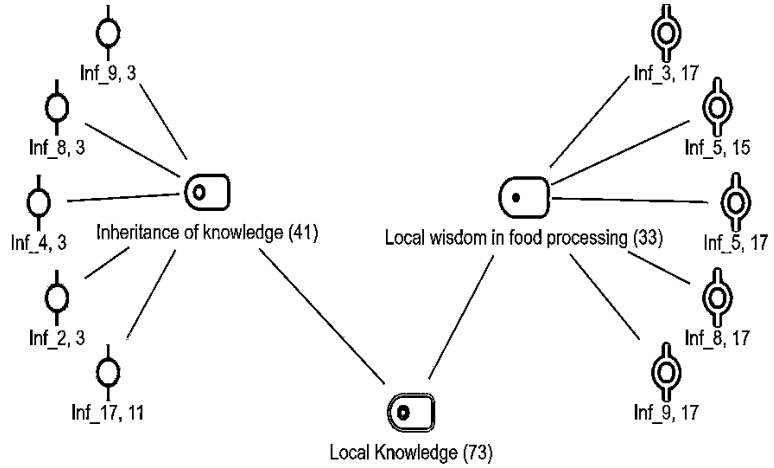


Figure 3. Local Knowledge - Code-Subcodes-Segments Model
Source: Field Data Processing with MAXQDA 24 Software

A qualitative analysis of the "Local Knowledge" dimension shows that the community's knowledge structure rests on the transmission of traditional values and practices, comprising 73 data segments. This dimension is divided into two complementary pillars: "Inheritance of knowledge" (41 segments) and "Local wisdom in food processing" (33 segments). The "Inheritance of knowledge" pillar highlights the intergenerational continuity of information; informant Inf_17 emerges as a key contributor with 11 data segments, supported collectively by other informants such as Inf_2, Inf_4, Inf_8, and Inf_9. This indicates that the preservation of traditional values remains robust, driven by the roles of central figures within the community.

Meanwhile, the "Local wisdom in food processing" pillar represents the practical application of this knowledge in daily life, particularly regarding food self-sufficiency. Narratives within this aspect are shaped by relatively balanced contributions from informants such as Inf_3, Inf_8, and Inf_9 (17 segments each), as well as Inf_5, who offers perspectives from two distinct viewpoints (15 and 17 segments). Qualitatively, this structure demonstrates that local knowledge extends beyond mere collective memory or historical heritage; it is actively manifested in the technical skills used to process natural resources. The integration of these two pillars illustrates a healthy knowledge ecosystem, where the theories of past heritage and contemporary practices operate in tandem to sustain the community's identity and resilience.

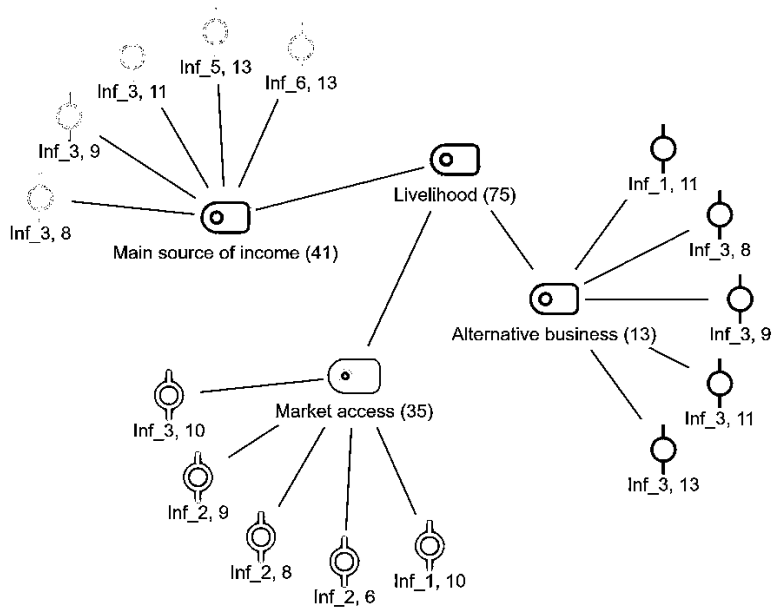


Figure 4. Livelihood - Code-Subcodes-Segments Model
Source: Field Data Processing with MAXQDA 24 Software

A qualitative analysis of the livelihood dimension shows that the economic resilience of the studied community rests on three strategic elements, comprising 75 data segments. The most dominant element is the "main source of income" (41 segments), representing the community's reliance on a primary income pillar. Qualitatively, narratives from key informants such as Inf_3, Inf_5, and Inf_6 strongly support the consensus on the importance of stable primary income.

The second strategic element is "market access" (35 segments), which highlights economic connectivity as a prerequisite for business continuity. Collective perspectives from Inf_1, Inf_2, and Inf_3 indicate that market reach and distribution channel efficiency are crucial to strengthening the local economy's bargaining position. Meanwhile, the "alternative business" element (13 segments), despite having the lowest frequency, reflects creative initiatives for economic diversification aimed at mitigating the risk of failure in the primary income source. The involvement of informants such as Inf_1 and Inf_3 in this sub-theme demonstrates a growing awareness of the importance of economic resilience through new business opportunities beyond traditional sectors.

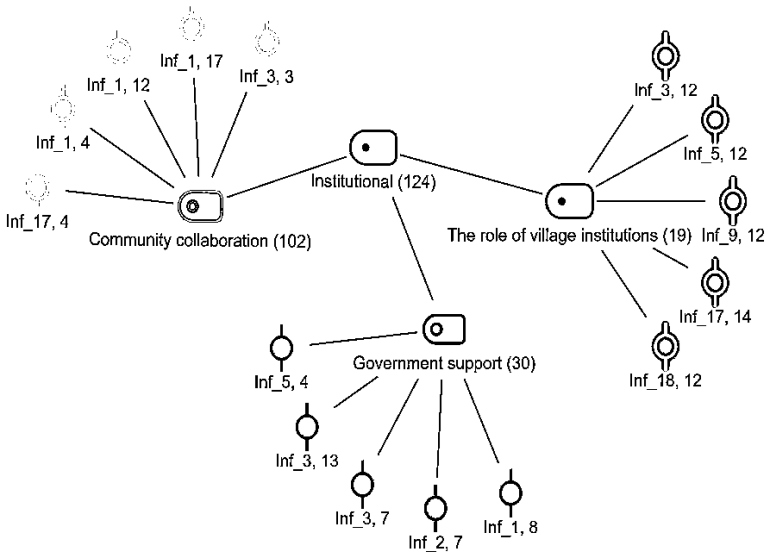


Figure 5. Institutional - Code-Subcodes-Segments Model
Source: Field Data Processing with MAXQDA 24 Software

A qualitative analysis of the institutional dimension reveals that the primary driving forces within this ecosystem are organizational structures and partnerships, comprising a total of 124 data segments. The dominant pillar is "Community collaboration" (102 segments), indicating that collaboration among residents forms the foundation of community activities. Qualitatively, this dominance is driven by significant contributions

from informants such as Inf_1 and Inf_17, reflecting strong social ties and a collective awareness of the need to cooperate toward shared goals.

The second pillar is "Government support" (30 segments), representing the role of external actors in providing support frameworks and policies. Narratives regarding government support frequently emerge from the perspectives of Inf_1, Inf_2, Inf_3, and Inf_5, highlighting both expectations for and recognition of formal interventions by authorities as a complement to local initiatives. Meanwhile, the pillar concerning "The role of village institutions" (19 segments) underscores the function of village officials as grassroots facilitators. The involvement of informants such as Inf_3, Inf_9, Inf_17, and Inf_18 in this sub-theme demonstrates that local institutions are viewed as vital bridges connecting macro-level policies with micro-level practices on the ground. Overall, this structure depicts an institutional system that relies heavily on internal strengths, specifically community collaboration, while simultaneously integrating structural support from both the government and village authorities.

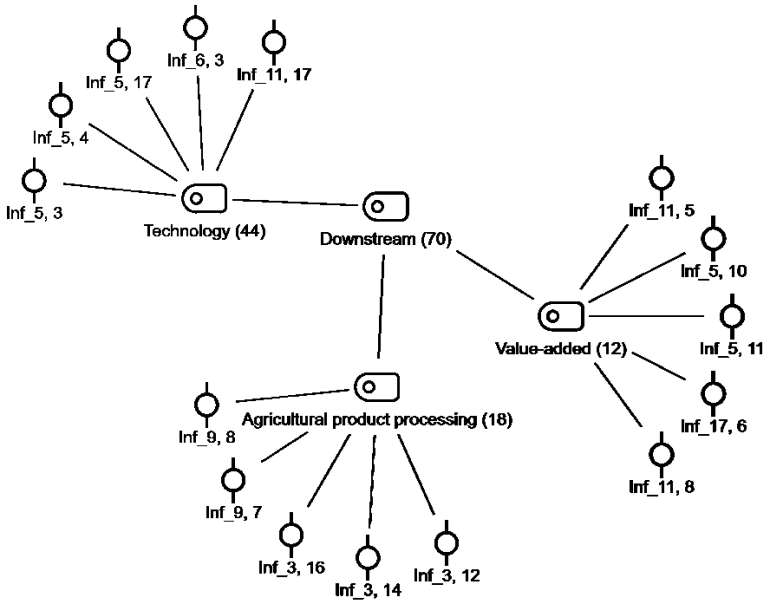


Figure 6. Downstream - Code-Subcodes-Segments Model
Source: Field Data Processing with MAXQDA 24 Software

A qualitative analysis of the downstream dimension reveals that the post-harvest product development strategy in this community comprises 70 data segments across three technical pillars. The most prominent pillar is Technology (44 segments), indicating that the adoption of tools or mechanisation methods is the primary focus of the value-added process. Qualitatively, the narrative around technology is strongly driven by

informants such as Inf_5, Inf_6, and Inf_11, reflecting a consensus that technical upgrades are the main engine of production modernisation.

The second pillar, Agricultural product processing (18 segments), represents the practical implementation stage where raw materials are transformed into finished products. This perspective is consistently supported by Inf_3 and Inf_9, pointing to a specific group of informants possessing specialised expertise in the product processing chain. Meanwhile, the Value-added pillar (12 segments), despite having the lowest frequency, reflects the strategic dimension of generating economic value beyond standard processing. The involvement of informants such as Inf_11, Inf_5, and Inf_17 in this sub-theme indicates a growing awareness of the importance of product innovation for enhancing market competitiveness, although the scope of this area still requires expansion relative to the focus on purely technological aspects.

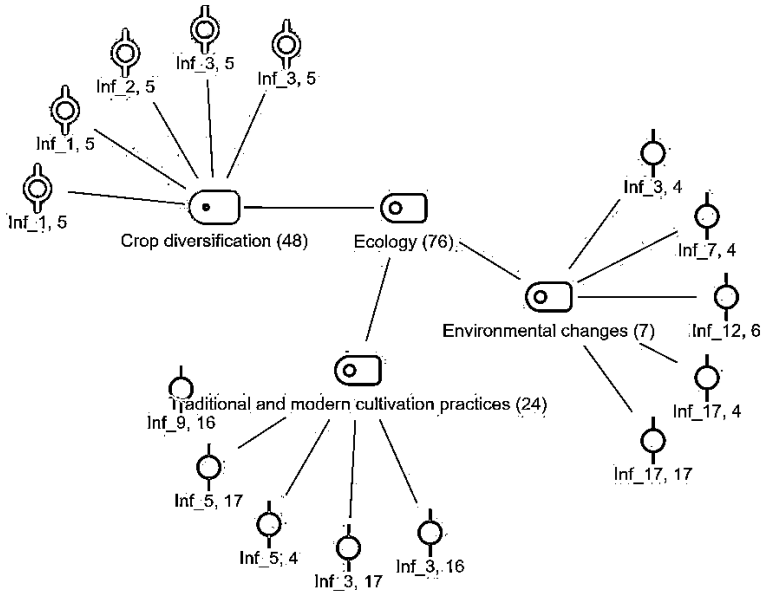


Figure 7. Ecology - Code-Subcodes-Segments Model
Source: Field Data Processing with MAXQDA 24 Software

A qualitative analysis of the ecological dimension reveals that the community's environmental awareness rests on three main pillars, comprising a total of 76 data segments. The most dominant pillar is "crop diversification" (48 segments), indicating that crop diversification is the primary ecological strategy the community understands and implements. Qualitatively, narratives regarding this diversification are supported by the collective perceptions of informants such as Inf_1, Inf_2, and Inf_3, reflecting the community's efforts to maintain food security and the stability of their land's ecosystem.

The second pillar, "traditional and modern cultivation practices" (24 segments), highlights the interplay between ancestral farming methods and contemporary cultivation techniques. Insights from informants such as Inf_3, Inf_5, and Inf_9 illustrate how the community seeks to integrate local wisdom with modern innovations to optimize agricultural yields. Meanwhile, the "environmental changes" pillar (7 segments) appears with the lowest frequency, qualitatively signalling that long-term environmental change has not yet become a central topic of discussion among the informants. Although informants such as Inf_3, Inf_7, Inf_12, and Inf_17 contributed to this sub-theme, the limited scope of the data suggests a need to strengthen ecological literacy regarding the impact of climate change on local agricultural systems.

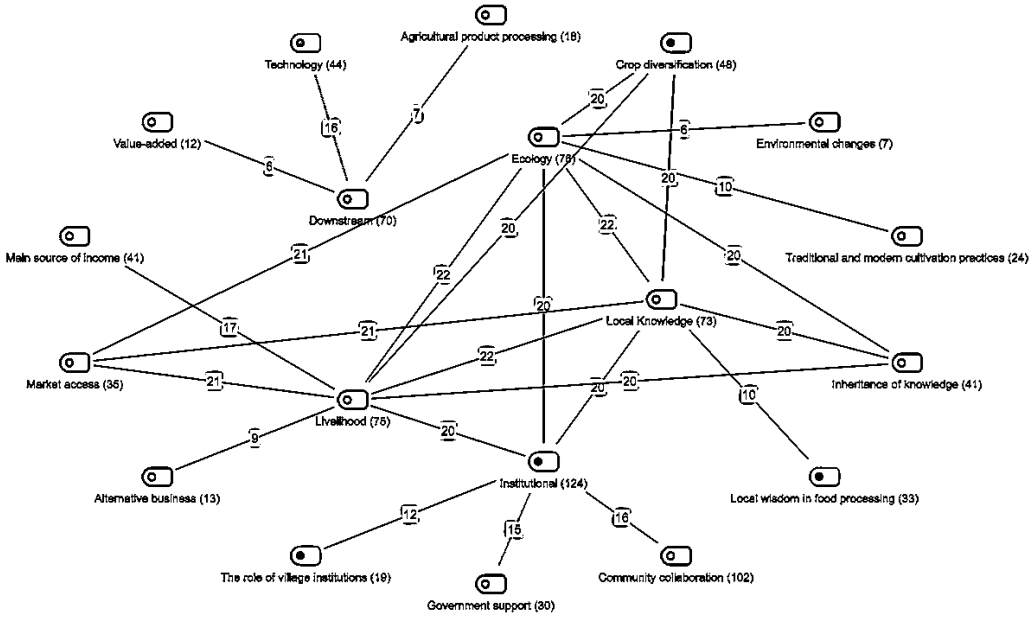


Figure 8. Code Co-occurrence Model (Code Occurrence)
Source: Field Data Processing with MAXQDA 24 Software

This qualitative study reveals a highly strong and cohesive integration among the five main dimensions, with the Institutional (124) and Ecology (76) categories acting as central anchors or connectors within the system. The strongest relationships (highest correlation weight of 22) occur between the Institutional category and both Ecology and Local Knowledge, as well as between Livelihood and Ecology. Qualitatively, this indicates that institutional policies and local livelihood strategies are heavily dependent on ecological conditions and the utilisation of traditional knowledge. Uniform interconnections with a weight of 20 among nearly all major categories (such as the links from Downstream to Ecology and Institutional to Livelihood) underscore an intertwined

ecosystem in which the success of one aspect (e.g., downstream product processing) is largely determined by institutional support and environmental sustainability.

At a more granular level, the map visualises how technical sub-themes are linked to the main pillars through varying connections. For instance, Market access (35) shares strong ties with the Downstream (21) and Livelihood (21) dimensions; qualitatively, this signifies that market access serves as a critical bridge connecting product processing activities with improvements in the informants' standard of living. Conversely, sub-themes such as Environmental changes (7) and Alternative business (13) exhibit lower relationship weights (6 and 9, respectively), indicating that while these issues exist within the system, they are not yet strongly integrated or prioritised within the current dynamics of inter-category relationships. Overall, this network illustrates a holistic community development model in which Community collaboration (102), situated within the institutional dimension, acts as the primary driving force binding all research variables together.

Discussion

This discussion elaborates on research findings on agricultural downstreaming strategies to strengthen food security in Buru Regency, using an integrative qualitative analytical lens. Based on an analysis of field data, the downstreaming phenomenon in this region is viewed not merely as a process of industrial mechanisation, but as a manifestation of synergy among village-level institutional strengths, community social capital, and the utilisation of deeply rooted local knowledge. The analysis examines how the interplay of community collaboration and institutional support catalyses increased product value-added while maintaining ecological balance through traditional wisdom passed down through generations. By exploring the dialectical relationships among the identified dimensions—from upstream to downstream—this section shows how Buru Regency's social and cultural structures respond to food security challenges amid environmental and global economic change.

The Significance of Indigenous Knowledge within Rural Societies

In the context of agricultural downstreaming strategies aimed at enhancing food security in Buru Regency, local knowledge emerges as an intellectual and practical foundation, ensuring that value-added policies remain grounded in cultural roots. This aligns with Ecological Capital theory (Costanza, 1999), which views traditional knowledge as an ecological asset crucial to community resilience. This qualitative study reveals that Buru Regency communities' knowledge structure relies heavily on transmitting

traditional values and practices, comprising 73 data segments. This dimension is divided into two complementary strategic pillars (Figure 3): Inheritance of knowledge (41 segments), which ensures the intergenerational continuity of information, and Local wisdom in food processing (33 segments), which serves as the technical basis for implementing downstreaming at the grassroots level. This phenomenon reinforces Subejo's findings that local knowledge systems are not merely relics of the past but adaptive mechanisms providing sustainable solutions for food sovereignty (Subejo et al., 2026).

"This qualitative study reveals that the knowledge structure of Buru Regency communities relies heavily on the transmission of traditional values and practices (73 data segments). As mapped in the thematic hierarchy structure in Figure 2, this dimension is systematically divided into two strategic pillars: Inheritance of knowledge (41 segments) and Local wisdom in food processing (33 segments). This visualisation underscores that local knowledge is not merely a collection of random information but a structured intellectual system designed to support community resilience."

The presence of Inf_17 as a key figure or "knowledge guardian" indicates that traditional authority plays a crucial role in guiding technology adoption without eroding local identity; this informant provided the most significant contribution, accounting for 11 data segments. Theoretically, this process reflects Bandura's Social Learning Theory, wherein collective learning occurs through social interaction and the role modeling of key figures within the community (Bandura, 1978). Qualitatively, the success of downstreaming in this region hinges heavily on the systemic integration of local knowledge with other dimensions. Network analysis (Figure 8) reveals a robust relationship, with the highest correlation weight (22) observed between the "Local Knowledge" category and the "Institutional" and "Ecology" categories. This interconnection supports Adger's research on Social-Ecological Systems, which posits that the success of natural resource governance largely depends on the extent to which formal institutions can collaborate with local knowledge (Neil Adger et al., 2021).

Local knowledge on food processing, supported by informants such as Inf_3, Inf_8, and Inf_9 (each contributing 17 segments), shows the potential for role specialisation within the downstream supply chain. However, key challenges include limited discussion of value-added innovation (12 segments) and adaptation to environmental changes (7 segments). This gap is evident in the coverage graph (Figure 1) and the linkage models (Figures 6 and 7), where these aspects have not yet become primary priorities in the informants' collective memory. These findings align with Lundholm's observations, which note that while local knowledge is robust regarding

traditional technical aspects, obstacles remain in integrating it with modern market dynamics and global climate change (Lundholm et al., 2020). This strongly indicates that future downstreaming strategies must strengthen technological literacy and climate mitigation efforts, while continuing to position local wisdom as the primary driver of long-term resilience and food security.

Community Institutional Assistance for the Execution of Downstream Processing

The resilience of local institutions ultimately culminates in strengthening the community's livelihood dimension, which in this study comprises 75 data segments. The most dominant element within this dimension is the "main source of income" (41 segments), indicating that the stability of primary income remains a fundamental priority for informants (such as Inf_3, Inf_5, and Inf_6) amidst the transition toward downstream processing. Qualitatively, the Buru Regency community's survival strategies rely heavily on market access (35 segments). This aligns with Ribot and Peluso's Theory of Access, which posits that access is not merely a matter of ownership rights but the ability to derive benefits from resources through authority, capital, and markets (Ribot & Peluso, 2003). Figure 4 clearly illustrates this systemic relationship, where market access bridges local economic potential and broader distribution networks.

This economic transformation is reinforced by the "downstream" dimension, encompassing 70 data segments, with the technology pillar emerging as the most prominent factor (44 segments). The dominance of narratives regarding technology driven by Inf_5, Inf_6, and Inf_11—reveals a collective consensus that the modernization of production tools and methods serves as the primary engine for creating value-added agricultural products. This phenomenon confirms Rogers' Diffusion of Innovations theory, in which the adoption of technology by key actors (such as expert informants) catalyses socio-economic change at the rural level (Rogers, 1976). As illustrated in Figure 6, this technology pillar works in synergy with agricultural product processing (18 segments) to transform raw materials into finished goods, a practical implementation stage closely overseen by expert informants (Inf_3 and Inf_9).

Nevertheless, the linkage analysis in Figure 8 reveals that the successful integration of technology (downstream processing) and economic resilience is heavily determined by the Ecology variable (76 segments). The strong correlation between the ecological and livelihood dimensions underscores that downstream development in Buru Regency must not disregard environmental carrying capacity. The finding that crop diversification (48 segments) dominates as a primary ecological strategy indicates that the community already has a robust foundation for adaptation. This aligns with the

Livelihood Portfolio framework developed by Killa, in which diversification of ecological assets serves as natural insurance against external shocks (Killa et al., 2026). It is the synergy among modern technology, village institutional capacity—as emphasised in Uphoff's concept of Local Institutional Development (Uphoff, 1993), and the preservation of ecological assets that will ensure agricultural downstreaming not only boosts economic growth figures but also guarantees sustainable food resilience for the entire community.

The Role of Downstream Processing in Ensuring Food Security

The dominance of the crop diversification pillar (48 segments) indicates that the community in Buru Regency possesses a natural defence mechanism against ecological vulnerability. As visualised in Figure 7, this crop diversification is closely linked to the stability of the main source of income (41 segments), underscoring that environmental sustainability and biodiversity are absolute prerequisites for livelihood sustainability. This aligns with Folke's concept of social-ecological resilience, where a social system's ability to persist relies heavily on the integrity of its ecosystem (Folke, 2006). These findings also reinforce livelihood diversification theory, which posits that diversifying assets and activities is a key strategy for rural households to mitigate economic and ecological risks (Ellis, 2000).

The dominance of the technology pillar in downstream processing (44 segments) indicates that mechanisation adoption has been a primary driver. The distribution of data contributions presented in Figure 5 shows that the consensus regarding the importance of processing technology is consistently supported by key informants, specifically Inf_3, Inf_5, and Inf_9. This aligns with Hayami and Ruttan's research on induced innovation, where technological change in agriculture is driven by local needs to overcome resource constraints and increase value addition (Ruttan & Hayami, 1973). This shows that aspirations to modernise agricultural equipment have been internalised across various actors within the downstream supply chain in Buru Regency.

This inter-dimensional integration culminates in the systemic relationships illustrated by the network analysis (Figure 8). The relationships, characterised by balanced correlation weights (averaging 20–22) between key categories, such as connections from Downstream to Ecology and Institutional to Livelihood, underscore that no single aspect can succeed in isolation. Qualitatively, the model depicts "Community collaboration" (102 segments) within the institutional dimension as the "driving force" or centripetal force binding all variables together. This confirms Putnam's argument regarding social capital, wherein collaborative networks and trust among

citizens serve as the lubricant for the engine of local economic development (Putnam, 1994).

However, a deeper look at the data shows that while the pillars of technology (44 segments) and market access (35 segments) are taking shape, challenges related to "environmental changes" (7 segments) require continued vigilance. As evidenced by the document trend graph (Figure 1), a gap in discourse regarding climate change indicates that awareness of environmental mitigation has not yet been strongly integrated into the informants' collective consciousness. Adger's research on vulnerability warns that an absence of discourse on climate adaptation can undermine long-term resilience, even when social capital appears robust (Neil Adger et al., 2021). This creates an opportunity for future policy interventions to strengthen climate adaptation literacy, thereby protecting the ecological assets that underpin downstream processing.

The agricultural downstreaming strategy in Buru Regency is not merely a technical transformation but a social movement rooted in local wisdom. By positioning village institutions as a critical bridge—as emphasised in the study on polycentric governance by Wit & Freitas (Wit & Freitas, 2019)— Buru Regency holds immense potential to achieve self-reliant food sovereignty, where economic stability and ecological sustainability advance hand-in-hand toward long-term resilience.

Dissemination of Knowledge and Environmental Conservation

Taken together, the dimensions under study form an interconnected ecosystem, with the Institutional dimension (124 segments) serving as the binding framework for the others. The prominence of Community collaboration (102 segments) indicates that social capital is the most critical non-physical infrastructure for the effectiveness of downstreaming policies. This aligns with New Institutionalism theory, which emphasises that the "rules of the game" within local institutions are decisive for economic efficiency and resource sustainability (Chatzinikolaou & Vlados, 2026). As visualised in Figure 8, the strength of the relationship (correlation weight of 22) between the Institutional dimension and the Ecology and Local Knowledge dimensions underscores that successful food governance in Buru Regency relies not merely on technical interventions, but on the capacity of local institutions to orchestrate traditional knowledge and the preservation of natural assets.

Previous research by Amin on "Sacred Ecology" demonstrates that local knowledge is not merely a legacy of the past but an adaptive management system crucial for ecosystem resilience (Amin et al., 2026). This synergy culminates in stronger Livelihoods (75 segments), where the stability of the "Main source of income" (41

segments) and expanded "Market access" (35 segments) indicate household economic success. Qualitative data derived from network analysis reveal a strong correlation (21) between market access and the Downstream dimension (70 segments), particularly regarding the Technology pillar (44 segments). This confirms that the agricultural processing technologies adopted by informants (such as Inf_3, Inf_5, and Inf_9) have acted as engines for value creation, directly bolstering farmers' bargaining power in the market, paralleling Li's (2014) findings on how appropriate technology in a rural context can drive social transformation without severing the community's cultural roots.

However, the visual mapping in Figures 1 and 7 highlights strategic vulnerabilities within the discourses on "Environmental changes" (7 segments) and "Innovative value-added" (12 segments). These gaps indicate that, while the current socio-ecological system remains relatively stable, adaptive capacity in the face of global climate change requires enhanced literacy. Drawing on the concept of socio-ecological resilience, a failure to integrate global environmental dynamics into local knowledge risks creating a "rigidity trap" (Folke, 2006). Without integrating progressive environmental awareness, resilience rooted in inherited knowledge risks becoming static when confronted with rapidly shifting global ecosystem dynamics.

The agricultural downstreaming strategy in Buru Regency exemplifies a community-based development model. Long-term success in achieving food sovereignty hinges on village institutions consistently facilitating collaboration, maintaining crop diversification as an ecological safeguard, and driving technological modernisation grounded in local wisdom. Consequently, Buru Regency not only produces agricultural commodities but also establishes a resilience system capable of independently and sustainably ensuring food availability, affordability, and stability.

Conclusion

This study concludes that the agricultural downstreaming strategy to enhance food security for the people of Buru Regency is a holistic ecosystem whose success hinges on strong social capital and the integration of local knowledge. Village-level institutional support, driven by community collaboration and emerging as the dominant pillar across 102 data segments, serves as the primary engine ensuring that downstreaming is not merely a technical transformation but an organised social movement. This institutional strength is reinforced by local knowledge, which serves as an intellectual foundation; the intergenerational transmission of values, guided by key figures such as Inf_17, ensures that adoption of food processing technology remains grounded in local cultural roots. The synergy between strong institutions and preserved local wisdom supports livelihood

stability through higher primary income and expanded market access, directly strengthening economic resilience and household food availability.

Furthermore, the contribution of downstream processing to food security in Buru Regency is heavily dependent on a commitment to ecological preservation a legacy upheld through generations via crop diversification practices. The strong correlation between local knowledge, institutions, and ecology shows that environmental sustainability is a prerequisite for the continued supply of raw materials to village-based agricultural industries. However, this study offers a critical observation: to achieve its full potential, future downstreaming strategies must address existing gaps in product value-added innovation and climate change literacy, both of which remain low. Thus, strengthening food security in Buru Regency requires a synthesis of technological modernisation in downstream processing and enhanced environmental adaptation, while maintaining community collaboration and local wisdom as the primary driving forces.

Research Limitations

Despite the in-depth insights provided by this phenomenological study, several methodological and contextual limitations remain. First, the qualitative design and reliance on 22 purposively selected informants—predominantly female farm labourers, female fish traders, housewives, and village heads across seven villages—restrict the broader generalisability of the findings. While this demographic focus successfully captured the critical role of women and village-level institutions in local food security, it may underrepresent the perspectives of other vital supply-chain actors, such as male farmers, regional policymakers, or mid-level commercial distributors. Consequently, the naturalistic generalisation of this community-based model is largely confined to archipelagic regions with similar socio-ecological profiles.

Second, the study is built entirely upon qualitative perceptions and self-reported lived experiences. Although MAXQDA was utilised to structure and measure thematic segment frequencies, the research lacks empirical macroeconomic validation. The study does not incorporate quantitative data—such as exact measurements of household income fluctuations, agricultural yield volumes, or the specific financial margins generated by the downstream products—to objectively quantify the economic impact of the technological adoption discussed by the informants.

Finally, the phenomenological approach inherently limits the scope to the informants' current collective memory and awareness. As explicitly identified in the results, there was a significantly low discourse regarding long-term "environmental changes" (7 segments) and advanced "value-added" innovation (12 segments). Because the

community's current ecological literacy regarding global climate shifts is low, the study cannot comprehensively project how future climate extremes or advanced industrial disruptions might threaten the agricultural downstreaming framework in Buru Regency. Future research should integrate quantitative economic impact assessments and broader climate forecasting to build upon these qualitative findings.

Research Recommendations

Based on the findings and limitations of this study, several recommendations for future research are proposed to further advance the understanding and implementation of agricultural downstreaming for food security in Buru Regency.

First, given the significant gap in discourse regarding long-term environmental changes, future studies must prioritize the intersection of climate change adaptation and local ecological knowledge. Research should focus on developing and testing climate-smart agricultural frameworks that can be seamlessly integrated into the existing traditional cultivation practices of the Buru community. Enhancing climate literacy at the grassroots level is essential to ensure that downstreaming initiatives remain resilient against global ecological shifts.

Second, to address the limited focus on product value-added innovation identified in the current qualitative data, future research should explore advanced post-harvest technologies and market-driven product diversification. Feasibility studies and action research focused on specific, accessible mechanisation and packaging innovations are recommended. Such studies will help identify practical ways to elevate the economic competitiveness of local commodities without disrupting the established social capital.

Third, future investigations should transition towards mixed-methods or purely quantitative research designs to empirically validate the phenomenological models proposed in this study. By measuring specific macroeconomic indicators—such as exact changes in household income, precise margins of value-added products, and regional food security indices before and after technological interventions—researchers can provide concrete data to support evidence-based policy formulation.

Finally, to build a more comprehensive picture of the agricultural supply chain, future research should expand its demographic and stakeholder scope. While this study successfully highlighted the critical contributions of women and village-level institutions, subsequent studies should incorporate perspectives from a wider array of actors. Engaging regional policymakers, private-sector distributors, and male farmers will provide a holistic understanding of the polycentric governance required to scale community-based downstreaming programs into robust regional economic engines.

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Author's Contribution

FAY: Methodology, Writing - Review & Editing, Supervision.

Conflict of Interest

The authors declare no conflict of interest

Data Availability Statement

Data will be made available on request.

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