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From Product Validation to Commercialization: Value Chain Analysis and Enterprise Development of Golden Apple Snail *(Pomacea canaliculata*) Sausage as a Community-Based Agribusiness Innovation

Joyce D. Cuyangoan

Agribusiness/Entrepreneurship Program, Mountain Province State University, Mountain Province, Philippines/jdcuyangoan@gmail.com

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Abstract

This study examined the commercialization feasibility, value chain structure, and enterprise development potential of golden apple snail (*Pomacea canaliculata*) sausage as a continuation of a prior product validation study that established its sensory, nutritional, microbiological, and physicochemical acceptability. Using a mixed-methods descriptive-developmental design, data were gathered from 60 purposively selected participants in Western, Mountain Province, including farmers, snail collectors, consumers, processors, entrepreneurs, and local government or extension representatives. Findings showed that the value chain consists of raw material sourcing, processing, value addition, marketing, and consumption, but remains fragmented due to informal collection systems and limited coordination among actors. Raw material supply was promising, with shell-on snails bought at ₱10.00 per kilogram, a 25% to 35% meat recovery rate, and an estimated annual requirement of 6,122 to 8,571 kilograms of shell-on snails for 15,000 packs. The 70% GAS formulation yielded 28 links per batch and generated ₱129.90 net income, a 33.62% profit margin, and a projected 22.37-month payback period. Market acceptance was conditional on safety, affordability, and trust. The product demonstrates potential as a pest-to-protein agribusiness innovation through organized sourcing, standardized production, and cooperative enterprise development for livelihood generation, local value creation, and responsible invasive species utilization in rice communities.

Keywords: Golden Apple Snail, Value Chain Analysis, Enterprise Development, Agribusiness Innovation, Community-Based Commercialization

Introduction

Background of the Study

The golden apple snail (*Pomacea canaliculata*) is a persistent concern in rice-based agroecosystems because it damages young rice plants, reproduces rapidly, and adapts well to flooded environments. In communities that depend heavily on rice farming, the species is not merely an ecological nuisance; it creates recurring crop-protection, labor, and farm-management burdens. This makes the topic especially important in rice-farming areas such as Western, Mountain Province, where the presence of the invasive snail coincides with the need for practical and locally appropriate livelihood opportunities (Horgan, 2017; Horgan, 2018; Joshi et al., 2017; Schneiker et al., 2016).

Most management responses treat the golden apple snail only as a pest to be controlled or discarded. Although population control remains necessary, disposal-based responses do not recover value from the biomass removed from infested fields. A responsible utilization strategy provides a complementary approach by collecting the snail from naturally infested areas, preventing further propagation, and converting it into a usable food input. This pest-to-product pathway is worth studying because it can connect invasive-species management with local value addition, alternative protein development, and supplementary income generation (Yao et al., 2025; Visca & Palla, 2018).

The food potential of golden apple snail meat strengthens this opportunity. Studies have reported that snail-derived materials contain useful protein and mineral components and can be incorporated into processed food or feed products when proper formulation and handling procedures are followed. However, nutritional potential alone does not establish practical value. A product can benefit communities only when it is safe, acceptable, affordable, consistently produced, and supported by a dependable supply and marketing system (Lutan & Nerona, 2024; Nusantoro et al., 2024; Visca & Palla, 2018; Yao et al., 2025).

The prior sensory, nutritional, microbiological, and physicochemical evaluation of golden apple snail sausage provided an essential product-level foundation. It demonstrated that the sausage could meet acceptable quality and safety conditions under controlled development and pilot-production settings. This validation established that the product was technically possible, but it did not yet determine whether the innovation could operate effectively as a community enterprise (Cuyangoan, 2026).

This distinction is critical. Product validation answers whether a food formulation can be made and accepted, whereas commercialization research determines whether it can be supplied, produced, sold, and sustained. Without evidence on raw material seasonality, collection organization, meat recovery, production yield, equipment and labor requirements, cost structure, consumer trust, market channels, and institutional support, a validated product may remain a laboratory output rather than become a useful livelihood intervention. Premature commercialization could lead to interrupted production, inconsistent quality, weak consumer confidence, and financial losses for participating communities.

Value chain analysis is therefore appropriate because it examines the complete movement of the product from raw material sourcing to processing, value addition, marketing, and consumption. It identifies where coordination is weak, where costs and risks

occur, and where value can be created or lost. When combined with an enterprise development perspective, it also clarifies the roles of farmers, collectors, processors, entrepreneurs, consumers, local government units, and extension agencies in converting a product innovation into an organized and accountable business system (Porter, 1985; Gereffi et al., 2005; Kaplinsky & Morris, 2016).

The need for the present study arises from the absence of an integrated assessment that connects the validated sausage product with the actual conditions of Western, Mountain Province. The area must be examined not only as a source of raw materials but also as a potential setting for collection, processing, enterprise organization, and market development. The central question is whether the locally available golden apple snail can be used responsibly and effectively enough to generate value without encouraging the spread or deliberate propagation of an invasive agricultural pest.

Accordingly, the study evaluates utility and effectiveness through concrete enterprise indicators: the availability and seasonality of the raw material, collection and meat-recovery capacity, technical production requirements, yield, cost and pricing structure, profitability, payback period, consumer perception, and the readiness of community and institutional actors. These indicators provide a more realistic basis for deciding whether the product should proceed to pilot commercialization, what safeguards are required, and which parts of the value chain must first be strengthened.

By moving from product validation to commercialization analysis, the research addresses a practical gap between food innovation and community adoption. Its contribution is not to assume that golden apple snail sausage will automatically succeed, but to determine the conditions under which it may become a safe, economically workable, environmentally responsible, and community-based agribusiness option. The resulting evidence can guide pilot implementation, resource allocation, training, partnership formation, and future evaluation of actual enterprise performance.

Significance of the Study

This study assesses whether a validated food product can be developed into a safe, viable, and environmentally responsible community enterprise. It may provide additional income opportunities for farmers and snail collectors, guide processors and agripreneurs in production and financial planning, and protect consumers through proper safety, quality, labeling, and marketing standards.

The findings may also guide government agencies and extension workers in designing appropriate training, financing, regulatory, and market-support programs. Moreover, the study promotes responsible pest utilization and provides a framework for future research on similar pest-to-product livelihood initiatives.

Conceptual Framework

This study is anchored on an integrated conceptual framework that combines the Value Chain Analysis approach and the Enterprise Development Model to explain how golden apple snail (*Pomacea canaliculata*) sausage can be transformed from a validated food product into a viable community-based agribusiness enterprise (Figure 1). The framework

recognizes that product validation alone is not enough to ensure long-term impact. Systems for raw material sourcing, production scaling, market integration, enterprise organization, and sustainability must also support food innovation. It is guided by value chain theory and agribusiness enterprise development principles, which emphasize value creation, coordination, and upgrading across interconnected stages (Porter, 1985; Kaplinsky & Morris, 2016).

The first component of the framework is the Value Chain Analysis, which traces the movement of the product from raw material supply to final consumption. The value chain begins with input or raw material sourcing, which includes the collection, availability assessment, seasonality, handling, and supply of golden apple snails. This stage is essential in ensuring a stable and sustainable raw material base for production. The second stage is production and processing, which involves cleaning, depuration, meat extraction, formulation, mixing, emulsification, stuffing, cooking, cooling, and packaging. This stage focuses on efficiency, product consistency, and food safety compliance.

The third stage is value addition and quality assurance. This includes quality control, product standardization, branding, labeling, packaging, and storage management. These activities help increase the commercial value of the product and strengthen consumer trust. The fourth stage is marketing and distribution, which involves the movement of the product through local markets, institutional buyers, small retailers, online platforms, and direct selling channels. The final stage is consumption, where consumer perception, willingness to try, perceived safety, affordability, and purchase interest are considered as indicators of market feasibility.

The value chain is supported by enabling factors such as infrastructure, human resources, technology, finance, and institutional support. These include processing facilities, equipment, cold storage, skills training, labor management, appropriate processing technology, capital access, food safety regulations, LGU support, business permits, and extension services. These factors determine the capacity of the value chain to become scalable, resilient, and sustainable.

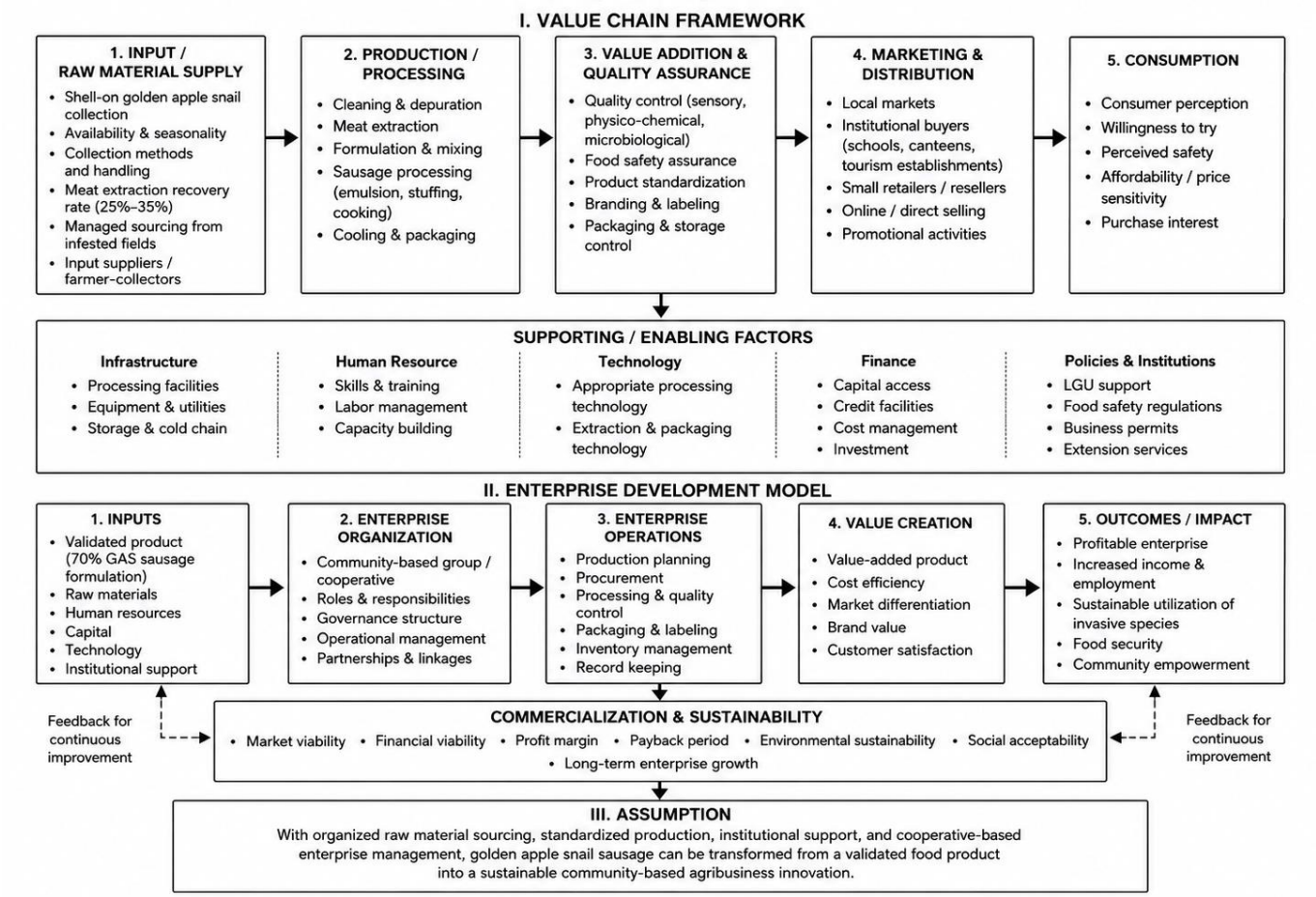

Figure 1. Conceptual framework of the study

The second component is the Enterprise Development Model, which explains how the value chain can be organized into a functional community-based enterprise. It begins with inputs such as the validated 70% GAS sausage formulation, raw materials, labor, capital, technology, and institutional support. These are organized through a cooperative or community-based structure with defined roles, governance systems, partnerships, and operational responsibilities. Enterprise operations include production planning, procurement, processing, quality control, packaging, inventory management, and record keeping. These lead to value creation through cost efficiency, market differentiation, branding, and customer satisfaction. Ultimately, the framework aims for commercialization and sustainability through market viability, financial viability, environmental sustainability, social acceptability, and long-term enterprise growth. The framework assumes that with organized sourcing, standardized production, institutional support, and cooperative-based management, golden apple snail sausage can become a sustainable community-based agribusiness innovation.

Objectives

1. To map the value chain of golden apple snail sausage production from raw material sourcing to end-market distribution.
2. To assess the sustainability of raw material supply for golden apple snail sausage production in terms of availability, seasonality, collection practices, and meat recovery rate.

3. To evaluate the production feasibility of the 70% golden apple snail sausage formulation based on processing flow, yield, equipment needs, labor requirements, and food safety considerations.
4. To determine the commercialization feasibility of golden apple snail sausage based on cost structure, pricing, profitability, payback period, and consumer perception.
5. To develop a community-based enterprise model for golden apple snail sausage production and commercialization.

Methodology

Research Design

This study employed a mixed-methods descriptive–developmental research design to examine the commercialization feasibility, value chain structure, and enterprise development potential of golden apple snail (*Pomacea canaliculata*) sausage. The quantitative component focused on cost and return analysis, pricing analysis, profitability computation, raw material requirement estimation, and payback period analysis. The qualitative component explored stakeholder perspectives on raw material supply, production feasibility, consumer perception, institutional support, and enterprise development. The study is descriptive because it examined the existing conditions of the value chain, sourcing system, production process, market perception, and institutional support environment. It is developmental because the findings served as a basis for formulating a value chain-based community enterprise and commercialization model for golden apple snail sausage.

Research Locale

The study was conducted in selected rice-farming communities in Western, Mountain Province, where golden apple snails are commonly found in rice fields and freshwater ecosystems. The locale was selected because of the observed availability of golden apple snails, the presence of farming households, and the potential of the area for community-based livelihood and agro-enterprise development. Nearby local markets and community-based selling points were also considered in gathering information on consumer perception, price sensitivity, and possible marketing channels.

Respondents and Participants

The study involved 60 participants selected through purposive sampling based on their direct relevance to the value chain and enterprise development system. The participants consisted of 20 farmers and snail collectors, 25 consumers and community members, 8 food processors or small-scale entrepreneurs, and 7 local government unit representatives or extension workers. Farmers and snail collectors provided information on raw material availability, seasonality, collection practices, buying price, collection volume, and extraction yield. Consumers and community members responded to willingness to try the product, perceived safety, affordability, price sensitivity, and purchase interest. Food processors and entrepreneurs shared insights on production feasibility, costing, equipment needs, labor requirements, and scalability. LGU representatives and extension workers provided perspectives on institutional support, training needs, regulatory concerns, livelihood potential, and commercialization readiness.

Participants were included if they had knowledge, experience, or potential involvement in the commercialization of golden apple snail sausage. Farmers and collectors

were included if they had experience observing, collecting, or managing golden apple snails. Consumers were included if they were potential buyers of processed food products. Processors and entrepreneurs were included if they had experience in food preparation, processing, enterprise, or local marketing. LGU and extension representatives were included if they were involved in agriculture, livelihood development, food safety, or enterprise promotion.

Research Instruments

The study used a value chain mapping tool, interview guide, market perception questionnaire, production and raw material assessment sheet, and cost and return analysis sheet. The value chain mapping tool identified key actors, activities, linkages, and constraints from raw material sourcing to consumption. The interview guide gathered qualitative insights from farmers, collectors, processors, entrepreneurs, community members, and LGU representatives regarding supply, production, marketing, and enterprise development concerns. The market perception questionnaire gathered information on willingness to try, perceived affordability, perceived safety, price sensitivity, and purchase interest. The production and raw material assessment sheet documented production yield, recipe requirements, shell-on snail collection volume, buying price, and meat recovery rate after extraction. The cost and return analysis sheet determined production cost, selling price, net income, projected annual financial performance, and payback period. The instruments were reviewed for clarity, relevance, and alignment with the objectives of the study.

Production and Formulation Basis

The production and economic analysis focused on the 70% golden apple snail formulation because it showed strong commercialization potential. One production cycle used 800 grams ground golden apple snail meat, 100 grams ground pork back fat, 3 tablespoons vinegar, 2 tablespoons pepper, 1 cup water, 4 tablespoons cornstarch, ½ cup quick-cooking oats, 6 cloves minced garlic, and 1 teaspoon salt. One cycle yielded 28 sausage links, each weighing 30 grams, equivalent to 840 grams of finished saleable product or approximately 5.6 five-link pack-equivalents. Each pack contained five links and was priced at ₱69.00. This formulation served as the basis for the small-batch cost and return analysis and the projected annual financial analysis.

Data Gathering Procedure

Data gathering followed a systematic process. First, value chain mapping was conducted through field observation and stakeholder interviews to identify actors, processes, and linkages involved in golden apple snail sausage production and commercialization. Second, farmers and collectors were interviewed to determine the availability, seasonality, collection volume, buying price, and extraction yield of golden apple snails.

Third, processors and entrepreneurs were consulted regarding production requirements, processing constraints, equipment needs, labor requirements, hygiene concerns, and scalability issues. Fourth, consumers and community respondents were asked about willingness to try, perceived safety, affordability, price sensitivity, and purchase interest. The market analysis was exploratory and perception-based and did not involve formal demand estimation, demand elasticity modeling, or large-scale forecasting.

Fifth, production and costing data were analyzed using the 70% GAS formulation. Raw material supply analysis considered the buying price of ₱10.00 per kilogram of shell-on golden apple snails, collection capacity of approximately 10 to 20 kilograms per hour, and meat recovery rate of approximately 250 to 350 grams per kilogram of shell-on snails. Finally, all qualitative and quantitative findings were synthesized to develop the proposed value chain-based enterprise and commercialization model.

Data Analysis

Qualitative data from interviews and stakeholder responses were analyzed thematically, focusing on recurring patterns related to raw material availability, seasonality, collection practices, production constraints, equipment needs, consumer trust, affordability, institutional support, cooperative readiness, and enterprise sustainability.

Quantitative data were analyzed using cost and return analysis, pricing analysis, profitability computation, raw material requirement estimation, and payback period analysis. Sales were computed based on pack-equivalent yield and the selling price of ₱69.00 per five-link pack. Total cost was computed by adding direct and indirect costs. Net income was computed by subtracting total cost from total sales. Profit margin was computed by dividing net income by total sales and multiplying by 100. The annual projection used a target of 15,000 packs per year. Payback period was computed by dividing the initial investment by estimated annual net income or cash flow and converting the result into months.

Raw material requirement was computed using the recipe requirement of 800 grams of extracted golden apple snail meat per cycle and the equivalent yield of 5.6 packs per batch. The annual extracted meat requirement was estimated based on the 15,000-pack production target, while the shell-on snail requirement was estimated using the 25% to 35% meat recovery rate.

Ethical Considerations and Output

Ethical standards were observed throughout the study. Informed consent was obtained from all participants, and they were informed of the purpose of the study, voluntary participation, confidentiality, and their right to withdraw. Data were used solely for academic purposes. The methodological process culminated in the development of a value chain-based enterprise and commercialization model integrating raw material sourcing, production and processing, market perception, financial feasibility, institutional support, and cooperative-based enterprise organization for golden apple snail sausage in Western, Mountain Province.

Results and Discussion

This study examined the commercialization feasibility, value chain structure, and enterprise development potential of golden apple snail (*Pomacea canaliculata*) sausage as a continuation of the product validation research conducted by Cuyangoan (2026), which established the sensory acceptability, nutritional value, microbiological safety, and physicochemical stability of the product. The present study shifted the focus from product validation to value chain and enterprise-level commercialization analysis. This transition is necessary because a food product that has been proven acceptable and safe under product development conditions must also be examined in terms of raw material sustainability,

production scalability, market feasibility, financial viability, and enterprise organization before it can be adopted as a community-based agribusiness innovation.

The findings are discussed according to the five objectives of the study: value chain mapping and analysis, raw material supply sustainability, production and technical feasibility, economic and market feasibility, and enterprise development and commercialization model. The results show that golden apple snail sausage has commercialization potential. Still, its successful adoption depends on the organization of raw material sourcing, standardization of production, consumer trust-building, and institutional support for community-based enterprise development.

Value Chain Mapping and Analysis

The value chain analysis revealed that golden apple snail sausage production consists of five major stages: raw material sourcing, processing, value addition, marketing, and consumption. These stages reflect the movement of the product from the collection of golden apple snails in rice ecosystems to its transformation into sausage and eventual distribution to consumers. The value chain is functional, but it remains fragmented because collection, production, and marketing are not yet fully coordinated through a formal enterprise system.

At the raw material sourcing stage, golden apple snails are collected from rice fields and freshwater areas in Western, Mountain Province. Farmers confirmed the availability of the resource, stating that “there are many snails in the rice fields, but they are not systematically collected for business purposes.” This statement indicates that raw material abundance exists, but it is not yet organized into a reliable supply chain. This finding supports the view that value chain governance is important in coordinating actors, improving production capability, and linking supply systems to markets (Gereffi et al., 2005).

The processing stage involves the transformation of golden apple snail meat into sausage. The process includes cleaning, extraction, grinding, mixing, emulsification, stuffing, cooking, cooling, and packaging. Processors noted that “the process is manageable, but consistency in production is needed,” suggesting that the product can be produced at the community level but requires standard operating procedures to ensure uniform quality. This indicates that the technical process is workable but not yet fully systematized for enterprise-level operation.

Value addition occurs through formulation, packaging, pricing, and product positioning. The sausage provides added value by transforming an invasive agricultural pest into a processed food product. However, value addition depends on consumer trust. One consumer respondent stated that “if it is properly prepared and safe, they would try it, especially if it is cheaper than pork.” This shows that consumer acceptance is influenced by perceived safety and affordability. This is consistent with studies on novel food acceptance, which indicate that trust, perceived risk, and consumer familiarity strongly affect willingness to try unfamiliar food products (Siegrist & Hartmann, 2020).

The marketing stage is still at an exploratory level. Potential market channels include local markets, community-based selling points, institutional buyers, small retailers, and direct selling. However, no formal distribution system has been established. This suggests that the

value chain is still in a pre-commercialization stage. It has identifiable actors and processes, but these actors are not yet linked through a coordinated production and marketing system.

As a whole, the value chain of golden apple snail sausage is promising but underdeveloped. Its main weakness is not the absence of raw material or product potential, but the lack of system integration. The findings imply that commercialization requires the establishment of organized collection, standardized processing, coordinated marketing, and institutional support. A cooperative or cluster-based production system may serve as the appropriate structure for integrating the value chain actors.

Raw Material Supply Sustainability

Findings revealed that golden apple snails are available in rice-farming ecosystems in Western, Mountain Province, particularly in irrigated fields and freshwater areas where the species is commonly observed by farmers. However, supply remains seasonal and fluctuates according to rainfall patterns, cropping cycles, and pest management practices. Farmers reported that “during the rainy season, snails are abundant, but there are also times when they are difficult to find,” indicating that raw material availability is ecologically driven rather than production-planned.

The seasonal character of the supply is consistent with studies describing *Pomacea canaliculata* as an invasive pest in irrigated rice systems and managed wetlands. Horgan et al. (2014) reported that invasive apple snails have become major pests of aquatic crops, including rice, while Schneiker et al. (2016) described the golden apple snail as an important invasive pest in irrigated rice that feeds on young rice plants. These studies support the finding that the species is abundant in rice ecosystems but must be managed carefully to avoid further agricultural damage.

The raw material buying price was estimated at ₱10.00 per kilogram of golden apple snails with shells. Based on respondent accounts, approximately 10 to 20 kilograms of shell-on golden apple snails can be collected within one hour, depending on field conditions, snail abundance, accessibility of the area, and collector efficiency. At the prevailing buying price, one hour of collection may generate an estimated gross value of ₱100.00 to ₱200.00 for collectors. This indicates that snail collection may serve as a supplementary income-generating activity for farmers and community members, especially during periods of high snail abundance.

After shell removal and meat extraction, approximately 250 to 350 grams of usable snail meat are obtained from every kilogram of shell-on golden apple snails. This represents an estimated meat recovery rate of 25% to 35%. Thus, 10 kilograms of shell-on snails may yield approximately 2.5 to 3.5 kilograms of extracted meat, while 20 kilograms may yield approximately 5.0 to 7.0 kilograms of extracted meat. This conversion is important because shell-on weight does not directly represent usable meat volume for sausage production.

Using the recipe as a basis, one production cycle requires 800 grams of extracted golden apple snail meat and yields 28 sausage links or approximately 5.6 five-link pack-equivalents. This means that each five-link pack requires approximately 142.86 grams of extracted golden apple snail meat. For a projected annual production of 15,000 packs, the

estimated extracted snail meat requirement would be approximately 2,142.86 kilograms per year. Given a 25% to 35% extraction recovery rate, this would require approximately 6,122 to 8,571 kilograms of shell-on golden apple snails annually. At ₱10.00 per kilogram with shells, the estimated annual shell-on raw material cost would range from approximately ₱61,220 to ₱85,710, excluding labor, transport, cleaning, extraction, and storage costs.

The study further found that collection systems remain informal and unstructured. Farmers or community members manually gather snails, but there is no established aggregation system, buying schedule, collection center, or quality inspection process. LGU respondents emphasized that "this is a good livelihood opportunity, but it needs an organized collection system to be sustainable." This statement supports the finding that raw material abundance alone does not guarantee enterprise viability. Without organized collection, production may be interrupted during lean supply periods or when collection labor is unavailable.

To ensure continuity of supply, the enterprise may designate specific rice fields or naturally infested areas as managed collection sites for golden apple snails. However, this should not be interpreted as unrestricted open-field farming or deliberate multiplication of *Pomacea canaliculata*, since the species is recognized as an invasive agricultural pest. Instead, the proposed supply strategy should focus on managed sourcing from designated infested fields, scheduled collection, temporary holding under controlled and contained conditions, and cooperative-based aggregation of shell-on snails or extracted snail meat. This is important because utilization should support pest management rather than encourage ecological spread.

From an enterprise perspective, a cooperative-based aggregation system is necessary to stabilize raw material flow. This may include designated farmer-collectors, barangay-level collection points, scheduled collection days, proper weighing and recording, quality checking, and delivery to the processing unit. Food safety should also begin at the sourcing stage through sorting of live and usable snails, removal of dead or contaminated materials, washing, depuration, proper transport, and hygienic extraction before processing.

Generally, raw material supply is promising because of the local availability of golden apple snails, the low buying price of ₱10.00 per kilogram with shells, the 25% to 35% meat recovery rate, and the reported collection capacity of 10 to 20 kilograms per hour. However, its sustainability requires institutionalization through organized collection, cooperative aggregation, managed sourcing from designated infested fields, quality control, contained holding practices, and seasonal supply planning. With these mechanisms in place, golden apple snails can become a reliable raw material for a community-based agribusiness enterprise while also contributing to pest management and livelihood generation.

Production and Technical Feasibility

The production system was found to be technically feasible under small- to medium-scale conditions, particularly using the 70% GAS formulation as the basis for commercialization. The term "70% GAS formulation" is retained as the treatment label used in the product validation study; however, the production computations in this chapter are based on the actual recipe inputs used for one batch.

The recipe consisted of 800 grams ground golden apple snail meat, 100 grams ground pork back fat, 3 tablespoons vinegar, 2 tablespoons pepper, 1 cup water, 4 tablespoons cornstarch, ½ cup quick-cooking oats, 6 cloves minced garlic, and 1 teaspoon salt. The process involved preparation of extracted snail meat, grinding, mixing with pork back fat and other ingredients, emulsification, stuffing, cooking, cooling, and packaging.

For one production cycle, the formulation yielded 28 sausage links, with each link weighing 30 grams. This represents a saleable finished yield of 840 grams or approximately 5.6 five-link pack-equivalents. Since each pack contains five links and is sold at ₱69.00, the production output demonstrates that the product can be produced at a small-batch or pilot-enterprise level.

Because the raw formulation includes added water, binders, seasonings, and fat, the reported 840-gram output should be interpreted as finished saleable yield after processing rather than total raw mixture weight. This distinction is important in enterprise planning because production yield affects cost computation, pricing, and projected profitability.

The production process requires basic food processing equipment such as a grinder, mixing bowls or a food mixer, a weighing scale, a sausage stuffer, cooking or steaming equipment, packaging materials, and cold storage. While these requirements are manageable for small-scale production, they become limiting factors when production volume increases. Processors stated that “when production increases, equipment and space become insufficient,” indicating infrastructure bottlenecks in scaling the product from pilot production to enterprise-level operation.

Hygiene and food safety are critical technical requirements because golden apple snail meat is a novel raw material for sausage production. Proper cleaning, sorting, depuration, sanitation of equipment, cooking control, hygienic packaging, and cold storage must be strictly observed to ensure product safety and consumer confidence. These requirements are particularly important because consumer acceptance of novel food products is strongly affected by perceived risk, trust, and confidence in the production process (Siegrist & Hartmann, 2020).

Community participants added that “if they are properly trained, this can become a viable livelihood.” This reinforces the importance of human capital development in community-based enterprise scaling. Training should include food handling, sanitation, product formulation, packaging, equipment operation, record keeping, pricing, and basic enterprise management.

Overall, production is technically feasible at the small-batch level but not yet industrially scalable. Its transition to enterprise-level production requires equipment upgrading, adequate production space, standardized operating procedures, food safety protocols, quality control measures, and continuous training for community-based processors.

Economic and Market Feasibility

The economic analysis focused on the 70% golden apple snail formulation because it showed strong commercialization potential. The product yielded 28 sausage links per batch,

each weighing 30 grams. Since each pack contains five links and is priced at ₱69.00, the equivalent selling price per link is ₱13.80. Based on the 28-link yield, the batch is equivalent to 5.6 five-link packs, generating total pack-equivalent sales of ₱386.40. The product is approximately 31% cheaper than pork sausages based on a comparable pork sausage price of about ₱100.00 per pack, indicating strong price competitiveness. Cost-return analysis (Table 1) showed that the 70% GAS formulation incurred direct costs of ₱207.75, consisting of ingredients and labor, and indirect costs of ₱48.75, consisting of packaging materials and utilities. This resulted in a total production cost of ₱256.50. After deducting total cost from total sales, the formulation generated a net income of ₱129.90 per production cycle.

Table 1
Cost and Return Analysis of 70% GAS Sausage Formulation

Number of Yield, 30g per link	28 links
Pack-equivalent yield, 5 links per pack	5.6 packs
Sales	₱386.40
Direct Costs, ingredients, and labor	₱207.75
Indirect Costs, packaging materials, and utilities	₱48.75
Total Costs	₱256.50
Net Income	₱129.90

On a per-unit basis, the production cost was approximately ₱9.16 per link, while the selling price was ₱13.80 per link. This generated an estimated profit of ₱4.64 per link. In terms of pack-equivalent computation, the production cost was approximately ₱45.80 per five-link pack, while the selling price was ₱69.00, resulting in an estimated profit of ₱23.20 per pack. The computed profit margin was approximately 33.62%, suggesting favorable income-generating potential at the small-batch level.

For a projected production scale of 15,000 packs per year, gross sales would amount to ₱1,035,000.00 based on the ₱69.00 selling price per pack (Table 2). Using the estimated production cost of ₱45.80 per pack, the total annual production cost would be approximately ₱687,053.57. This would result in an estimated annual net income or cash flow of ₱347,946.43.

Table 2
Projected Annual Financial Performance of 70% GAS Sausage

Projected annual production	15,000 packs
Selling price per pack	₱69.00
Annual gross sales	₱1,035,000.00
Estimated cost per pack	₱45.80
Estimated annual production cost	₱687,053.57
Estimated profit per pack	₱23.20
Estimated annual net income/cash flow	₱347,946.43
Initial investment	₱648,750.00
Payback period	22.37 months / about 1 year and 10 months

Using the estimated annual net income of ₱347,946.43 and an initial investment of ₱648,750.00, the corrected payback period is approximately 22.37 months, or about 1 year

and 10 months. This means that the initial investment may be recovered in less than two years, assuming that projected annual production and sales targets are achieved.

The favorable cost structure may be attributed to the low acquisition cost of golden apple snails as a raw material. Since shell-on snails are bought at ₱10.00 per kilogram and produce approximately 25% to 35% usable meat after extraction, the raw material offers a cost advantage compared with conventional meat ingredients. Studies also support the nutritive potential of golden apple snail, with Yao et al. (2025) reporting that fresh golden apple snail meat contains protein and other nutrients, while Nusantoro et al. (2024) reported that golden apple snail meat is rich in protein on a dry matter basis.

From a market perspective, consumer response indicated conditional acceptance. One respondent stated that “if it is properly prepared and safe, they would try it.” This suggests that purchase interest is influenced not only by affordability but also by perceived safety, trust, and product familiarity. Thus, the market feasibility of the product should be interpreted as exploratory and perception-based rather than a formal demand estimation.

Competitor benchmarking indicates that the product may compete not only with pork sausages but also with chicken sausage, fish-based processed products, and low-cost local protein products. Its advantage lies not only in affordability but also in its identity as a locally sourced pest-to-protein innovation. However, this advantage will only become meaningful if supported by attractive packaging, consumer education, proper labeling, food safety assurance, and consistent product quality.

The 70% GAS formulation demonstrates positive economic potential. Its net income, competitive pricing, estimated profit margin, and projected payback period support its feasibility as a community-based agribusiness product. However, successful commercialization will depend on stable raw material supply, consistent production quality, food safety compliance, consumer education, product positioning, and sustained market demand.

Enterprise Development and Commercialization Model

The enterprise development analysis indicates that golden apple snail sausage is most appropriate for a community-based cooperative system. This model integrates raw material sourcing, production and processing, quality assurance, marketing, and institutional support. The proposed model responds to the fragmented condition of the current value chain by organizing farmers, collectors, processors, community members, and LGU partners into a coordinated enterprise system.

LGU respondents stated that “this can become a livelihood project as long as there is training and support,” highlighting the role of institutional governance in agribusiness scaling. Community members also expressed willingness to participate, stating that “they are willing to join if there is additional income.” These statements indicate social readiness for enterprise formation, but also confirm that participation depends on the availability of training, support, and clear income opportunities.

The cooperative model can assign roles across the value chain. Farmers and collectors may serve as raw material suppliers. Community processors may handle cleaning, extraction, formulation, cooking, and packaging. Entrepreneurs or cooperative marketing committees may manage pricing, distribution, and sales. LGUs and extension workers may provide training, technical assistance, linkage to regulatory agencies, and livelihood support. This type of coordination is consistent with global value chain governance theory, which emphasizes that coordinated actor relationships improve production capability, upgrading, and market integration (Gereffi et al., 2005).

The proposed commercialization model also aligns with circular economy thinking because it transforms an invasive agricultural pest into an economic input. Instead of treating golden apple snail only as a production problem, the enterprise model converts it into a value-added food product that may support income generation while contributing to pest population management. However, the model must avoid intentional open-field propagation of *Pomacea canaliculata*. The enterprise should rely on managed sourcing from naturally infested fields and controlled collection systems.

The model requires five major components. First, a raw material sourcing system should organize collectors, buying points, quality inspection, and seasonal supply planning. Second, a production and processing unit should ensure standardized formulation, equipment use, sanitation, and quality control. Third, a marketing and distribution system should identify target buyers, pricing strategies, packaging formats, and selling channels. Fourth, an institutional support system should provide training, financing assistance, food safety guidance, and enterprise registration support. Fifth, a monitoring and feedback mechanism should evaluate production performance, consumer response, profitability, and supply stability.

Commercialization success depends not only on product viability but also on the institutionalization of the enterprise system. Without a cooperative structure, the product may remain a promising innovation but fail to scale. With organized sourcing, standardized production, and institutional support, golden apple snail sausage can be developed into a viable community-based agribusiness enterprise.

The findings demonstrate that golden apple snail sausage is technically feasible, economically viable, and structurally adaptable for community-based agribusiness development. The product has already been validated in terms of sensory acceptability, nutritional value, microbiological safety, and physicochemical stability by Cuyangoan (2026). The present study extends that validation by showing that the product also has commercialization potential when supported by value chain coordination, raw material supply planning, production standardization, market positioning, and enterprise organization.

The results reveal a clear commercialization pathway. First, golden apple snails are locally available in rice-farming ecosystems. Second, the raw material can be converted into usable extracted meat with a recovery rate of 25% to 35%. Third, the 70% GAS recipe can produce a saleable sausage product at the small-batch level. Fourth, the product shows positive net income and price competitiveness. Fifth, consumers show conditional willingness

to try the product when safety and affordability are assured. Finally, community members and LGU respondents recognize the product's potential as a livelihood enterprise.

However, the study also shows that product readiness does not automatically mean enterprise readiness. The main constraints are unorganized raw material collection, seasonality of supply, limited equipment and production space, need for food safety training, perception-based market acceptance, and absence of a formal cooperative system. These constraints must be addressed before full commercialization.

The study confirms that the strongest opportunity lies in transforming golden apple snail sausage from a laboratory-validated food product into a structured community-based enterprise. This supports the broader direction of sustainable agribusiness innovation, where ecological challenges can be converted into livelihood opportunities through organized value chains, responsible sourcing, and enterprise development. Ultimately, golden apple snail sausage may serve as a model for pest-to-product innovation, provided that commercialization is guided by food safety, environmental responsibility, and inclusive community participation.

Summary, Conclusions, and Recommendations

Summary

This study examined the commercialization feasibility, value chain structure, and enterprise development potential of golden apple snail (*Pomacea canaliculata*) sausage as a continuation of Cuyangoan's (2026) product validation study, which established its sensory acceptability, nutritional value, microbiological safety, and physicochemical stability. The present study extended the product validation phase by analyzing its potential as a community-based agribusiness enterprise. Findings showed that the value chain consists of raw material sourcing, processing, value addition, marketing, and consumption. However, the system remains fragmented because collection, production, and marketing are not yet formally organized. Golden apple snails are locally available in Western, Mountain Province, but their supply is seasonal and requires an organized collection and aggregation system.

The 70% GAS formulation was found technically feasible at the small-batch level. One production cycle yielded 28 sausage links or 5.6 five-link pack-equivalents. Economic analysis showed that one batch generated ₱386.40 in sales, ₱256.50 in total cost, and ₱129.90 in net income. For a projected annual production of 15,000 packs, the estimated gross sales would be ₱1,035,000.00, with an estimated annual net income of ₱347,946.43 and a payback period of approximately 22.37 months.

Market feasibility was promising but conditional. Consumer acceptance depended on perceived safety, affordability, trust, and product familiarity. The proposed enterprise model is a community-based cooperative system that integrates sourcing, production, marketing, quality assurance, and institutional support. Overall, the study shows that golden apple snail sausage can become a viable community-based agribusiness innovation if supported by organized raw material sourcing, standardized production, food safety compliance, consumer education, and LGU/community participation.

Conclusions

Based on the findings of the study, the following conclusions were drawn:

1. The value chain of golden apple snail sausage is functional but fragmented. Raw material sourcing, processing, value addition, marketing, and consumption are identifiable, but they are not yet fully coordinated through a formal enterprise system.
2. Golden apple snail supply in Western, Mountain Province, is promising due to local availability, low shell-on buying price, and reported collection capacity. However, supply sustainability is affected by seasonality, informal collection practices, and the absence of an organized aggregation system.
3. The production of golden apple snail sausage using the 70% GAS formulation is technically feasible at the small-batch level. However, expansion to enterprise-level production requires equipment upgrading, adequate processing space, standardized operating procedures, quality control, and food safety training.
4. The 70% GAS formulation demonstrates positive economic feasibility. It generated ₱129.90 net income per production cycle, an estimated ₱23.20 profit per pack, a 33.62% profit margin, and a projected payback period of approximately 22.37 months based on 15,000 packs per year.
5. Market feasibility is favorable but conditional. Consumer willingness to try the product depends strongly on perceived safety, affordability, trust, and product familiarity. Therefore, market acceptance should be developed through consumer education and product positioning.
6. A community-based cooperative enterprise model is the most appropriate commercialization structure because it can organize collectors, processors, marketers, LGU partners, and community members into one coordinated value chain system.
7. Overall, golden apple snail sausage can be developed as a viable community-based agribusiness innovation. However, its successful commercialization depends not only on product quality but also on organized raw material sourcing, production standardization, institutional support, and sustained market development.

Recommendations

Based on the conclusions, the following recommendations are proposed:

1. For community members, farmers, and snail collectors.

Organize a community-based collection system for golden apple snails. Farmer-collectors may establish scheduled collection days, designated collection points, proper weighing procedures, and quality checking of shell-on snails before delivery to the processing unit.

2. For proposed cooperatives or community-based enterprises.

Develop a cooperative-based enterprise structure that clearly defines the roles of collectors, processors, packagers, marketers, and finance handlers. This structure can help ensure accountability, stable raw material flow, fair income distribution, and continuous production.

3. For production and processing groups.

Adopt standardized operating procedures for cleaning, extraction, formulation, stuffing, cooking, cooling, packaging, and storage. Food safety practices such as sorting, depuration, sanitation, proper cooking control, and cold storage should be strictly implemented to ensure product safety and consumer confidence.

4. For local government units and extension workers

Provide technical training, livelihood support, enterprise registration assistance, and linkage to food safety and regulatory agencies. LGU support is necessary to strengthen the cooperative model and help transform the product from a research output into a sustainable livelihood enterprise.

5. For market development.

Conduct consumer education and product promotion activities emphasizing the product's affordability, safety, nutritional value, and environmental benefit as a pest-to-protein innovation. Packaging and labeling should also be improved to increase consumer trust and product acceptability.

6. For financial and enterprise planning

Use the 70% GAS formulation as the initial basis for commercialization because it demonstrated positive profitability and a reasonable payback period. However, financial projections should be continuously updated based on actual production volume, labor cost, packaging cost, raw material supply, and market demand.

7. For environmental management

Source golden apple snails only from naturally infested rice fields and freshwater areas. The enterprise should not encourage intentional open-field propagation or uncontrolled farming of *Pomacea canaliculata*, since it is an invasive agricultural pest. Managed collection should support pest reduction while providing livelihood opportunities.

8. For future researchers

Conduct further studies on shelf-life under commercial distribution conditions, formal consumer demand estimation, demand elasticity, expanded competitor benchmarking, product packaging preference, regulatory compliance, and pilot-scale commercialization. Future research may also validate the proposed cooperative enterprise model through actual implementation in selected communities.

The study confirms that golden apple snail sausage has the potential to move from product validation to community-based commercialization. Its strongest value lies in its ability to transform an invasive agricultural pest into a value-added agribusiness product. With organized sourcing, standardized processing, food safety compliance, consumer education, and cooperative-based enterprise support, golden apple snail sausage can become a sustainable livelihood product and a model for pest-to-product agribusiness innovation in Western, Mountain Province.

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