Randwick International of Social Sciences (RISS) Journal
Vol. 7, No.4, October 2026 | Page: 277-291
ISSN Online: 2722-5674 - **ISSN Print**: 2722-5666
https://www.randwickresearch.com/index.php/rissj

From Primary Production to Value-Added Fish Products: International Technology Transfer in A Rural Rice-Fish Farming Community

DOI: *https://doi.org/10.47175/rissj.v7i4.1323*

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ABSTRACT

Small-scale rice–fish farmers commonly market harvested fish as fresh products, limiting opportunities for product differentiation and downstream value creation. This community engagement program aimed to strengthen the initial capacity of a rice–fish farming community in Lubuk Bayas Village, North Sumatra, Indonesia, in value-added fish processing, food hygiene, product diversification, and market preparation through international academic collaboration. The program employed a participatory empowerment approach involving educational presentations, discussions, technical demonstrations, and hands-on processing activities. Community needs were identified through direct observation and discussions concerning existing fish-handling, processing, hygiene, packaging, and marketing practices. Program implementation and participant engagement were documented using attendance records, field notes, participant responses, photographs, and videos and were analyzed descriptively using a qualitative approach. Participants were introduced to fish nuggets, fish balls, and fish fillets as alternatives to conventional fresh-fish sales. The practical sessions integrated raw-material selection, processing consistency, hygienic handling, prevention of cross-contamination, packaging awareness, and initial market preparation. Observations indicated active participant involvement and initial procedural exposure to value-added processing. Collaboration between Universitas Sumatera Utara and Srinakharinwirot University facilitated the contextual exchange of food-processing and food-safety knowledge while providing students with community-based and intercultural learning opportunities. The program established an initial foundation for downstream fish-product development but did not verify sustained competence, food safety, shelf life, or commercial feasibility. Continued mentoring, standardized procedures, product-quality testing, regulatory preparation, and market evaluation are required to support independent and sustainable community production.

KEYWORDS

Community empowerment; Fish processing; Food hygiene; International collaboration; and Rice–fish farming.

INTRODUCTION

Integrated rice-fish farming is an agricultural system that combines rice cultivation and fish production within the same farming area. This system enables farmers to produce two

complementary food commodities while improving land-use efficiency, diversifying household production, and strengthening rural food security. The interaction between rice and fish may also improve nutrient cycling, support biological pest control, and reduce dependence on chemical agricultural inputs. Xie et al. (2011) demonstrated that ecological interactions within rice-fish coculture systems could reduce chemical use while maintaining relatively stable agricultural productivity. Furthermore, integrated rice-fish farming can provide additional sources of food and income for rural households and create more diversified livelihood opportunities than rice monoculture (Halwart& Gupta, 2004). These characteristics make rice-fish farming relevant to sustainable agricultural development and the achievement of Sustainable Development Goal 2 on zero hunger and Sustainable Development Goal 12 on responsible consumption and production.

Despite these advantages, increased production does not automatically provide farmers with a stronger position in the agrifood value chain. Small-scale rice-fish farmers commonly remain concentrated at the primary production stage and sell harvested fish in fresh form. This practice provides limited added value, shortens the available marketing period, and increases farmers' vulnerability to product deterioration and fluctuations in market prices. The transformation of agrifood markets increasingly requires small-scale producers to meet more demanding requirements related to product quality, consistency, food safety, packaging, and continuity of supply (Reardon et al., 2009). Farmers with limited processing technology, organizational capacity, and market access may find it difficult to participate in higher-value market segments. Therefore, value-chain upgrading is required to support the transition of farmers from primary production toward processing, product differentiation, branding, and more competitive marketing (Humphrey & Schmitz, 2002; Gereffi, 2018).

Downstream processing provides an opportunity to transform fresh fish into more convenient products with a longer shelf life and potentially higher market value. Fish can be processed into products such as fish nuggets, fish balls, and fillets, thereby expanding consumer choices and reducing farmers' dependence on fresh-fish sales. Nevertheless, product diversification alone does not guarantee that processed fish products will be safe, acceptable, and commercially sustainable. Food-processing activities must be supported by proper raw-material selection, hygienic handling, standardized formulations, sanitation procedures, prevention of cross-contamination, temperature control, appropriate packaging, clear labeling, and suitable storage conditions. These elements are consistent with the general principles of food hygiene, which emphasize hygiene controls throughout the food chain to ensure product safety and suitability (Codex Alimentarius Commission, 2022). The application of Good Manufacturing Practices and Good Handling Practices is consequently essential for improving production consistency, reducing food-safety risks, and strengthening consumer confidence.

These challenges were identified within the rice-fish farming community in Lubuk Bayas Village, Perbaungan District, Serdang Bedagai Regency, North Sumatra, Indonesia. Although the community had successfully undertaken rice and fish production, most of the fish harvest continued to be marketed as a fresh commodity. The community had not consistently developed differentiated processed products, while its application of hygiene principles, Good Manufacturing Practices, and Good Handling Practices remained limited. Other challenges included inadequate hygienic processing facilities, the absence of fully implemented production and sanitation procedures, limited progress in product licensing and halal certification, and underdeveloped branding, packaging, and market access. These conditions indicated that the community's challenges were no longer limited to increasing production. Instead, the community required support to process its fish harvest into safe, standardized, and marketable value-added products.

Previous studies have extensively examined rice-fish farming in relation to agricultural productivity, income diversification, ecological sustainability, and reduced chemical inputs. Existing studies on agrifood value chains have also highlighted the importance of improving products, production processes, and market participation among small-scale producers (Humphrey & Schmitz, 2002; Reardon et al., 2009; Gereffi, 2018). More recently, Sinaga et al. (2026) implemented a participatory community engagement program in Tanah Merah Village, North Sumatra. The program focused on strengthening farmers' understanding of environmentally friendly rice-fish farming through Focus Group Discussions and international collaboration. It identified several problems, including limited marketing opportunities, weak farmer institutions, and dependence on chemical inputs. However, that program primarily addressed the cultivation system, farmers' participation, and the identification of development priorities. Limited attention was given to the practical transition from primary fish production to standardized value-added food products.

Community empowerment requires more than the provision of technical training; it also involves sustained institutional support, active community participation, and opportunities to strengthen local capacities. Agus (2020) highlights the role of community development initiatives in supporting community empowerment in Indonesia. In the context of the present program, this perspective reinforces the importance of continued mentoring, institutional collaboration, and access to appropriate production and marketing resources to help rural rice–fish farmers translate their initial processing experience into sustainable livelihood opportunities.

The present program extends this community empowerment approach by focusing specifically on hands-on fish processing, product diversification, food hygiene and safety, packaging, labeling, storage, branding, and initial market preparation. Its distinctive contribution lies in integrating participatory community empowerment, food-processing technology transfer, food-safety standardization, and international academic collaboration to support the downstream development of a rural rice-fish farming community. To implement the program, Universitas Sumatera Utara collaborated with Srinakharinwirot University, Thailand, through educational sessions, participatory discussions, demonstrations, and practical fish-processing activities. Participants were introduced to fish nuggets, fish balls, and fillets and were encouraged to understand downstream development as an integrated process extending from raw-material selection to product marketing. Therefore, this article aims to describe the implementation and initial outcomes of an international collaborative community empowerment program designed to strengthen value-added processing, food-safety standardization, and market readiness among a rice-fish farming community in Lubuk Bayas Village, North Sumatra, Indonesia.

RESEARCH METHODS

Program Design

This community engagement program employed a participatory empowerment approach integrated with international knowledge and technology transfer. Community members were positioned not merely as recipients of information but as active participants in discussions, demonstrations, and hands-on fish-processing activities. The program was designed in response to the community's limited capacity to transform freshly harvested fish into standardized value-added products. International academic collaboration was incorporated to facilitate the exchange and local adaptation of knowledge related to food-processing technology, food safety, product development, and market preparation.

Location and Participants

The principal activity was conducted on August 11, 2026, in Lubuk Bayas Village, Perbaungan District, Serdang Bedagai Regency, North Sumatra, Indonesia. Participants included members of the local rice-fish farming community, other community representatives, students, and the community engagement team from Universitas Sumatera Utara.Asst. Prof. Dr. Ulisa Pachekrepapol from Srinakharinwirot University, Thailand, participated as an international resource person with expertise in food-processing technology and food-safety practices. The involvement of the university team, students, community members, and the international partner supported multidirectional knowledge exchange and enabled the introduced practices to be adapted to local needs and production conditions.

Community Needs Assessment

The program began with an assessment of existing production practices and downstream-development needs. Information was gathered through direct observation, discussions with community members, and an examination of existing fish-handling, processing, and marketing practices. The assessment covered the form in which harvested fish were marketed, the availability of processing equipment, hygiene and sanitation practices, product diversification, packaging and labeling, product-licensing readiness, and access to local markets.The assessment indicated that most harvested fish continued to be sold as fresh products with limited downstream processing. Product diversification had not been consistently implemented, and hygiene and food-safety practices had not been standardized. The community also had limited hygienic processing facilities, written production and sanitation procedures, product branding, packaging, licensing readiness, halal certification, and market access. These findings guided the selection of materials and practical activities delivered during the program.

Knowledge and Technology Transfer

Knowledge transfer was delivered through educational presentations and participatory discussions. The materials covered downstream fish processing, raw-material quality, product diversification, hygienic handling, food safety, packaging, labeling, storage, branding, and basic marketing strategies. Participants were introduced to the relationship between the different stages of downstream development, from selecting fresh raw materials to processing, packaging, storage, and marketing.

The international resource person contributed expertise in food-processing technology, product quality, and food-safety practices. The knowledge introduced during the program was adapted to locally available resources and the community's capacity for household- and group-based production. Participants were also encouraged to discuss their existing practices, operational constraints, and opportunities for developing products that would be acceptable to local consumers.

Demonstration and Hands-On Practice

The educational sessions were followed by demonstrations and hands-on fish-processing activities. Participants were introduced to several potential value-added products, including fish nuggets, fish balls, and fish fillets. The practical sessions covered raw-material selection, preparation, processing, hygienic use of equipment and working surfaces, prevention of cross-contamination, and handling of finished products.

Participants were directly involved in the processing activities under the guidance of the community engagement team and resource persons. This experiential approach was intended to make the introduced practices easier to understand and adapt to local

production conditions. The activities also emphasized the importance of consistency in product formulation, size, taste, texture, hygiene, and storage as an initial foundation for future product standardization.

Food Hygiene and Market Preparation

Food hygiene education emphasized handwashing, the use of clean equipment and working surfaces, separation of raw materials from cooked products, safe use of water and food ingredients, temperature control, and protection of finished products from contamination. These practices were introduced as an initial foundation for the subsequent development of production, hygiene, and sanitation procedures based on Good Manufacturing Practices and Good Handling Practices.

Participants also received introductory guidance on packaging, labeling, branding, and basic marketing strategies. The marketing component included identifying potential consumers, preparing trial-sized packages, providing clear product and producer information, distributing product samples, and collecting consumer feedback. At this stage, the activities were intended to build participants' awareness and initial readiness. Formal market testing, systematic sales monitoring, product licensing, halal certification, and assessment of changes in business revenue were planned as subsequent stages of the program.

RESULTS AND DISCUSSION

Implementation of the Community Engagement Program

The community engagement program was conducted in Lubuk Bayas Village, Perbaungan District, Serdang Bedagai Regency, North Sumatra, Indonesia. It involved members of the local rice-fish farming community, village residents, students, the community engagement team from Universitas Sumatera Utara, and an international resource person from Srinakharinwirot University, Thailand. The program integrated educational presentations, participatory discussions, technical demonstrations, and hands-on fish-processing activities. This combination was intended to connect scientific and technical knowledge with the community's existing experience, resources, and production conditions.

The program was designed in response to several interconnected challenges identified within the community. These included continued dependence on fresh-fish sales, limited product diversification, inconsistent application of food hygiene practices, and underdeveloped packaging, branding, and marketing capacity. Rather than presenting fish processing as an isolated technical activity, the program introduced downstream development as an integrated process encompassing raw-material selection, hygienic handling, processing, product standardization, packaging, labeling, storage, branding, and market preparation. This integrated orientation is relevant because small-scale farmers commonly encounter simultaneous technological, infrastructural, regulatory, and market-related constraints when attempting to develop value-added agricultural products. Moreover, improving farmers' access to markets requires not only increased production but also attention to product quality, market information, appropriate marketing channels, and producers' bargaining position (Ma et al., 2024).

Participant engagement was documented throughout the presentations, discussions, demonstrations, and practical sessions. Community members shared information about their existing fish-handling, processing, and marketing practices and participated directly in the preparation of value-added fish products. These activities enabled the facilitators to relate the program content to the community's actual production context. They also provided participants with opportunities to identify the technical requirements and practical constraints associated with the transition from selling fresh fish to producing processed

products with greater added value. However, because standardized pre-test and post-test instruments were not administered, these observations should be interpreted as evidence of active participation and initial practical exposure rather than as quantitative evidence of increased knowledge or skills.

The participatory approach was particularly relevant because community empowerment requires more than the one-way transmission of technical information. It involves active engagement, mutual learning, and the adaptation of external knowledge to farmers' experience and local circumstances. Participatory agricultural extension can facilitate access to both local and expert knowledge while strengthening communication among farmers, researchers, and facilitators (Jack et al., 2020). Empirical evidence also indicates that participatory farmer-to-farmer training can support knowledge exchange and the adoption of agricultural practices by allowing farmers to learn through interaction and practical experience (Kansanga et al., 2021). In the North Sumatran context, Sinaga et al. (2026) previously applied a participatory approach to strengthen organic rice-fish farming through Focus Group Discussions and international collaboration. The Lubuk Bayas program extended this orientation by placing greater emphasis on downstream fish processing, product diversification, food-safety practices, and initial market preparation.

Product Diversification and Initial Upgrading of Fish-Processing Practices

One of the principal outcomes of the community engagement program was the expansion of participants' knowledge regarding alternative uses of fish harvested from the rice–fish farming system. The initial needs assessment indicated that harvested fish were predominantly marketed in fresh form, leaving community members highly dependent on a relatively undifferentiated product with limited opportunities for further value creation. During the program, participants were introduced to fish nuggets, fish balls, and fish fillets as potential product alternatives. Fish filleting represents an initial form of primary processing, whereas nuggets and fish balls involve a greater degree of product transformation through formulation, shaping, and cooking. Collectively, these alternatives demonstrated that the same raw material could be converted into products with different characteristics, modes of consumption, and potential market segments.

This diversification is relevant because processed fish products may offer consumers greater convenience and provide producers with opportunities to differentiate their products from fresh fish. However, the introduction of several product alternatives should be interpreted as an initial stage of product development rather than evidence of commercial success. At this stage, the main achievement was the participants' exposure to feasible processing options that could be adapted to locally available fish, equipment, skills, and consumer preferences. Studies on fish-based products have similarly shown that the acceptability and quality of products such as fish nuggets are influenced by their formulation, physicochemical properties, texture, and sensory characteristics (Moosavi-Nasab et al., 2019).

The educational sessions also emphasized that the quality of a processed product begins with the selection and appropriate handling of its raw materials. Participants were introduced to basic sensory indicators of fish freshness, including normal odor, suitable appearance, firm texture, and appropriate physical condition. These indicators provided participants with a practical basis for conducting an initial assessment before processing. Appearance, odor, and textural properties are widely recognized as important sensory indicators in fish freshness evaluation (Zhang et al., 2022). Nevertheless, sensory observation alone cannot confirm microbiological safety or determine product shelf life. Consequently, the activity should not be interpreted as having verified the safety or storage

stability of the products because microbiological, chemical, and shelf-life assessments were not conducted.

Participants were further encouraged to consider consistency in formulation, portion size, shape, taste, and texture. These attributes are important because consumers evaluate processed foods not only according to flavor but also according to visual appearance, uniformity, convenience, safety, and reliability. Inconsistent formulations or processing conditions may produce variations between batches and consequently reduce consumer confidence. Therefore, future production activities will require standardized recipes, accurate measurement of ingredients, documented processing sequences, and control of relevant parameters such as processing time and temperature. Maintaining simple batch records would also enable producers to identify sources of variation and gradually improve product consistency.

The hands-on sessions allowed participants to engage directly in preparing and processing fish products. Observations during the activity indicated that participants were able to follow the demonstrated stages with assistance from the facilitators. This finding provides qualitative evidence of active participation and initial procedural exposure, but it should not be interpreted as proof of independent technical competence. No formal competency assessment or pre- and post-intervention measurement was undertaken. Nevertheless, direct practice helped translate the information delivered during the educational sessions into observable production stages, including raw-material preparation, ingredient formulation, shaping, cooking, and finished-product handling.

The practical activity also helped participants recognize that downstream processing is not merely a physical transformation of fish. It involves a sequence of interrelated and controlled activities that affect the consistency and market readiness of the final product. Through this process, participants could identify practical requirements such as appropriate utensils, clean working surfaces, standardized measurements, adequate processing time, hygienic handling, and suitable packaging. Thus, the practical sessions served not only as product demonstrations but also as an initial opportunity to identify technical and operational requirements that would need to be addressed before routine household- or community-scale production could be established.

From a value-chain perspective, the introduction of fish nuggets, fish balls, and fillets represents an initial form of product upgrading. Product upgrading refers to the development of products with higher value or more sophisticated characteristics, whereas process upgrading involves improving the efficiency, consistency, and quality of production practices (Humphrey & Schmitz, 2002). Studies of small-scale fisheries also indicate that value-chain upgrading may be pursued through improvements in product quality, product design, processing, and diversification (Rosales et al., 2017). In the Lubuk Bayas context, the program primarily contributed to initial product diversification and exposure to improved processing practices. It did not yet demonstrate functional upgrading, sustained market access, or increased household income.

The findings therefore suggest that product diversification could provide an entry point for reducing community dependence on undifferentiated fresh-fish sales. Nevertheless, the transition from experimental production to a viable community enterprise requires further development. Follow-up activities should include the formulation of standardized recipes, sensory acceptability testing, microbiological and chemical quality assessment, shelf-life evaluation, calculation of production costs, packaging and labeling development, compliance with applicable food regulations, and small-scale market testing. Value addition can generate meaningful economic opportunities only when product development is accompanied by appropriate quality assurance, market access, and value-chain coordination (Ababouch, 2023). Accordingly, claims concerning increased income,

expanded market access, or improved business performance should be made only after production and sales have been monitored over an adequate period.



Figure 1. Fish nuggets, fish balls, and fish fillets introduced as alternative value-added products during the community engagement program.



Figure 2. Participants and facilitators conducting hands-on preparation of fish-based products in Lubuk Bayas Village.



Figure 3. Selected stages of community-based fish processing, from raw-material preparation to finished-product handling.



Figure 4. Facilitator-assisted demonstration of fish-processing techniques during the practical session.

Strengthening Food Hygiene and Safety Practices

Food hygiene and safety were positioned as integral components of value-added fish processing rather than as supplementary considerations. During the educational and practical sessions, participants were introduced to essential food-handling principles, including appropriate handwashing, cleaning of utensils and working surfaces, separation of raw fish from cooked or ready-to-eat products, use of safe water and ingredients, adequate cooking and temperature control, and protection of finished products from environmental contamination. These practices were emphasized as fundamental requirements for maintaining product quality, minimizing contamination risks, and improving consumer confidence in locally processed fish products.

The food-safety messages introduced during the program were consistent with the World Health Organization's Five Keys to Safer Food: keeping food preparation areas clean, separating raw and cooked foods, cooking food thoroughly, maintaining food at safe temperatures, and using safe water and raw materials (World Health Organization, 2006). They were also aligned with the General Principles of Food Hygiene established by the Codex Alimentarius Commission, which identify Good Hygiene Practices as the foundation for controlling food-safety hazards throughout food production and handling (Codex Alimentarius Commission, 2022). These internationally recognized principles provided a relevant framework for introducing basic food-safety practices within the community-scale processing context.

The practical sessions enabled the participants to relate these principles directly to each stage of fish processing. With guidance from the facilitators, participants were encouraged to consider how fish, ingredients, utensils, hands, working surfaces, and finished products should be handled at different stages of production. Particular attention was given to avoiding contact between raw fish and cooked products, cleaning equipment between processing stages, and keeping finished products covered after cooking. This stage-specific approach demonstrated that contamination may occur at multiple points in the processing chain and that hygienic control must therefore be maintained throughout the entire workflow.

Integrating food-safety education into practical processing was particularly important because the acquisition of knowledge does not automatically ensure consistent behavioral change. A systematic review and meta-analysis found that food-safety training generally improves food handlers' knowledge, attitudes, and self-reported practices; however, the effects on actual practices and microbiological outcomes are more variable (Insfran-Rivarola et al., 2020). This distinction is relevant to the present program. Participants' engagement and ability to follow the demonstrated procedures indicate initial exposure to hygienic processing practices, but these observations do not establish that the practices would be implemented consistently during subsequent independent production.

The practical demonstration also highlighted the interdependence of sanitation, process control, and product quality. For example, clean utensils alone cannot ensure product safety if unsafe water is used, raw and cooked materials are placed on the same surface, or cooked products are exposed during cooling and packaging. Similarly, adequate cooking must be accompanied by appropriate post-processing handling to reduce the possibility of recontamination. Evidence from small-scale fish processing indicates that the application of relatively simple Good Manufacturing Practices—including potable water, temperature control, protective equipment, hygienic cooling, and appropriate waste management—can contribute to better microbial and biochemical quality (Geraldo et al., 2024). Nevertheless, such improvements must be demonstrated through objective testing and cannot be inferred solely from participation in a training activity.

From an implementation perspective, the program established an initial foundation for the gradual development of Good Hygiene Practices, Good Handling Practices, and Good Manufacturing Practices within the community. The immediate outcome was principally educational: participants became acquainted with basic hygiene requirements and observed how these requirements could be integrated into fish-processing activities. The intervention should therefore be interpreted as an early capacity-building stage rather than evidence that a complete food-safety management system had been established. No structured hygiene-compliance assessment or microbiological examination of the products, utensils, water, working surfaces, or participants' hands was conducted.

Further development will require the preparation of simple and context-appropriate Standard Operating Procedures covering personal hygiene, raw-material reception, equipment cleaning and sanitation, prevention of cross-contamination, cooking, cooling, packaging, cold storage, waste management, and record keeping. Visual instructions and production checklists may be particularly useful for supporting consistent application at the household or community-enterprise level. Regular mentoring and observation will also be needed to determine whether participants can apply the procedures independently and consistently under actual production conditions.

At the time of the program, standardized operating procedures, documented production controls, microbiological verification, product licensing, and halal certification had not yet been completed. These elements should therefore be reported as priorities for subsequent development rather than as outcomes of the intervention. Future evaluation should combine observational checklists with objective measurements, such as product temperature records, water-quality assessment, surface or utensil swabs, microbiological examination, and shelf-life testing. Such evidence would make it possible to determine whether the knowledge introduced during the program translates into sustained improvements in processing hygiene and product safety.



Figure 5. Separation and handling of raw materials and cooked fish products during the practical processing session.

Contribution of International Academic Collaboration

The involvement of Srinakharinwirot University, Thailand, introduced an international academic dimension to the community engagement program. The international resource person contributed expertise in food-processing technology, product quality, and food-safety practices. This contribution complemented the local team's understanding of the community's rice–fish production system, available resources, and socioeconomic conditions. The collaboration therefore expanded the range of knowledge available to the participants while maintaining a focus on processing practices that could potentially be applied at the household or community-group level.

The international contribution was not limited to institutional representation or the delivery of a formal presentation. It functioned as a mechanism for exchanging knowledge

among the international resource person, the Indonesian academic team, students, and community participants. Technical concepts were discussed and demonstrated in relation to the fish species available locally, the participants' existing processing experience, the equipment accessible within the community, and the possibility of developing small-scale production. This contextualization was necessary because a processing method that is technically appropriate in one setting may not be directly applicable in another without adjustments to raw materials, infrastructure, production scale, consumer preferences, and local regulatory requirements.

The interaction between academic expertise and community experience also introduced an initial form of knowledge co-production. In this context, the community was not positioned solely as a passive recipient of externally generated information. Participants contributed information about existing fish-handling practices, local production constraints, available resources, and potential product preferences. These contributions helped the facilitators relate the technical material to the community's actual conditions. Knowledge co-production is understood as an interactive process through which academic actors and community members integrate different forms of expertise to develop knowledge that is more relevant and applicable to local problems (Satterthwaite et al., 2024). Similarly, research on university engagement in rural communities shows that combining academic knowledge with community-based knowledge can support more context-sensitive responses to local development challenges (Lang et al., 2024).

Nevertheless, the degree of knowledge co-production achieved during the program should be interpreted cautiously. The activity provided opportunities for discussion, questions, and practical interaction, but the processing methods and product alternatives were primarily introduced by the academic facilitators. Consequently, the program represented an early movement from one-way knowledge dissemination toward more reciprocal knowledge exchange, rather than a fully developed co-design or co-production process. More extensive community involvement in product selection, recipe modification, packaging design, costing, and market testing would be required to demonstrate deeper knowledge co-production.

The findings also extend the international collaboration previously reported by Sinaga et al. (2026) in relation to participatory rice–fish farming development in North Sumatra. Whereas the earlier engagement emphasized production-related discussion and the development of rice–fish farming practices, the Lubuk Bayas program directed international academic collaboration toward downstream activities. These activities included fish processing, product diversification, food hygiene, production consistency, packaging awareness, and initial market preparation. The distinction is important because the present program addressed the post-harvest stages required to transform harvested fish into differentiated food products rather than focusing primarily on improving cultivation practices.

From a value-chain perspective, this shift suggests an expansion in the scope of the collaboration from primary production to post-harvest value creation. However, the program should not yet be interpreted as having produced standardized or commercially viable products. Its contribution was primarily the introduction of new processing possibilities and the identification of technical requirements that must be addressed before regular production can begin. Product standardization, safety verification, production costing, regulatory compliance, consumer testing, and sales monitoring remain necessary before the economic contribution of the international knowledge exchange can be assessed.

The involvement of students created an additional educational dimension. By participating in the presentations, discussions, demonstrations, and interactions with community members and the international resource person, students were exposed to the

practical translation of academic knowledge into a community setting. They could observe that technical recommendations need to be communicated in accessible language and adapted to local resources and priorities. Community-engaged learning has been associated with positive academic, social, and civic-learning outcomes among university students (Guanlao et al., 2025). Nevertheless, because the present program did not employ reflection reports, competency assessments, or structured evaluations of student learning, these benefits should be described as potential educational contributions rather than measured outcomes.

The contribution of the international collaboration can therefore be interpreted at three interconnected levels. At the community level, it broadened participants' exposure to processing and food-safety knowledge. At the institutional level, it strengthened interaction between Universitas Sumatera Utara and Srinakharinwirot University through a community-oriented academic activity. At the student level, it provided an opportunity for experiential and intercultural learning. These contributions demonstrate the program's broader educational value, although their longer-term effects require systematic evaluation.

The sustainability of this international knowledge transfer will depend on whether the introduced practices are subsequently adopted, adapted, and reproduced independently by the community. Follow-up activities should therefore include refresher training, local facilitator development, simplified processing manuals, standardized recipes, production checklists, mentoring, and periodic evaluation. Future collaboration could also involve joint product development, virtual consultation, student exchanges, comparative evaluation, and community-based market testing. These mechanisms would allow the partnership to progress from a single knowledge-transfer activity toward a more continuous and reciprocal model of university–community collaboration.



Figure 6. The international resource person from Srinakharinwirot University delivering a session on fish-processing technology, product quality, and food-safety practices.



Figure 7. Representatives of Srinakharinwirot University, Universitas Sumatera Utara, students, and community participants involved in the community engagement program.

CONCLUSION

The community engagement program established an initial foundation for developing value-added fish products within the rice–fish farming community of Lubuk Bayas Village. The introduction of fish nuggets, fish balls, and fish fillets broadened the community's understanding of alternatives to conventional fresh-fish sales. The program also demonstrated that downstream development requires the integration of product diversification, raw-material selection, standardized processing, food hygiene, packaging, and market preparation. Participants' involvement in the discussions, demonstrations, and practical sessions indicated active engagement and provided initial procedural experience in processing locally harvested fish.

International academic collaboration between Universitas Sumatera Utara and Srinakharinwirot University strengthened the program by connecting international expertise with local knowledge, resources, and production experience. The collaboration extended the focus of community engagement from primary rice–fish production toward post-harvest processing and preliminary market readiness. It also provided students with opportunities to observe the contextual application of academic knowledge in a community setting.

Nevertheless, the findings represent preliminary capacity building rather than evidence of sustained technical competence, verified food safety, or commercial success. The program did not include standardized pre- and post-intervention assessments, microbiological testing, shelf-life analysis, or sales monitoring. Subsequent activities should therefore prioritize standardized recipes and operating procedures, hygiene monitoring, product-quality and shelf-life testing, production-cost analysis, packaging and labeling development, regulatory compliance, halal-certification readiness, and small-scale market testing. Continued mentoring and the development of local facilitators will be essential to support the community's ability to reproduce, adapt, and sustain the introduced practices independently.

REFERENCES

Ababouch, L. (2023). Value chains and market access for aquaculture products. Journal of the World Aquaculture Society. https://doi.org/10.1111/jwas.12964

Agus, A. (2020). Practicing of corporate social responsibility for community empowerment: A case of a mining company in Indonesia. Randwick International of Social Science Journal, 1(3), 608–618. https://doi.org/10.47175/rissj.v1i3.115

Codex Alimentarius Commission. (2022). General principles of food hygiene (CXC 1-1969). Food and Agriculture Organization of the United Nations and World Health Organization.

Geraldo, V., Ampofo-Asiama, J., Adinortey, C. A., Okyere, I., Tulashie, S. K., Nuer, A. T. K., et al. (2024). Implementation of good manufacturing practices (GMP) to improve the quality of smoked fish (Scombercolias). Heliyon, 10(5), e27401. https://doi.org/10.1016/j.heliyon.2024.e27401

Gereffi, G. (2018). Global value chains and development: Redefining the contours of 21st century capitalism. Cambridge University Press. https://doi.org/10.1017/9781108559423

Guanlao, R., Pax, J., Wei, Y., & Zhang, W. (2025). A meta-analysis of community engaged learning and thriving in higher education. Frontiers in Education, 10, 1525176. https://doi.org/10.3389/feduc.2025.1525176

Halwart, M., & Gupta, M. V. (Eds.). (2004). Culture of fish in rice fields. Food and Agriculture Organization of the United Nations and The WorldFish Center.

Humphrey, J., & Schmitz, H. (2002). How does insertion in global value chains affect upgrading in industrial clusters? Regional Studies, 36(9), 1017–1027. https://doi.org/10.1080/0034340022000022198

Insfran-Rivarola, A., Tlapa, D., Limon-Romero, J., Baez-Lopez, Y., Miranda-Ackerman, M., Arredondo-Soto, K., & Ontiveros, S. (2020). A systematic review and meta-analysis of the effects of food safety and hygiene training on food handlers. Foods, 9(9), 1169. https://doi.org/10.3390/foods9091169

Jack, C., Adenuga, A. H., Ashfield, A., & Wallace, M. (2020). Investigating the drivers of farmers' engagement in a participatory extension programme: The case of Northern Ireland Business Development Groups. Sustainability, 12(11), 4510. https://doi.org/10.3390/su12114510

Kansanga, M. M., Bezner Kerr, R., Lupafya, E., Dakishoni, L., &Luginaah, I. (2021). Does participatory farmer-to-farmer training improve the adoption of sustainable land management practices? Land Use Policy, 108, 105477. https://doi.org/10.1016/j.landusepol.2021.105477

Lang, W., Gkartzios, M., Yan, J., & Chen, T. (2024). Community co-creation through knowledge (co)production: The engagement of universities in promoting rural revitalization in China. Journal of Rural Studies, 112, 103455. https://doi.org/10.1016/j.jrurstud.2024.103455

Ma, W., Rahut, D. B., Sonobe, T., & Gong, B. (2024). Linking farmers to markets: Barriers, solutions, and policy options. Economic Analysis and Policy, 82, 1102–1112. https://doi.org/10.1016/j.eap.2024.05.005

Moosavi-Nasab, M., Asgari, F., &Oliyaei, N. (2019). Quality evaluation of surimi and fish nuggets from Queen fish (Scomberoidescommersonnianus). Food Science & Nutrition, 7(10), 3206–3215. https://doi.org/10.1002/fsn3.1172

Reardon, T., Barrett, C. B., Berdegué, J. A., &Swinnen, J. F. M. (2009). Agrifood industry transformation and small farmers in developing countries. World Development, 37(11), 1717–1727. https://doi.org/10.1016/j.worlddev.2008.08.023

Rosales, R. M., Pomeroy, R., Calabio, I. J., Batong, M., Cedo, K., Escara, N., Facunla, V., Gulayan, A., Narvadez, M., Sarahadil, M., &Sobrevega, M. A. (2017). Value chainanalysis and small-scale fisheries management. Marine Policy, 83, 11–21. https://doi.org/10.1016/j.marpol.2017.05.023

Satterthwaite, E. V., Knapp, C. N., Mair, P., Reeve-Arnold, K., Katona, S., Shapiro, A., et al. (2024). Centering knowledge co-production in sustainability science: Why, how, and when. Oceanography, 37(1).

Sinaga, H., Nauly, M., Ayu, S. F., Aulia, D., Salmiah, & Situmorang, P. S. I. (2026). Strengthening organic rice-fish farming through participatory focus group discussions and international collaboration in North Sumatra, Indonesia. Randwick International of Social Science Journal, 7(3), 172–181. https://doi.org/10.47175/rissj.v7i3.1297

World Health Organization. (2006). Five keys to safer food manual. World Health Organization.

Xie, J., Hu, L., Tang, J., Wu, X., Li, N., Yuan, Y., Yang, H., Zhang, J., Luo, S., & Chen, X. (2011). Ecological mechanisms underlying the sustainability of the agricultural heritage rice-fish coculture system. Proceedings of the National Academy of Sciences of the United States of America, 108(50), E1381–E1387. https://doi.org/10.1073/pnas.1111043108

Zhang, Z., Sun, Y., Sang, S., Jia, L., & Ou, C. (2022). Emerging approach for fish freshness evaluation: Principle, application and challenges. Foods, 11(13), 1897. https://doi.org/10.3390/foods11131897