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Research article

Technology Transfer Assessment of Amino Acid Block Fertilizer Production from Salted Egg White Waste for Coconut Farming in Paktrae, Songkhla Province

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Abstract: This study aimed to investigate farmers' knowledge of Good Manufacturing Practice (GMP)-compliant production of salted egg products, evaluate the technology transfer process, and assess user satisfaction with the application of amino acid block fertilizer derived from salted egg white waste for coconut cultivation. The study sample comprised 25 salted egg producers from Paktrae Subdistrict, Ranot District, Songkhla Province, Thailand. Data were collected using structured questionnaires and analyzed using descriptive statistics, including percentages, mean, and standard deviation, as well as a paired t-test. The results indicated that before the technology transfer, farmers exhibited a low level of knowledge, with a mean score of 5. After the technology transfer, knowledge increased significantly, with a mean score of 14, and the difference was statistically significant at the 0.01 level. The technology transfer process for amino acid block production from salted egg white waste was implemented through a participatory approach, including GMP training, technology introduction, hands-on practice, participatory discussions on product labeling, and the development **of** user manuals and infographic-based labels. Overall satisfaction with the technology transfer was at the highest level, with a mean score of 4.30. The highest satisfaction ratings were associated with lecturers (4.66), staff services (4.65), and knowledge and understanding gained from the training (4.48), followed by knowledge application (4.32) and training location (4.15). These findings suggest that participatory technology transfer can effectively enhance farmers' knowledge and satisfaction. Continuous monitoring and sustained technology support are recommended to ensure effective adoption and long-term utilization of the transferred technology among target communities.

Keywords: Evaluation; technology transfer; satisfaction; amino acid block fertilizer

1. Introduction

Technology transfer is essential for applying scientific knowledge and innovation in practical contexts, particularly in agriculture. It supports the adoption of appropriate technologies that enhance productivity, add value to local resources, and promote sustainable community development [1]. Effective technology transfer requires clear communication from the knowledge provider to the recipient. Currently, agriculture places great importance on technology to improve efficiency, and technology plays a significant role in Thailand' s

agricultural sector [2]. The application of knowledge and technology resulting from research serves as a catalyst for community development by fostering management innovations that solve local problems and promote change through an area-based approach. This empowers local communities to create sustainable livelihoods and incomes, thereby enhancing the stability of the grassroots economy and improving quality of life, which is a key component of national development in response to ongoing societal changes [3].

The Paktrae Salted Egg Production Group, located in Paktrae Subdistrict, Ranot District, Songkhla Province, produces salted eggs using free-range duck eggs. These ducks are raised on rice farms in the Ranot District and surrounding areas. Their products include salted eggs and salted egg yolks, with the latter especially popular for its versatility in a variety of dishes, both sweet and savory, such as Chinese pastries, mooncakes, bun fillings, and spicy salads served in restaurants. Salted egg yolks are produced by separating the yolks from eggs that have been cured in salt for 21 days, then vacuum-sealing them in bags. With its 10 members, the group has a production capacity of 45,000 salted eggs and salted egg yolks per month, which does not fully meet current market demand. The production process generates by-products, including approximately 2,250 kilograms of eggshells and 13,500 kilograms of salted egg whites each month. Initially, the group managed this waste by producing a fermented liquid, mixing eggshells with soil, and selling the resulting material as a raw ingredient for animal feed. However, more than 70% of the salted egg whites and eggshells remained unused, leading to unpleasant odors. These materials still hold potential for value creation, particularly through the development of processes that utilize salted egg whites.

Salted eggs are widely used as ingredients in food processing, particularly in bakery and confectionery products, where only the egg yolk is typically utilized. As a result, substantial quantities of by-products, including salted egg shells and salted egg whites, are generated and often discarded into the environment. However, these by-products possess potential value, as both egg shells and egg whites contain nutrients and minerals beneficial to plant growth. Therefore, they can be reutilized by incorporating them with other agricultural residues to produce organic fertilizers. This approach represents an effective strategy for waste valorization, contributing to environmental sustainability and the efficient use of resources. The production of amino acid block fertilizer from salted egg white waste represents an innovative approach that supports sustainable agriculture and the circular economy. Salted egg white is a by-product of the food processing industry that is often discarded in large quantities, potentially causing environmental pollution due to its high organic content. Transforming this waste into value-added fertilizer not only reduces environmental burdens but also promotes efficient resource utilization [4].

Amino acids play a crucial role in plant growth and development, as they are directly involved in protein synthesis, enzyme activation, and metabolic processes. The application of amino acid–based fertilizers has been reported to enhance nutrient uptake, stimulate root development, and improve plant tolerance to abiotic stresses such as salinity and drought [5]. These properties are particularly important for perennial crops that require continuous nutrient availability. Coconut is an economically important crop that requires adequate, balanced nutrition to support vegetative growth, flowering, and fruit development. The use of amino acid block fertilizer can provide a slow-release source of organic nutrients, improving fertilizer use efficiency and supporting sustained growth in coconut plantations. Moreover, amino acids can act as chelating agents, facilitating the absorption of essential nutrients and enhancing overall plant productivity [6].

Community-based participatory technology transfer is a learning process that emphasizes the active involvement of recipients through hands-on practice, experience sharing, and collaborative learning between technology providers and the community. This approach enhances understanding and enables the appropriate application of technology within the local context, increasing the likelihood of technology adoption, bridging the gap between academic knowledge and practical use, and strengthening community self-reliance [7]. Based on the above, the researchers recognize the importance of knowledge related to the production of salted egg products under GMP standards, as well as the transfer of amino acid block technology derived from salted egg white waste for application in coconut production. This is essential for the development and advancement of the Paktrae salted egg group and its network.

The objectives of the study were to investigate the level of knowledge related to GMP-compliant salted egg production, evaluate the technology transfer process, and assess satisfaction with the transfer of amino

block technology for use in coconut production. The results of this study can serve as guidelines for developing knowledge-based groups and networks. They also provide a framework for creating alternative careers and additional sources of income to help address poverty among farmers in a manner that is both appropriate and aligned with established standards. Furthermore, the findings can support the expansion of knowledge transfer to other farmer groups.

2. Materials and Methods

Study area

Salted egg farmers in Paktrae, Ranot District, Songkhla Province, are registered under the Paktrae Group as producers of OTOP salted egg products. The group comprises 25 members, including local farmers and unemployed individuals who are interested in increasing their income in Paktrae Subdistrict. Therefore, purposive sampling was applied to include all members of the group, ensuring a comprehensive representation of the community's problems and potential. Data collection and statistical analyses. This study was reviewed and approved by the Institutional Ethics Committee. All participants were informed about the objectives, procedures, potential benefits, and possible risks of the study, and written informed consent was obtained before participation.

Data collection.

This study employed a structured questionnaire to gather data on the transfer of amino acid block fertilizer production from salted egg white waste for coconut farming, divided into five parts, as follows:

Part 1: Basic farmer information.

Part 2: Assessment of knowledge on GMP-compliant production of Paktrae salted eggs in Paktrae Subdistrict, Songkhla Province, conducted before and after the technology transfer. The assessment consisted of closed-ended questions with four response options (A, B, C, and D). Each correct answer was scored as 1 point, while incorrect answers received 0 points. The mean knowledge scores were interpreted using a three-level criterion, as follows:

A score of 5 or fewer points indicates a low level of knowledge.

A score of 6–10 points indicates a moderate level of knowledge.

A score of 11–15 points represents a high level of knowledge.

Part 3: Transfer of technology for amino acid block fertilizer production from salted egg white waste for coconut farming. The technology transfer process for amino acid block fertilizer derived from salted egg white waste for application in coconut production employed a community-based participatory approach, with collaborative activities. It was divided into five key technology transfer activities, as follows:

Activity I: Provision of knowledge on GMP-compliant production of salted egg products;

Activity II: Introduction of amino acid block fertilizer technology;

Activity III: Demonstration and hands-on practice;

Activity IV: Participatory discussion and feedback on product label design;

Activity V: Summary of outcomes through the development of a manual and infographic-based product labels.

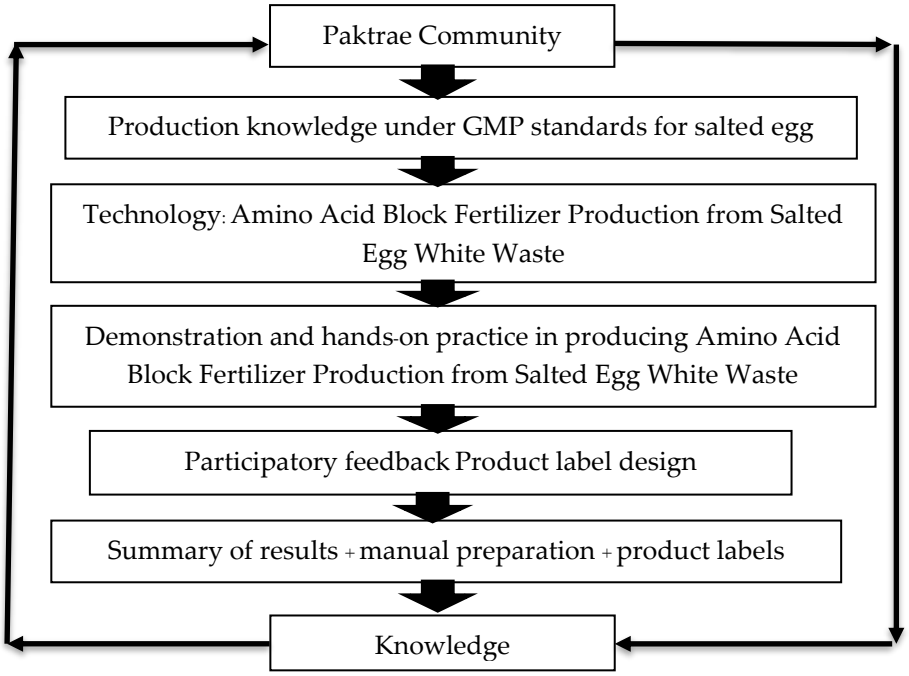

Figure 1. The process of transfer of technology for Amino Acid Block Fertilizer Production from Salted Egg White Waste for Coconut Farming in Paktrae, Songkhla Province

Part 4: Satisfaction with the technology transfer of amino acid block fertilizer production from salted egg white waste for coconut farming in Paktrae Subdistrict, Songkhla Province. Questionnaires comprising both closed- and open-ended questions were used to collect basic personal data and assess farmers' satisfaction with the technology transfer for amino acid block fertilizer production. The questionnaire used a five-point Likert scale, consisting of least satisfaction (1), low satisfaction (2), moderate satisfaction (3), high satisfaction (4), and highest satisfaction (5).To interpret the respondents' mean scores, a five-level criterion scale was applied, as follows:

Mean score of 4.21–5.00: Most satisfied
Mean score of 3.41–4.20: Very satisfied
Mean score of 2.61–3.40: Moderately satisfied
Mean score of 1.81–2.60: Slightly satisfied
Mean score of 1.00–1.80: Least satisfied

To ensure questionnaire quality, content validity was evaluated by three experts, who assessed the congruence between the questionnaire items, their content, and alignment with the research objectives using the Item–Objective Congruence (IOC) index. The revised questionnaire was subsequently pilot-tested with 30 non-sample farmers. Its reliability was assessed using Cronbach's alpha, yielding an alpha of 0.94 for the entire instrument. Data analysis was conducted using IBM SPSS statistical software. Descriptive statistics were employed, including frequency distributions, percentages, means, and standard deviations. The results were presented in frequency distribution tables, including minimum and maximum values for each variable.

3. Results and Discussion

3.1 Farmers' Basic Demographic Information

An analysis of the basic characteristics of farmers in Paktrae Subdistrict, Ranot District, Songkhla Province, indicated that the majority were female (66.67%), with an average age of 61.36 years. Most respondents had attained lower secondary education (76.00%), followed by upper secondary education (16.00%), while the smallest proportion held a bachelor's degree (8.00%). In terms of marital status, 86.67%

were married, while 13.33% were divorced. The most common occupation was agriculture (53.33%), followed by general labor (26.67%), with the smallest proportion employed as private company employees (6.67%) (Table 1).

Table 1. Farmers' Basic Demographic Information

Farmers' Basic Demographic Information	Frequency	Percentage
Gender		
Male	8	32.00
Female	7	68.00
Age		
Less than 41 years	4	16.00
42 year – 50 year	3	12.00
51 years – 59 years	5	20.00
60 years – 68 years	6	24.00
More than 69 years	7	28.00
Education Level		
Junior high school	19	76.00
Senior high school	4	16.00
Associate's degree	0	0.00
Bachelor's degree	2	8.00
Marital status		
Marital status	22	88.000
Divorced	**3**	12.00
Occupation		
Government service	1	4.00
Personal business	1	4.00
General labor	7	28.00
Private company employees	2	8.00
Agriculture	14	56.00

3.2 Assessment of knowledge on GMP-compliant production of Paktrae salted egg products

The assessment of farmers' knowledge regarding GMP-compliant production of Paktrae salted egg products indicated that, before the technology transfer, farmers demonstrated low (56.00%), moderate (40.00%), and high (4.00%) levels of knowledge. After the technology transfer, the assessment showed that 92.00% of farmers demonstrated a high level of knowledge, while 8.00% had a moderate level. Notably, no farmers remained in the low knowledge category after the technology transfer (Table 2).

Table 2. Knowledge before and after knowledge transfer training about the production of Paktrae salted egg products under GMP standards

Test Scores	Before knowledge transfer		After knowledge transfer	
	Numbers	Percentage	Numbers	Percentage
Low (0-5 score)	14	56.00	0	0.00
Moderate (6-10 score)	10	40.00	2	8.00
High (11-15 score)	1	4.00	23	92.00
Mean ± S.D	5 ± 2.22		14 ± 1.28	
Min	4		10	
Max	10		15	

A comparison of farmers' knowledge before and after the transfer of GMP-compliant production practices for Paktrae salted egg products, using a paired t-test, revealed a statistically significant difference at $\alpha = 0.01$. The farmers' knowledge after the transfer was significantly higher than at the beginning of the training. Before training, the farmers had an average score of 5 points, which increased to 14 points after the technology transfer. This indicates a significant improvement in their knowledge of GMP-compliant

production of Paktrae salted egg products. This improvement can be attributed to a clear and systematic technology transfer process that emphasized hands- on learning. This approach helped farmers better understand the principles of Good Manufacturing Practices (GMP), including production site hygiene, raw material quality, production processes, and product quality control. The results of the knowledge assessment further indicated that farmers answered 11 questions correctly at a rate of 80.00% or higher, whereas four questions had a correct response rate of less than 79.00% (Table 3).

Table 3. Comparative knowledge before and after the technology transfer of amino acid block fertilizer production from salted egg white waste for coconut farming in Paktrae, Songkhla Province

Items	Pre-test Post-test	Correct answers	Mean± S.D.	t	p value
1. How long is a community product standard certificate valid?	Pre-test	19	0.76 ± 0.43	-1.445	0.161
	Post-test	23	0.92 ± 0.27		
2. Which ministry certifies the Community Product Standard (CPS)?	Pre-test	9	0.36 ± 0.48	-3.098	0.005**
	Post-test	19	0.76 ± 0.43		
3. This mark represents which of the following product certifications?	Pre-test	5	0.20 ± 0.40	-3.934	0.001**
	Post-test	19	0.76 ± 0.43		
4. To what food group do raw salted eggs belong?	Pre-test	23	0.92 ± 0.27	-1.445	0.161
	Post-test	25	1.00 ± 0.00		
5. Where should I contact to apply for Community Product Standard (CPS) certification?	Pre-test	9	0.36 ± 0.48	-1.541	0.136
	Post-test	15	0.60 ± 0.50		
6. What is the application period for Community Product Standards (CPS) certification?	Pre-test	7	0.28 ± 0.45	-7.856	0.000**
	Post-test	25	1.00 ± 0.00		
07. How many digits are in a food registration number (FDA number)?	Pre-test	7	0.28 ± 0.45	-7.856	0.000**
	Post-test	25	1.00 ± 0.00		
8. Which of the following are the first two digits of the FDA registration number for a manufacturing facility in Songkhla province?	Pre-test	6	0.24 ± 0.43	-8.718	0.000**
	Post-test	25	1.00 ± 0.00		
9. Benefits of applying for community product certification.	Pre-test	6	0.24 ± 0.43	-8.718	0.000**
	Post-test	25	1.00 ± 0.00		
10. What is the minimum height of a table from the floor?	Pre-test	11	0.44 ± 0.50	-5.527	0.000**
	Post-test	25	1.00 ± 0.00		
11. What types of microorganisms serve as indicators of personal hygiene?	Pre-test	17	0.68 ± 0.47	-2.009	0.056*
	Post-test	23	0.92 ± 0.27		
12. Which of the following is the most correct approach for applying for an FDA registration number?	Pre-test	14	0.56 ± 0.50	-1.732	0.096
	Post-test	19	0.76 ± 0.43		
13. What GMP (Good Manufacturing Practice) regulations are currently in place for obtaining certification of a manufacturing facility?	Pre-test	13	0.52 ± 0.50	-4.707	0.000**
	Post-test	25	1.00 ± 0.00		
14. Which of the following is NOT a basic requirement of GMP (Good Manufacturing Practice) for obtaining certification of a manufacturing facility?	Pre-test	12	0.48 ± 0.50	-5.099	0.000**
	Post-test	25	1.00 ± 0.00		
15. Which production facilities are classified as factories?	Pre-test	5	0.20 ± 0.40	-9.798	0.000**
	Post-test	25	1.00 ± 0.00		

Remark: * Statistically different at probability level 0.05 ** Statistically different at probability level 0.01

3.3 Technology transfer of amino acid block fertilizer production from salted egg white waste for coconut farming in Paktrae, Songkhla Province

The production of salted eggs is a food processing method that requires careful consideration of consumer safety, as eggs are raw materials highly susceptible to contamination by pathogenic microorganisms. Therefore, the application of Good Manufacturing Practice (GMP) in food production is crucial for controlling product quality and ensuring food safety throughout the manufacturing process. Accordingly, training and technology transfer for salted egg production in accordance with GMP standards are essential to improve production standards in Paktrae Subdistrict. An increasing awareness and commitment among farmers to enhance product quality in compliance with established standards were observed, particularly among small-scale entrepreneurs and community enterprises. This contributes to the production of safe, high-quality food and enhances sustainable commercial competitiveness, consistent with previous findings [8]. Previous studies comprehensively evaluated the mechanisms underlying the formation of quality in salted eggs, including water and salt mass transfer, protein conformational changes, and the synthesis of small molecules. In addition, various pickling-assisted physical technologies and chemical additives have been developed and assessed to improve processing efficiency and product quality, as well as potential value-added applications of salted eggshells, salted egg whites (SEW), and salted egg yolks (SEY).

This context led to the initiation of efforts to expand knowledge on the production of amino acid block fertilizer derived from salted egg white waste for coconut cultivation. Amino acid–based fertilizers have been reported to enhance nutrient use efficiency and crop productivity by promoting root development and stimulating beneficial soil microbial activity. Such principles can be effectively applied to coconut production, particularly through the integration of biofertilizers and organic compounds, such as humic substances and amino acids, thereby increasing productivity and sustainability in agricultural systems [9]. Furthermore, studies on organic fertilization strategies in coconut farming indicate that incorporating biologically derived nutrient sources, including materials rich in amino acids, supports long-term soil health and productivity in coconut plantations [10].

The technology transfer of amino acid block fertilizer production from salted egg white waste for coconut farming was systematically designed to strengthen conceptual understanding, technical competence, and practical skills among the target group, within a participatory, knowledge-driven framework. The process was grounded in established theories of technology transfer, experiential learning, and adult education, integrating both theoretical instruction and applied practice to facilitate effective knowledge internalization and skill acquisition.

The transfer activities comprised structured academic lectures, hands-on training sessions, and on-site demonstrations conducted in an open learning environment that encouraged scholarly discussion, critical reflection, and knowledge exchange. The implementation commenced with a comprehensive introduction to the scientific background, objectives, and anticipated benefits of the technology, to establish a shared understanding of the problem context, the technology transfer model, and the chemical and nutritional characteristics of the amino acid block fertilizer. Subsequently, the production process was systematically and reproducibly presented, covering raw material selection, equipment requirements, and step-by-step manufacturing procedures, all under quality control principles. Particular emphasis was placed on the scientific rationale underlying each production stage to enhance participants' analytical understanding. In parallel, guidelines for fertilizer application in coconut cultivation were provided based on principles of plant physiology, nutrient management, and sustainable agricultural practices.

In addition, academic knowledge related to product development, value addition, and market planning was incorporated to support effective technology utilization at the community level. The practical training component was carefully structured with defined learning outcomes, enabling participants to translate theoretical knowledge into practice, critically evaluate the technology, and adapt it to local conditions. This academically oriented technology transfer approach contributed to the effective adoption, contextualization, and potential dissemination of the innovation within the target community.

The research team transferred the amino acid block technology to the salted egg production group in Paktrae through collaborative efforts involving Thaksin University, the Ranot District Administration Office,

and the Ranot District Community Development Office. These organizations jointly promoted the utilization of waste generated from salted egg yolk production by developing value-added products from unused egg whites through technology transfer. The knowledge transfer was conducted through practical training activities combining theoretical instruction and hands-on experience, which were subsequently applied in coconut production practices. The project results demonstrated that farmers reduced production costs and improved product quality and safety, benefiting both producers and consumers. In addition, the approach's environmental friendliness highlights its potential for sustainable technology development at the community level. This finding is consistent with [11], which emphasized that effective innovation transfer requires a clear understanding of recipients' living conditions, lifestyles, and knowledge levels to select appropriate delivery formats and communication methods. Aligning transfer strategies with the characteristics of each target group enhances learning outcomes and supports long-term sustainability.

Figure 2. Production of amino acid blocks from salted egg white powder

Following the completion of amino acid block product development, subsequent efforts focused on marketing extension, with an emphasis on establishing a distinct product identity through strategic branding. The research team facilitated consultative discussions among key stakeholders, including farmer groups, relevant government agencies, and local community representatives, to generate ideas collaboratively and reach consensus on product branding. As a result, the product was officially named "Paktrae Salted Egg White Amino Salt," a designation intended to reflect both the geographical origin and the distinctive characteristics of the raw materials utilized in its production. In addition, product label design and development were undertaken to reinforce the producer group's identity and enhance consumer trust. This effort aimed to strengthen the product's market competitiveness and address the absence of an official label during the initial stage of product development, a critical limitation that affects value creation and market positioning.

The label development process was therefore considered a strategic intervention to enhance product value and promote the sustainability of community-based products. The labels were designed to meet marketing requirements by incorporating visually appealing, distinctive elements that clearly reflect the product's characteristics, explicitly communicate the origin of the raw materials (Paktrae salted eggs), and emphasize the role of local wisdom in the production process. The labeling strategy aimed to establish and reinforce brand recognition for "Paktrae Salted Egg White Amino Salt," attract the attention of the target consumer segment, and stimulate initial purchase decisions. Furthermore, the labels were intended to support long-term customer engagement by fostering brand loyalty and encouraging repeat purchases.

Group members actively contributed their perspectives on marketing communication strategies. Based on a synthesis of these inputs, the message "Amino Egg White, Sweet Coconut Water (Paktrae)" was identified as an appropriate and effective communication theme for advertising and public relations across multiple online platforms. This message was formulated to convey the product's uniqueness while supporting the objective of generating sustainable, long-term income for the community.

This finding is consistent with previous research [12], which reported that major challenges in product packaging development stem from entrepreneurs' limited knowledge and understanding of packaging design. Although many producers have established brands, these brands often lack market recognition, and

the packaging materials are frequently unsuitable for use as souvenir products. In addition, product labels commonly fail to comply with labeling standards, resulting in incomplete or unclear information for consumers.

In response to these challenges, the packaging design was systematically improved to enhance product visibility and strengthen brand recognition through the use of modern design elements and illustrative graphics. The revised packaging includes complete, standardized product information and accessible contact channels to facilitate consumer engagement. Furthermore, the packaging was redesigned to support convenient handling and consumption, while ensuring durability and effective preservation of product quality. These improvements enhance market appeal and align the product with contemporary consumer expectations.

Figure 3. Product label

3.4 Satisfaction with the technology transfer of amino acid block fertilizer production from salted egg white waste for coconut farming in Paktrae, Songkhla Province

Farmers who participated in the technology transfer reported the highest overall satisfaction, with a mean score of 4.45. When considering each aspect, farmers reported the highest levels of satisfaction with the trainers (mean 4.66) and the services provided by officials (mean 4.65). In terms of knowledge and understanding, farmers expressed a high level of satisfaction (mean 4.48). Satisfaction with the training location was also high (mean 4.15), followed by knowledge and understanding, which was rated at a moderately high level, and application of knowledge, which was rated at a high level (mean 4.32). The study results are summarized below.

1) Trainers*:* Farmers reported the highest overall satisfaction in this category, with a mean score of 4.66. Among the specific aspects evaluated, the trainers' preparation and readiness received the highest rating (mean 4.81). Their ability to explain content clearly and concisely, using appropriate, easy-to-understand language, also received a high satisfaction score (mean 4.71). The delivery of lectures was rated at the highest level (mean 4.67), as was their responsiveness to questions (mean 4.57). In addition, the appropriateness of lecture materials received a high rating (mean 4.48). This finding is consistent with [13], who reported that effective lecturers should be able to create a positive learning atmosphere and communicate content clearly to trainees.

2*)* Training location*:* Farmers expressed a high overall level of satisfaction with the training location (mean 4.15). Among the evaluated aspects, the training duration was rated as the most appropriate (mean 4.38). The availability of audiovisual equipment and food services was rated as very appropriate (mean 4.19), while the cleanliness and suitability of the venue were also rated as appropriate (mean 3.86). The training schedule was designed to align with farmers' availability, and equipment and facilities were adequately prepared. The venue's cleanliness and organization contributed to a comfortable learning environment that encouraged active participation.

3) Services provided by officials*:* Farmers expressed the highest overall satisfaction with the services provided by officials (mean 4.65). Specifically, staff service quality received the highest rating (mean 4.71).

Project coordination and facilitation by staff were also rated at the highest level (mean 4.67), as were staff members' advice and responsiveness to questions (mean 4.57). The professionalism, attentiveness, and effective coordination of the staff contributed to farmers' confidence and sense of support throughout the technology transfer process.

4) Knowledge and understanding*:* Farmers expressed a high overall level of satisfaction with their knowledge and understanding (mean 4.48). After the training, their overall understanding was rated at the highest level (mean 4.67). Farmers were able to clearly explain the benefits of amino acid block development (mean 4.57) and the details of the production process (mean 4.48). Their ability to organize and apply knowledge systematically to work development was also rated at a high level (mean 4.05).

5) Knowledge application*:* Farmers expressed a high level of overall satisfaction with knowledge application (mean 4.32). They demonstrated the highest ability to disseminate and transfer knowledge to the community (mean 4.48). In addition, they were able to apply the acquired knowledge in their work and provide guidance to coworkers (mean 4.29), while also showing strong confidence and capability in applying the knowledge independently (mean 4.24). This finding is consistent with [14], which emphasized that agricultural technology and innovation transfer enable farmers to apply knowledge to improve their livelihoods and those of their families (Table 4).

Table 4. Satisfaction with the technology transfer of amino acid block fertilizer production from salted egg white waste for coconut farming in Paktrae, Songkhla Province

Satisfaction	Mean	S.D.	Level
Trainers	**4.66**	**0.46**	**Highest**
1. The trainers' preparation and readiness	4.81	0.39	Highest
2. Explain the content clearly and concisely	4.71	0.45	Highest
3. Using appropriate and easy-to-understand language	4.71	0.45	Highest
4. Delivery of the lectures	4.67	0.47	Highest
5. Responsiveness to questions	4.57	0.49	Highest
6. Appropriateness of the lecture materials	4.48	0.50	Highest
Location	**4.15**	**0.66**	**High**
1. Training duration	4.38	0.49	Highest
2. Availability of audiovisual equipment	4.19	0.59	High
3. Availability of food	4.19	0.73	High
4. Cleanliness and suitability of the venue	3.86	0.83	High
Service Provided by Officials	**4.65**	**0.47**	**Highest**
1. The staff's service quality	4.71	0.45	Highest
2. Project staff coordination	4.67	0.47	Highest
3. Project staff facilitation	4.67	0.47	Highest
4. The staff's advice and responsiveness to questions	4.57	0.49	Highest
Knowledge and Understanding	**4.48**	**0.51**	**High**
1. After training, knowledge and understanding	4.67	0.47	Highest
2. The benefits of developing amino acid blocks from salted egg white powder for application in coconut production can be explained.	4.57	0.49	Highest
3. The advantages of developing amino blocks from salted egg white powder for application in coconut production can be explained.	4.57	0.49	Highest
4. The development of amino blocks, a salt substitute from salted egg white powder, can be described in detail for application in coconut production	4.48	0.50	Highest
5. Can organize/process ideas into systematic work development.	4.05	0.58	High

Table 4. Satisfaction with the technology transfer of amino acid block fertilizer production from salted egg white waste for coconut farming in Paktrae, Songkhla Province (Continue)

Satisfaction	Mean	S.D.	Level
Knowledge Application	**4.32**	**0.64**	**Highest**
1. Disseminate and transmit knowledge to the community	4.48	0.50	Highest
2. Demonstrated the ability to apply the knowledge gained in their work	4.29	0.63	Highest
3. Provide advice to coworkers to a great extent	4.29	0.63	Highest
4. Farmers showed strong confidence and capability in applying the knowledge acquired	4.24	0.81	Highest
Total	**4.45**	**0.55**	**Highest**

Remark: Levels

Average 4.21 - 5.00 Most Satisfied
Average 3.41 - 4.20 Very Satisfied
Average 2.61 - 3.40 Moderately Satisfied
Average 1.81 - 2.60 Slightly Satisfied
Average 1.00 - 1.80 Least Satisfied

4. Conclusions

The findings revealed that farmers had significantly higher knowledge levels regarding GMP-compliant production of Paktrae salted egg products following the technology transfer. The difference in knowledge levels before and after the transfer was statistically significant, at $\alpha = 0.01$, indicating the effective implementation of the technology transfer process. The transfer of amino acid block fertilizer production technology derived from salted egg white waste is a key strategy to promote waste management and value addition within the salted egg production process, with an emphasis on sustainable development. This approach enables the community to utilize unused salted egg whites effectively. Previously regarded as waste from salted egg yolk production, salted egg whites have been developed into value-added products that benefit both the agricultural sector and community-based enterprises. This innovation is community-based, fostering new business opportunities, generating additional employment, increasing household income, and reducing waste from the production process. It reflects efficient resource use, promotes environmental sustainability, and contributes to resilient, sustainable community development. The evaluation of satisfaction with the transfer of amino acid block fertilizer technology revealed the highest overall satisfaction, particularly with respect to the lecturers and the services provided by project staff. In terms of knowledge application, training location, and overall understanding, satisfaction was high. The activities were organized with an emphasis on participatory learning and hands-on training. Lecturers, as subject matter experts, clearly and effectively communicated the content. Staff provided efficient coordination and support, while the training venue was appropriate, accessible, and conducive to learning. The content was practical, easy to understand, and applicable to real-world situations.

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