ASEAN
Journal of Scientific and Technological Reports
Online ISSN:2773-8752

Research article

Technology Transfer Needs Assessment for Turmeric Farmers in Paphayom District, Phatthalung Province

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Citation:
Lekbangpong, S.; Ratanachai, A. Technology transfer needs assessment for turmeric farmers in paphayom district, Phatthalung province. *ASEAN J. Sci. Tech. Report.* **2025**, *28*(1), e254806.https://doi.org/10.55164/ajstr.v28i1.254806.

Article history:
Received: July 1, 2024
Revised: October 2, 2024
Accepted: October 25, 2024
Available online: December 14, 2024

Abstract: These research findings indicated that most farmers in the study were female, with an average age of 55.88 years and an average of 10.80 years of experience in cultivating turmeric. Often, turmeric is grown in conjunction with rubber cultivation. Farmers typically cultivated turmeric on 1.38 rai, preferring sandy loam soil conditions. Their preferred turmeric variety was Trang 84-2. The planting method involves digging holes 10 centimeters deep, with a spacing of 25 cm x 25 cm. Turmeric cultivation usually commences in June and concludes with its harvest in April. During planting, farmers apply a combination of chemical and biological fertilizers, along with organic manures. Weed control is primarily achieved by manual removal, while chemical treatments are employed to manage diseases and insect pests. During the 2021/2022 production season, farmers achieved an average turmeric yield of 1,675.81 kg. Farmers encounter various problems in turmeric production, particularly in maintenance, disease, and insect management. These issues adversely affect the planting area, often reducing production yields. The most pressing need for farmers is to acquire turmeric production technology, particularly in pest mitigation and elimination. Farmers want to receive knowledge transfer, such as with individualized guidance through farm visits. The media that farmers require include brochures and the assistance of extension officers. Additionally, the level of experience in turmeric production significantly influenced the farmers' technology transfer needs at a 0.01 significance level.

Keywords: Production; Problems; Technology transfer; Turmeric

1. Introduction

According to Euromonitor, the herbal products market in Thailand in 2021 was valued at 45.64 billion baht, a slight decrease of approximately 1% from 2020. Notably, some products showed declining demand while there was increasing demand for dietary supplements. Therefore, it is anticipated that herbal products will continue to experience demand growth, with the market value projected to reach 59.5 billion baht by 2026 [1]. This presents a favorable outlook to encourage the cultivation of medicinal plants, providing trade opportunities and a potential way for farmers to generate income within local communities[2]. Turmeric (*Curcuma longa* L.) has a rich history of medicinal use dating back to ancient times. It possesses properties for treating digestive issues, including flatulence, and is considered one of the six essential Thai herbal medicines. Turmeric is widely utilized as an ingredient in both food and

cosmetic products. Extracts derived from turmeric primarily contain two substances: curcuminoids and essential oils.

In Phatthalung province, farmers have adopted the cultivation of turmeric as an intercrop within fruit tree orchards and rubber plantations. This method optimizes land use and allows farmers to generate income while waiting for their fruit trees and perennials to become established. Furthermore, according to a recent survey [3], the total land area in Phatthalung province is 127,962 rai, distributed across Paphayom, Khuan Khanun, Sri Banphot, Srinakarin, Kong Ra, and Khao Chaison districts. This region holds significant potential for turmeric cultivation and is classified as an "S1" area, indicating its suitability for crop cultivation. According to a research report [4], turmeric products cultivated in the Paphayom district of Phatthalung province exhibit higher levels of curcuminoid and volatile oil than standard values and with turmeric produced in other regions. The suitability of the planting area in the Paphayom district lies in its terrain, characterized by mountainside slopes that cannot be flooded.

Additionally, the soil does not retain water, contributing to the production of high-quality turmeric. Moreover, turmeric cultivation is characterized by its simplicity, minimal capital investment, and potential to generate substantial farmer income, leading to a growing interest among farmers in the Paphayom district. Turmeric is frequently intercropped with other plants, and the land is continuously utilized without fallow periods. However, this continuous cultivation can lead to challenges in turmeric farming, including rot or wilt diseases. These diseases are primarily attributed to a buildup of bacteria in the soil, particularly in regions with extensive and uninterrupted planting, ultimately leading to reduced turmeric yields. Reduced turmeric yields and income have compelled many farmers to discontinue turmeric cultivation. Those farmers who continue turmeric cultivation often do so with less intensive care since their primary focus is on selling the harvested produce, be it fresh turmeric or turmeric powder. They primarily use turmeric as a component in various curry pastes rather than directing it toward pharmaceutical applications. Attaining the desired curcuminoid levels is paramount, especially when striving to produce turmeric that meets the necessary quality and standards for pharmaceutical applications. This requires a meticulous commitment to production processes and ongoing vigilance by the farmers. In a study conducted [5], it was discovered that the majority of farmers cultivated turmeric without adhering to certification standards.

Consequently, the quality of their produce falls short of meeting market requirements. Therefore, their turmeric tends to fetch relatively lower prices in the market. However, suppose farmers adhere to proper cultivation practices that align with production principles and strive to meet GAP (Good Agricultural Practices) standards for certification. In that case, it can lead to increased market demand and the ability to sell their products at higher prices. Additionally, through interviews conducted with local farmers, it was found that issues in turmeric production stemmed from farmers' insufficient knowledge and understanding of correct turmeric cultivation practices. Their turmeric cannot be utilized in health products due to the use of chemicals in production. Additionally, the soil condition where turmeric is planted can be degraded, leading to potential issues for future plantings. This includes diseases during planting and improper harvesting of the produce while it is still in its early stages, resulting in a lower-quality product. Consequently, the selling price is significantly reduced.

From the observations above, it becomes evident that turmeric production by farmers in the Paphayom district lacks integration with academic knowledge and modern production practices. Consequently, the harvested products still do not meet the quality standards necessary for their utilization in the production of high-value products. Therefore, farmers receive meager returns from their efforts, leading to a lack of motivation to sustain their cultivation activities despite the region's high suitability for turmeric production. Furnishing farmers with customized turmeric production technology tailored to their specific needs is crucial to enabling them to cultivate turmeric correctly and achieve superior product quality. Transfer of appropriate turmeric production technology that meets farmers' needs. What should it be? Consequently, this will empower farmers to command higher prices for their produce. In light of these factors, it becomes apparent that addressing production challenges and the imperative requirement for technology transfer are essential for improving turmeric production by farmers in the Paphayom district. This research gives valuable insights for devising effective strategies in technology transfer to farmers. This effort aimed to equip them

with the knowledge and skills needed to enhance the quality of their production. By addressing the existing production and delivering technology transfer tailored to their requirements, farmers can resolve their current issues and pave the way for a more profitable future.

2. Materials and Methods

Study area

The turmeric cultivation area in the Paphayom district of Phatthalung province encompasses the Lan Khoi subdistrict, comprising four villages. These include Village No. 3, Ban Thung Chumphon; Village No. 5, Ban Tham La; Village No. 8, Ban Huai Ramphueng; and Village No. 9, Ban Khuan Yao. It extends into the Ko Tao subdistrict, encompassing four villages: Village No. 3, Ban Bang Lo; Village No. 5, Ban Sai; Village No. 9, Ban Khuan Tabaek; and Village No. 11, Baan Ko Yuan. The research population of turmeric farmers Purposive Sampling of 118 farmers within Paphayom district, Phatthalung province.

Data collection and statistical analyses

The research utilizes a questionnaire to gather data on the transfer of turmeric production technology divided into 5 parts. Part 1: Basic farmer information. Part 2: Turmeric production practices among farmers. Part 3: Problems of turmeric production. Part 4: Needs and methods for technology transfer to do turmeric production. Part 5: Media is needed for technology transfer to produce turmeric. The severity of problems in turmeric production will be measured using a rating scale: a mean of 0.00–0.67 indicates no problems, 0.68–1.33 indicates minor problems, and 1.34–2.00 indicates significant problems. The level of need for technology transfer in turmeric production will be measured using a rating scale: a mean of 0.00–0.74 indicates no need, 0.75–1.49 indicates low need, 1.50–2.24 indicates moderate need, and 2.25–3.00 indicates high need. The need for media in technology transfer for turmeric production will be measured using a rating scale: a mean of 1.00–1.67 indicates a low need, 1.68–2.33 indicates a moderate need and 2.34–3.00 indicates a high. To ensure the quality of the questionnaire, a review was conducted by three experts. They focused on assessing the congruence between the questions, their contents, and their alignments with the research objectives, as measured by the Item Objective Congruence (IOC). The revised structured interview was then administered as a trial to a group of 30 non-sample farmers. Its reliability was assessed using Cronbach's alpha coefficient, which yielded a high confidence value of 0.96 for the entire interview. The data analysis in this study was conducted using IBM SPSS, a software for social science statistics. Descriptive statistics were used, including frequency distribution, percentage, mean, and standard deviation. The results were presented as a frequency distribution table, showcasing maximum and minimum values for each variable. Stepwise multiple regression correlation analysis was employed to determine the factors influencing the need for technology transfer in turmeric production.

3. Results and Discussion

3.1 Personal characteristics, economic status, and social position of farmers in Paphayom district, Phatthalung province

The research findings indicate that turmeric producers in Paphayom District, Phatthalung Province, are predominantly female, with an average age of 55.88, and most completed their primary education. On average, there are 3.63 members per household, with 2.15 household members engaged in agricultural activities. The average total agricultural landholding per household was 13.94 rai. Mountainside slopes primarily characterize the agricultural area. Farmers have an average of 10.80 years of experience in turmeric cultivation. This is consistent with the study of [6], which suggests that farmers with experience or those who have participated in agriculture-related activities are more likely to prioritize and show greater interest in activities promoting organic vegetable cultivation than farmers without such experiences. A notable proportion of them, 46.61% of the total, are members of agricultural groups or organizations. These organizations encompass a range of entities such as the Bank for Agriculture and Agricultural Cooperatives (BAAC), farmer occupational groups, community enterprise groups, and agricultural cooperative groups.

3.2 Turmeric production practices among farmers in Paphayom district, Phatthalung province

Turmeric producers among farmers in the Paphayom district, Phatthalung province, typically cultivate an average total area of 1.38 rai of turmeric. Most of them (67.80%) engage in intercropping turmeric with rubber trees. The prevalent soil type for cultivation is sandy loam, constituting 72.03%. The overwhelmingly favored turmeric variety is Trang 84-2, chosen by 98.31% of farmers due to its well-rooted structure, vibrant color, appealing taste, and high market demand. The most grown type of turmeric tuber among farmers is the mother tuber with stems, accounting for 79.31% of the cases. This preference is attributed to the cost-effectiveness of mother tubers with stems compared to those without stems. Farmers predominantly cultivate turmeric from purchased plants, accounting for 72.03% of cases. The planting area preparation typically involves 13.52 days, including a single plowing session and seven days of soil drying. Lime is applied once to adjust the soil's pH. The planting process entails digging holes 10 centimeters deep and maintaining a maximum planting distance of 25 cm x 25 cm. The planting season commences in June, with harvesting in April of the subsequent year. Natural rainwater is primarily used for irrigation during the production process. In turmeric production, farmers apply fertilizer at different stages, including a single application of biological fertilizer at a rate of 50 kilograms per rai, administered before the planting phase, followed by two chemical fertilizer applications at a rate of 50 kilograms per rai. The first application of chemical fertilizer is done one month after planting. The second application utilizes a 0-0-60 chemical fertilizer formula administered during the tillering stage to nourish the bulbs. Manure is applied once, two months after the initial planting, at 80 kilograms per rai. Finally, a 13-13-21 chemical fertilizer formula is applied three months or more after planting turmeric to stimulate growth. Weed control is primarily achieved through manual removal, practiced by 98.31% of the farmers. Additionally, chemical treatments are used to manage diseases and insects. Chemical agents are employed alongside biological agents and biological fermentation techniques. The average time required for harvesting turmeric is 29.51 days. Farmers in this region prefer to use hoes to harvest their turmeric, consistent with a report [7] on turmeric harvesting in Bagalkot, Karnataka, India. In Bagalkot, turmeric is typically harvested when the leaves begin to yellow, and the stem eventually dries down. This harvesting season typically spans the period from February to April. The rhizomes become ready for harvest approximately 7-9 months after planting. The harvesting process involves digging underground clumps of rhizomes using a pickaxe or digging fork, followed by separation of the fingers from the mother rhizomes. During the 2021/2022 production season, farmers achieved an average turmeric yield of 1,675.81 kg. Farmers utilize their turmeric in three ways: outright sale, for use as seed heads, and for personal consumption. Turmeric sales are segmented into three primary categories. The first was turmeric powder, which accounted for 77.96% of the sales. This preference is driven by the convenience it offers, as it requires minimal grading and can be readily cleaned and sold. The average price for turmeric powder is 29.51 baht per kilogram. Next, turmeric produce is also sold as mother bulbs with stems, representing 51.69% of sales. These are sold at an average price of 43.19 baht per kilogram. Finally, a smaller proportion, 5.08%, is sold as tubers without stems, fetching an average price of 50 baht per kilogram. The price of tubers without stems is higher than those with stems attached due to the absence of attached stems. This results in a shorter growth period for stems and leaves than rooted varieties, contributing to the price difference.

Figure 1. Harvesting turmeric of farmers in Paphayom district, Phatthalung province.

3.3 Problems of turmeric production in Paphayom district, Phatthalung province

An overview of the challenges faced by farmers in Pa Phayom district, Phatthalung province, in turmeric production revealed that their primary issues were related to maintenance, diseases, and insects affecting their crops. While they encountered some challenges in receiving state support, these were relatively minor. (Table 1).

Table 1. Level of farmer's problems with turmeric production in Paphayom district, Phatthalung province

Problems of turmeric production	⚜	S.D.	Description
1. Preparation before planting	0.48	0.36	No problems
2. Planting	0.57	0.33	No problems
3. Preservation	1.00	0.64	Less problematic
4. Diseases and Insects	0.70	0.38	Less problematic
5. Harvest and Post-harvest	0.30	0.34	No problems
6. Marketing	0.67	0.58	No problems
7. Government Support	1.03	0.43	Less problematic
	0.67	**0.28**	**No problems**

Remark: Levels problems of turmeric production: mean 0.00-0.67 = No problems, mean 0.68-1.33 = Less problematic, mean 1.34-2.00 = Very troubling

3.4 Needs of farmers for technology transfer to do turmeric production in Paphayom district, Phatthalung province

3.4.1 Needs and methods for technology transfer to do turmeric production

There is a need to transfer technology and improved turmeric production techniques to farmers in the Paphayom district, Phatthalung province. An overall assessment reveals that farmers have a significant demand for technology transfer for turmeric production. When examining specific aspects of their requirements, it becomes evident that farmers have particularly pronounced needs related to pest mitigation and eradication. They express a need for individualized knowledge transmission methods, such as farm visits, and mass communication methods like campaigns. Campaigns are valuable for disseminating information persuasively, establishing trust, and facilitating the adoption of ideas and behaviors among farmers. This finding aligns with the research [8], which emphasized the effectiveness of electronic and mass media platforms in disseminating knowledge, skills, and improved technology to rice farmers. These media channels play pivotal roles in delivering extension services, particularly in light of the limited effectiveness of public extension agencies in providing essential agricultural extension services to farmers. Additionally, it is noteworthy that farmers have moderate needs for maintenance technology. For maintenance technology, the preferred method of knowledge transfer is mass communication, specifically through campaigns, rather than group-based approaches. This preference stems from the belief that group methods may not effectively address important issues and alternative methods are deemed more suitable for acquiring knowledge related to maintenance. For moderate priority needs, specifically those related to preparation before planting and the planting phase, farmers prefer technology transfer through both mass methods and individualized methods. Farmers exhibit reluctance to receive technology transfer in pre- and post-harvest phases. They perceive academic technology in these aspects as time-consuming and prefer to rely on knowledge obtained from diverse sources along with their accumulated experience to manage the pre- and post-harvest periods. (Table 2).

Table 2. Level of farmers' needs and methods for technology transfer for turmeric production in Paphayom district, Phatthalung province

Needs and method for technology transfer of turmeric production	⚜	S.D.	Description
1. Preparation before planting	1.29	0.56	Lowest
Individual method	1.52	0.12	Moderate
Group method	0.66	0.02	Needless
Mass method	1.99	0.06	Moderate
2. Planting	0.88	0.80	Lowest
Individual method	1.50	0.03	Moderate
Group method	0.67	0.40	Needless
Mass method	1.98	0.60	Moderate
3. Preservation	1.71	0.58	Moderate
Individual method	1.49	0.10	Lowest
Group method	0.67	0.04	Needless
Mass method	2.00	0.05	Moderate
4. Prevention and pest control	2.35	0.67	High
Individual method	1.50	0.07	Moderate
Group method	0.66	0.03	Needless
Mass method	1.99	0.05	Moderate
5. Before and after harvest	0.73	0.84	Needless
Individual method	1.50	0.08	Moderate
Group method	0.66	0.09	Needless
Mass method	2.00	0.05	Moderate

Remark: Levels needs for technology transfer of turmeric production:
mean 0.00 – 0.74 = needless, mean 0.75 – 1.49 = Lowest, mean 1.50 - 2.24 = Moderate, mean 2.25 – 3.00 = High

3.4.2. Needs media for technology transfer to do turmeric production

The overall level of demand for media-based technology transfer in turmeric production among farmers in the Paphayom district is assessed as moderate. The desired medium for technology transfer among farmers is brochures. Farmers find brochures easily accessible, enabling them to open and read them immediately, and they appreciate the comprehensive information provided. When examining the specific media needs for each aspect, it becomes evident that for preparation before the planting phase, farmers prefer brochures, followed by television and information from neighbors. Regarding the planting phase, farmers similarly prioritize brochures as their preferred media, followed by television and the Internet. For maintenance, pamphlets are in the highest demand, followed by consultations with government officials and community leaders. Regarding pest mitigation and elimination, most farmers prefer information broadcast by government officials, followed by online resources and instructional manuals. Pamphlets are the most preferred media for the pre-and post-harvest periods, followed by television and information from neighbors. This finding is consistent with the research conducted [9], on the effectiveness of print media in technology transfer among rural farm households in Imo State, Nigeria. The study revealed that farm households in Imo State most commonly used print media, specifically flyers, to access information and knowledge about the improved technologies being transferred to them. (Table 3).

Table 3. Level of farmers' needs for media technology of turmeric production in Paphayom district, Phatthalung province

The technology of turmeric production	Needs media	⚜	S.D.	Description
1. Preparation before planting	Neighbor	2.17	0.96	Moderate
	Community leader	2.13	0.46	Moderate
	Government official	1.71	0.85	Moderate
	Brochure	2.58	0.63	High
	Manual	2.13	0.56	Moderate
	Poster	1.26	0.61	Low
	Television	2.23	0.70	Moderate
	Video	1.62	0.76	Low
	Internet	2.11	0.85	Moderate
2. Planting	Neighbor	2.06	0.93	Moderate
	Community leader	2.10	0.59	Moderate
	Government official	1.87	0.86	Moderate
	Brochure	2.53	0.66	High
	Manual	2.10	0.67	Moderate
	Poster	1.41	0.70	Low
	Television	2.17	0.76	Moderate
	Video	1.60	0.68	Low
	Internet	2.16	0.84	Moderate
3. Preservation	Neighbor	1.50	0.83	Low
	Community leader	2.20	0.49	Moderate
	Government official	2.29	0.83	Moderate
	Brochure	2.34	0.75	High
	Manual	2.16	0.64	Moderate
	Poster	1.49	0.79	Low
	Television	2.25	0.70	Moderate
	Video	1.55	0.69	Low
	Internet	2.17	0.86	Moderate
4. Prevention and pest control	Neighbor	1.37	0.72	Low
	Community leader	2.11	0.44	Moderate
	Government official	2.57	0.73	High
	Brochure	2.25	0.68	Moderate
	Manual	2.29	0.68	Moderate
	Poster	1.44	0.78	Low
	Television	2.06	0.72	Moderate
	Video	1.57	0.69	Low
	Internet	2.30	0.86	Moderate
5. Before and after harvest	Neighbor	2.18	0.94	Moderate
	Community leader	2.14	0.51	Moderate
	Government official	1.72	0.86	Moderate
	Brochure	2.38	0.76	High
	Manual	2.10	0.61	Moderate
	Poster	1.50	0.81	Low
	Television	2.31	0.72	Moderate
	Video	1.60	0.68	Low
	Internet	2.07	0.87	Moderate

Remark: Levels needs media for technology transfer of turmeric production:
mean 1.00-1.67 = Low, mean 1.68-2.33 = Moderate, mean 2.34-3.00 = High

3.5 Factors affecting the need for technology transfer to do turmeric production for farmers in Paphayom district, Phatthalung province

The relationship between the independent and dependent variables was analyzed using stepwise multiple regression analysis. A total of 8 independent variables were considered, including gender, age, education level, the number of household members, the number of workers in the household, turmeric production experience, turmeric growing area, and turmeric production. The dependent variable in this analysis is the farmers' need for technology transfer in turmeric production. Analysis results are displayed in Table 4.

Table 4. Mean and standard deviation of the analyzed variables

Independent variables	⚜	S.D.
Sex (1= male / 2= female)	2.00	0.49
Age (years)	55.88	9.55
Education level (years)	2.38	0.82
Number of household members	3.63	1.14
Number of workers in the household	2.15	0.72
Turmeric production experience (years)	10.80	5.05
Landholding area (rai)	1.38	0.82
Turmeric yield (kg)	1,672.81	960.42

The multiple regression analysis obtained an F-value of 6.097 with a significance level of 0.01. When considering the multiple coefficients of determination (R^2), which is 0.73, it indicates that independent variables collectively explain 73 percent of the variation in the dependent variable. Specifically, one independent variable, experience in producing turmeric, significantly affects the dependent variable at the 0.01 level, with a coefficient value of Y = 1.186 + 0.239 x (turmeric production experience).

Farmers with extensive experience in turmeric production exhibit a greater need for technology transfer compared to farmers with limited experience. This finding aligns with the research conducted [10]. Their study investigated factors influencing farmers' need to promote organic vegetables in the Maefaekmai sub-district, Sansai district, Chiang Mai province. The study explained that farmers with experience or involvement in agricultural-related activities tend to place greater importance on and exhibit more interest in initiatives aimed at promoting organic vegetable cultivation compared to farmers without this background. This result aligns with the research conducted [11], which investigated the technical efficiency of turmeric (*Curcuma Longa* L.) production in Benue State, Nigeria. Their study found that producers' participation in and adoption of improved turmeric production techniques can effectively reduce the technical inefficiency of turmeric production in the study area. Additionally, this shows that as production experience increases, producers are likely to acquire more knowledge and technological insights on addressing issues related to turmeric production. This, in turn, can lead to increased output and income for the producers. (Table 5)

Table 5. Analysis of factors affecting farmers' needs for technology transfer in turmeric production in Paphayom district, Phatthalung province

Variables	Coefficient (b)	Beta	t	p-value
(Constant)	1.186		12.066	0.00
Sex	0.015	0.02	0.277	0.78
Age	-0.035	-0.02	-0.322	0.74
Education level	0.093	0.08	0.937	0.35
Number of household members	0.119	0.09	1.055	0.29
Number of workers in the household	0.183	0.12	1.341	0.18
Turmeric production experience	0.239	0.12	2.667	0.01*
Landholding area	0.067	0.11	1.001	0.32
Turmeric yield	0.050	0.02	0.251	0.80
SEest = 0.82, Durbin-Watson = 0.82, R = 0.30, R^2 = 0.73, F = 5.21, p-value = 0.01				

Significance level: * $p < 0.01$

4. Conclusions

The current study's findings indicate that turmeric production by farmers in the Paphayom district, Phatthalung province, typically involves intercropping alongside rubber cultivation. Sandy loam soil condition is ideal, with the preferred turmeric variety being Trang 84-2. The cultivation area is prepared through plowing and soil drying, followed by the application of fertilizers, including both biological and chemical fertilizers, along with manure. Weed control is achieved through manual removal, while chemicals are utilized for disease and insect management. Additionally, farmers incorporate biological substances and employ biological fermentation techniques. Notably, farmers prefer selling their produce in the form of turmeric powder. Farmers encounter various problems in turmeric production, with maintenance issues, diseases, insects, and inadequate state support being prominent concerns. These problems impact the planting area and yield, leading to a heightened need for turmeric production technology, particularly in pest mitigation and elimination. Farmers have the greatest need for prevention and pest control promotion methods and require moderate individual and mass promotion methods. Farmers need media for preparation before planting, planting, preservation, before and after harvest. There is the highest demand for brochures to convey turmeric production technology. As for prevention and pest control, farmers need government officials to transfer turmeric production technology. Based on the findings of this research, it is recommended that agricultural extension officers or relevant agencies establish a structured plan for visiting farms regularly and continuously to provide continuous guidance and support in turmeric production practices. Furthermore, it is suggested that user-friendly brochures on turmeric production technology be developed, with a focus on practical, hands-on methods that farmers can implement independently. These materials should cater to the specific needs of farmers, enabling them to acquire knowledge for producing higher-quality turmeric and addressing production challenges more effectively. This approach will empower farmers to produce consistently well-suited turmeric to their local conditions.

5. Acknowledgements

The authors thank the household respondents in Paphayom District, Phatthalung, Thailand. This study was conducted using the Human Ethics Study code PSU-HREC-2023-049-1-3, which participated in this study.

Author Contributions: Conceptualized, data collection and formal analysis writing- review and editing, S.L. and A.R. review, editing, and supervision. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by a research grant for a thesis in the 2023 fiscal year, provided by the Prince of Songkla University, Songkla, Thailand.

Conflicts of Interest: The authors declare no conflict of interest

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