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Research article

Knowledge, attitudes, and practices of beekeepers regarding good agricultural practice in Northern Thailand

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Abstract

Honey plays a significant role in Thailand's agricultural sector, valued for its nutritional, medicinal, and economic benefits. It holds substantial economic importance in Thailand, both as a source of income for rural households and as a valuable export commodity. Implementing the Good Agricultural Practice (GAP) framework is essential for enhancing hygiene and quality in honey production and meeting consumer health expectations. Various factors influence beekeepers' adoption of GAP standards, including their knowledge, attitudes, and perceptions. This study evaluates the knowledge, attitudes, and practices (KAP) of 102 beekeepers in Chiang Mai and Lamphun provinces regarding GAP standards using a structured questionnaire. The findings reveal that beekeepers demonstrate moderate levels of knowledge and attitude while their practices generally align with GAP standards. However, KAP related to data recording remains notably low. Statistical analysis indicates a significant association between GAP certification and improved practices (OR=4.327, p=0.012). Moreover, knowledge and attitudes significantly correlate with practices (r=0.013, p=0.020). Despite some compliance, beekeepers still exhibit a limited understanding of GAP implementation. Therefore, it is recommended that relevant authorities and stakeholders strengthen capacity-building efforts and promote sustainable practices within the beekeeping sector.

Keywords: Attitude, Beekeepers, Good Agricultural Practice, Honey bee, Knowledge, Practice.

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INTRODUCTION

Honey is a natural substance produced by honey bee from the nectar of flowers, comprising predominantly the monosaccharides fructose and glucose. It also contains moisture, proteins, amino acids, enzymes, vitamins, minerals, and various bioactive compounds such as polyphenols and flavonoids. Honey contains substances such as flavonoids, glucose oxidase, catalase, phenolic acids, ascorbic acid, and carotenoids, which have antioxidant activity (Bogdanov et al., 1999; Pattamayutanon et al., 2017; Zammit Young and Blundell, 2023). The quality and composition of honey are influenced by several factors, including the botanical origin of the nectar, geographical location, seasonal and climatic conditions, as well as processing and storage methods (da Silva et al., 2016).

Honey holds significant economic importance in Thailand, both as a source of income for rural households and as a valuable export commodity. It contributes to the livelihoods of small-scale beekeepers, supports local agribusinesses, and generates foreign exchange through international trade. Northern Thailand is a key honey-producing region, benefiting from abundant flower resources. Honey bee farms are mostly located in the upper northern provinces of Thailand, such as Chiang Mai, Chiang Rai, Lamphun, Phayao, Phrae, Lampang, and Nan. These farms collectively produce over 1,309,435 metric tons of honey annually. The export value of honey products stands at 6,219.50 million metric tons, contributing approximately USD 10.91 million to the economy (Phumalai et al., 2018). The quality and safety of honey are, therefore, crucial concerns. The national authorities have implemented Good Agricultural Practice (GAP) standard for honey bee farms (National Bureau of Agricultural Commodity and Food Standards, 2018). The GAP framework of management strategies, disease prevention, consumer safety measures, and thorough recordkeeping is crucial for promoting best practices to mitigate hazards in honey production and enhance export opportunities. By adhering to these standards, honey producers can improve product quality and meet consumer health demands (Bogdanov et al., 1999). According to the Department of Livestock Development data (Bureau of Livestock Standard and Certification, 2025), there were 295 GAP-certified honey bee farms in the northern region in 2012. By 2019, the Office of Regional Livestock 5 reported that 573 out of 740 honey bee farms nationwide (77.85%) had achieved GAP certification. Several factors motivate beekeepers to adopt GAP standards, including their knowledge, attitudes, and perceptions, as well as financial considerations, family income, and cultural beliefs. Assessing the knowledge, attitude and practice (KAP) of beekeepers helps to provide valuable insights into their motivations and the factors influencing their behavior (Abajebel et al., 2025).

This study aims to assess the KAP of local beekeepers concerning GAP standards. The findings are expected to be instrumental in enhancing the standard of honey production and understanding the challenges relating to their implementation.

MATERIALS AND METHODS

Study Design

This cross-sectional study was designed to collect information about the KAP of beekeepers in upper northern provinces in relation to GAP using a structural questionnaire from August 2021 to April 2022.

Study Areas and Population

Honey bee farms are mostly located in the upper northern provinces of Thailand, such as Chiang Mai, Chiang Rai, Lamphun, Phayao, Phrae Lampang, and Nan. Chiang Mai and Lamphun provinces, in particular, produce a significant amount of honey due to longan production in-season, and these provinces were

selected for study. Chiang Mai and Lamphun provinces had 268 and 80 honey bee farms, respectively.

Sample Size and Sampling Plan

The sample size of honey bee farms in the upper northern provinces of Thailand was calculated according to the formula used by Taro Yamane (Yamane, 1967). The population size of honey bee farms in Chiang Mai and Lamphun provinces consisted of 348 farms, and the error inaccuracy was accepted at 0.05. The sample size was calculated to be 187 farms, with proportional sampling used to calculate the sample size as 144 farms for Chiang Mai province and 43 farms for Lamphun province.

Tools and Validation

A structured questionnaire consisting of four parts with close-ended questions was developed for this study. Part 1 was designed to collect demographic information on the respondents. Parts 2 to 4 were developed to evaluate the KAP of beekeepers based on the GAP guidelines for honey bee farms issued by the National Bureau of Agricultural Commodity and Food Standards (Thai Agricultural Standard 8207-2567). Part 2 assessed the knowledge level through true and false questions. The knowledge level was categorized into three groups using Bloom's cut-off categories (Bloom, 1956): high (80–100%), moderate (60–79%), and low (<60%). Part 3 was designed to evaluate the attitude, while Part 4 assessed the practices. The respondents were asked to indicate their level of agreement with given statements using a five-point Likert scale. Attitude levels were classified as very low=1, low=2, moderate=3, high=4, very high=5. Practice levels were identified as: never=1, sometimes=2, moderate=3, usually=4, and always=5.

The questionnaire was further submitted to assess validity and reliability (Boateng et al., 2018; Mo et al., 2023). The questionnaire was assessed for content validity using the Index of Item-Objective Congruence (IOC). The questionnaire was submitted for review and content evaluation by three experts prior to use. The Cronbach's alpha method was used to test the questionnaire for reliability. The questionnaires were tested on 30 people in the study area.

Data Collection

Honey bee farms in Chiang Mai and Lamphun provinces were selected using the purposive sampling technique. The KAP of beekeepers from each honey bee farm were assessed using the structural questionnaire via e-mail or social media applications such as Line due to the COVID-19 restrictions.

Data Analysis

The descriptive analysis employed frequency, percentage, mean, and standard deviation to explain the distribution of demographic information and the level of KAP. The Chi-squared test was used to analyze the association between demographic characteristics and KAP level. The relationship between the KAP of beekeepers was subject to linear regression and spearmen correlation analysis. The statistically significant level was set up at 0.05, with SPSS software version 27 used for analysis.

Ethical Approval

This study was reviewed and approved by the Human Research Ethics Committee of the Faculty of Veterinary Medicine, Chiang Mai University (No.HS9-2564).

RESULTS

A total of 102 people participated in the study, 70 of whom were beekeepers in Chiang Mai, while 32 came from Lamphun province. This number was below the expected sample size due to the collapse of bee farms during the COVID-19 pandemic and the unwillingness of some beekeepers to respond to the questionnaires. The questionnaire was subject to review by three experts and received a validity test score equal to 0.72. The reliability test involving 30 people received a score of 0.82.

Demographic Characteristics of Respondents

Table 1 presents the demographic characteristics of beekeepers (n=102) from Chiang Mai (n=70) and Lamphun (n=32), including gender, education, age, farming information, and sources of GAP information. In terms of gender distribution, most beekeepers were male (94.12%), with only a small proportion being female (5.88%). The male-to-female ratio was similar across both provinces. Most respondents were over the age of 45 (73.52%). Education levels varied among beekeepers. The majority of beekeepers (82.35%) applied GAP and had more than five years of farming experience. The major natural nectar source for honey production in these areas was the longan flower, with the number of honey bee hives per farm typically ranging from approximately 100 to 300. Additionally, the main source of GAP information was neighboring beekeepers (40.49%), followed by printed media (30.16%) and social media (14.87%).

Knowledge Level of Beekeepers on GAP

The study assessed the knowledge of beekeepers on various aspects of GAP, including farm structure, farm management, honey production, disease control, and environmental considerations. The findings revealed both strengths and areas requiring improvement in knowledge among respondents. Figure 1 presents the distribution of beekeepers' knowledge levels across ten key topics of honey bee farm standards. The findings indicate that the highest proportion of respondents demonstrated a high level of knowledge (80–100%) in bee equipment (97.06%), environmental management (94.12%), and bee farm management (88.23%), suggesting that these aspects are well-understood among the majority of participants.

Several topics showed a predominance of moderate knowledge levels (60–79%), including pre-harvesting management (81.37%), farm structure (68.63%), and post-harvesting management (66.67%). Notably, bee health management produced the highest proportion of respondents with low knowledge (<60%) at 51.96%, followed by record management (25.49%) and honey production management (16.67%). These findings highlight the critical knowledge gaps in areas essential for farm record management, bee health management, and disease prevention, suggesting the need for further educational support to elevate these topics to a higher competency level.

Table 1 Demographic characteristics of beekeepers (n=102)

Variable	n (%)		
	Chaing Mai n = 70	Lamphun n = 32	Overall n = 102
1. Gender			
Male	66 (94.29)	30 (93.75)	96 (94.12)
Female	4 (5.71)	2 (6.25)	6 (5.88)
2. Age			
Less than 25 years	0 (0.00)	1 (3.13)	1 (0.98)
25-35 years	4 (5.71)	4 (12.50)	8 (7.84)
36-45 year	10 (14.28)	8 (25.00)	18 (17.64)
46-55 year	31 (44.29)	8 (25.00)	39 (38.23)
Above 55 years	25 (35.71)	11 (34.37)	36 (35.29)
3. Education			
Primary school	24 (34.29)	9 (28.13)	33 (32.35)
Secondary school	18 (25.71)	8 (25.00)	26 (25.49)
High school	14 (20.00)	8 (25.00)	22 (21.57)
College or higher	14 (20.00)	7 (21.87)	21 (20.59)
4. Farm type			
GAP	57 (81.43)	27 (84.37)	84 (82.35)
Non-GAP	13 (18.57)	5 (15.62)	18 (17.64)
5. Farming experience			
Less than 2 years	5 (7.14)	3 (9.37)	8 (7.84)
2-5 years	9 (12.86)	2 (6.25)	11 (10.78)
More than 5 years	56 (80.00)	27 (84.37)	83 (81.37)
6. Nectar source (answer more than 2 choices)			
Longan flower	64 (54.23)	32 (50.79)	96 (94.12)
Lychee flower	96 (94.12)	11 (17.46)	27 (14.92)
Coffee flower	16 (13.55)	0 (0.00)	2 (1.96)
Siamweed flowers (*Chromolaena odorata*)	22 (18.64)	13 (20.63)	35 (19.34)
Others	14 (11.86)	7 (11.11)	21 (11.60)
7. Number of honeybee hives			
1-50	4 (5.71)	3 (9.37)	7 (6.86)
51-100	12 (17.14)	6 (18.75)	18 (17.65)
101-200	17 (24.28)	5 (15.63)	22 (21.57)
201-300	14 (20.00)	7 (21.87)	21 (20.59)
Above 300	23 (32.85)	11 (34.37)	34 (33.33)
8. Source of GAP information (answer more than 2 choices)			
Internet/social media	23 (14.20)	13 (16.25)	36 (14.87)
Radio	0 (0.00)	1 (1.25)	2 (0.83)
Television	7 (4.32)	4 (5.00)	17 (7.02)
Seminar	13 (8.02)	4 (5.00)	17 (7.02)
Neighboring beekeepers	67 (41.35)	5 (6.25)	98 (40.49)
Printed media	48 (29.63)	25 (31.25)	73 (30.16)
Others	4 (2.47)	1 (1.25)	5 (2.07)

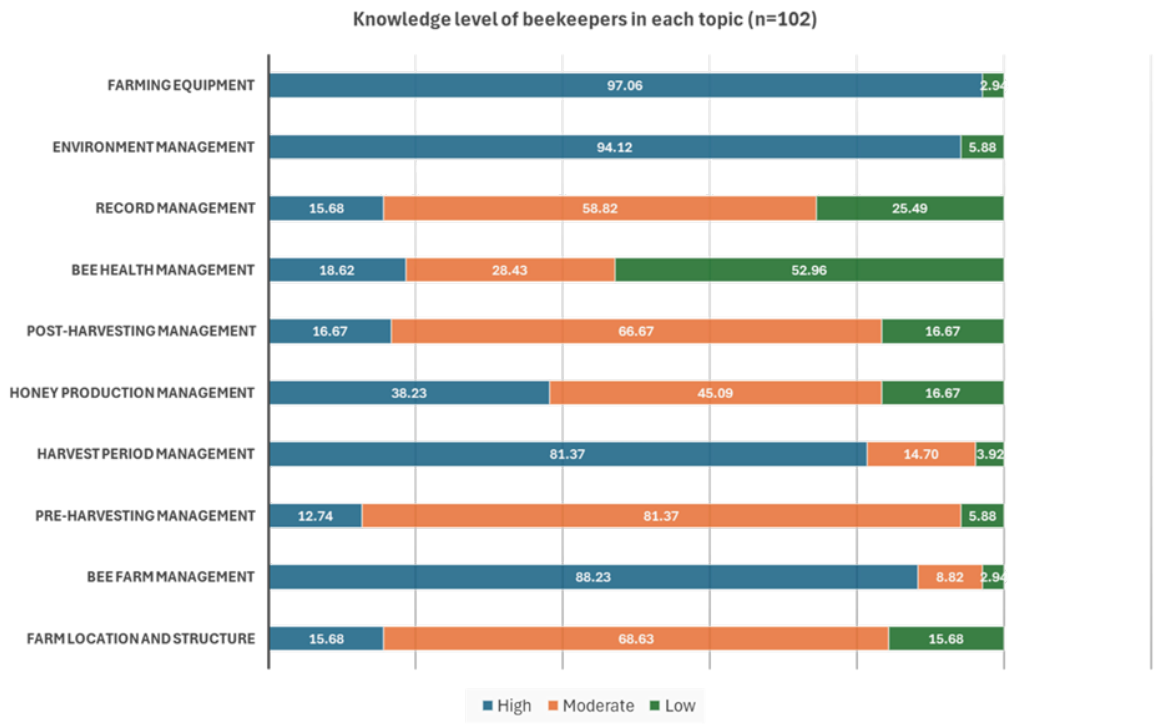

Figure 1 Knowledge level of beekeepers in each topic.

Attitude Level of Beekeepers on GAP

The overall attitude level of beekeepers was moderate at 3.93±0.35. Among all topics, farm location and structure received the highest mean attitude score (4.35±0.60), followed closely by bee health management (4.30±0.61), honey production management (4.28± 064), and post-harvesting management (4.24±0.62) (Figure 2). These findings indicate a strong recognition of the importance of farm structure, health, and quality control. High mean scores were also observed for pre-harvesting (4.08±0.46) and during harvesting (4.06±0.65) management, suggesting favorable perceptions toward implementing standard procedures throughout the harvesting process. Conversely, the lowest attitude score was reported for record management (2.89±0.00).

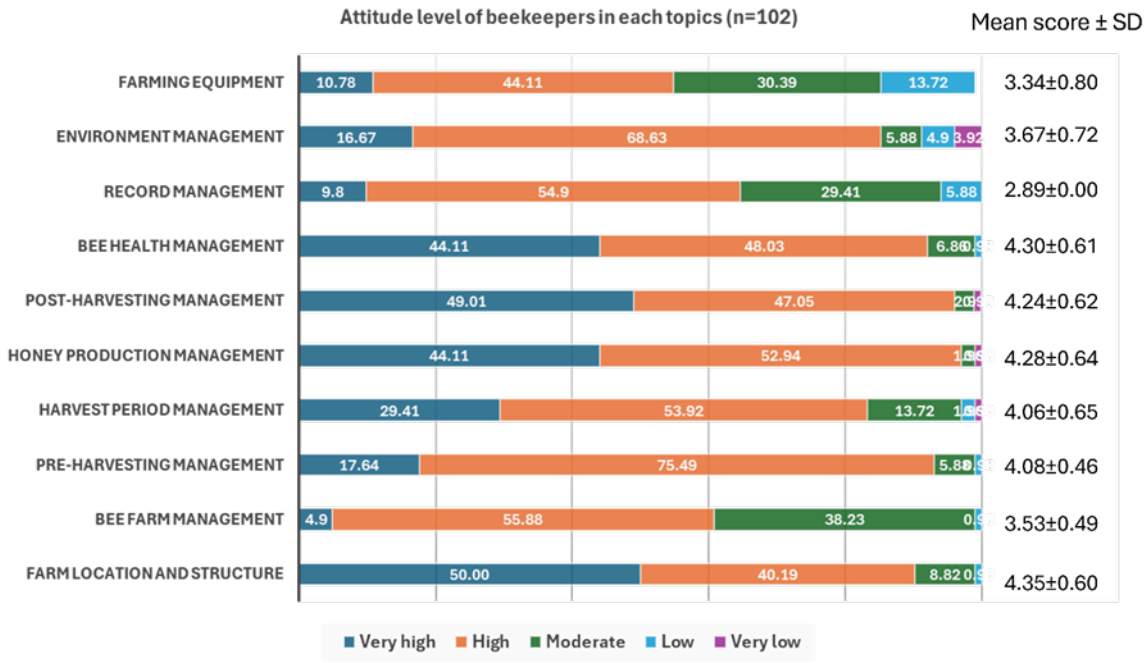

Figure 2 Attitude level of beekeepers in each topic.

Practice Level of Beekeepers on GAP

Overall, the findings indicate that the majority of respondents demonstrated a high to very high level of practice, with a mean summary score of 4.12±1.13, suggesting generally good GAP-related compliance. Figure 3 presents the practice levels of 102 honey bee keepers in relation to GAP standards. The highest level of compliance was observed in bee equipment management, with 92.16% of participants rating their practices as very high, with the highest mean score of 4.49±2.40. Additionally, before harvesting (4.25±1.18), during harvesting (4.24±1.21), and post-harvesting management (4.23±1.17) were among the top-rated areas, indicating strong adherence to procedural standards during honey collection and processing. Notably, bee farm management (4.17±1.33) and honey production management (4.16±1.26) received similarly high average scores, reflecting the beekeepers' awareness and application of production-related best practices. In contrast, farm location and structure (3.86±1.29) and record management (3.88±1.26) showed comparatively lower mean scores.

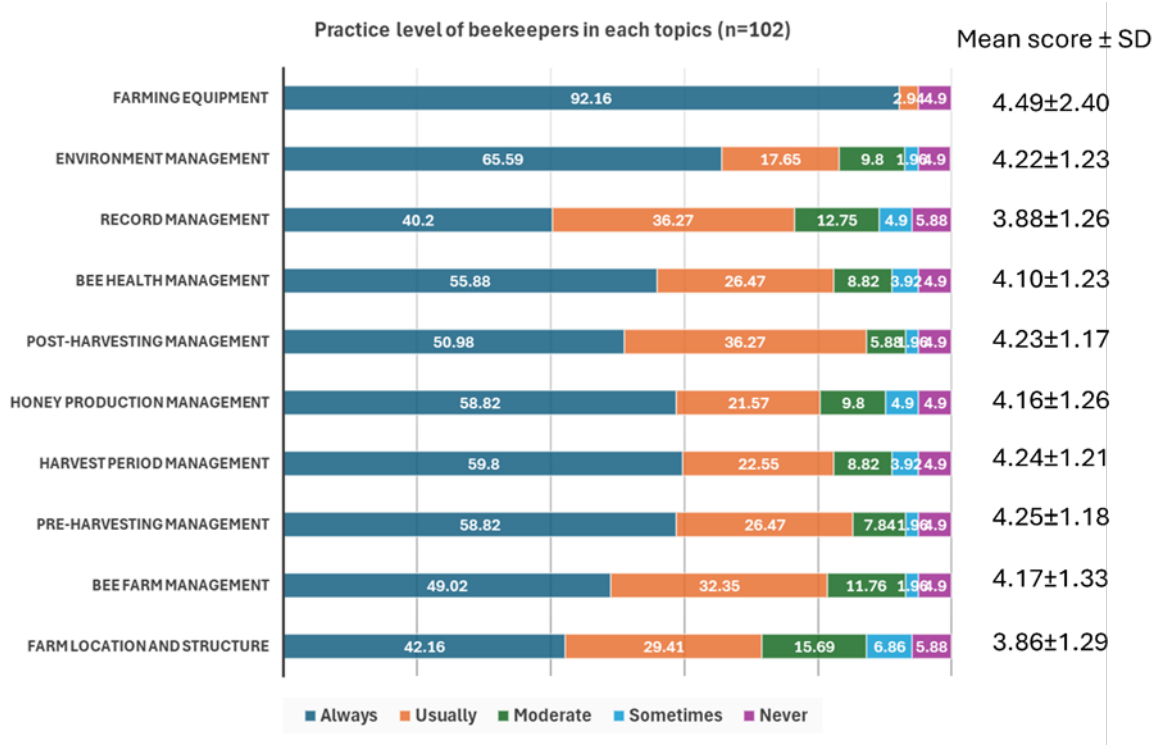

Figure 3 Practice level of beekeepers in each topic.

Association Between Demographic Factors and KAP Level

The results revealed that the farm type (p-value=0.049) and source of GAP information, i.e., social and printed media, demonstrated a statistically significant association with practice. Besides, education showed a statistically significant association with attitude (p-value=0.050) (Table 2). The demographic factors demonstrating statistical significance were then submitted for multivariate analysis. Only the farm type receiving GAP certification was significantly associated with improved practices (Odds Ratio=4.327, p-value=0.012). This finding shows that farm type (GAP and Non-GAP) affects the practice of beekeepers, although no difference between knowledge and attitude is exhibited for this factor.

Correlation Between Knowledge and Attitude Toward Practice

The correlation between knowledge and attitude toward practice was analyzed by linear regression (Table 3), with both the knowledge and attitude scores affecting the practice score. Knowledge correlated with practice (r=0.013), while attitude strongly and positively correlated with practice (r=0.020). Knowledge and attitude can be transferred to improve beekeepers' practice.

Table 2 Association between demographic factors and knowledge attitude and practice level

Factors	N	Knowledge		Attitude		Practice	
		Value	*p-value*	Value	*p-value*	Value	p-value
1. Gender							
Male	96	0.364	1.000	0.308	1.000	1.394	0.681
Female	6						
2. Age							
Less than 25 years	1	5.085	0.800	9.573	0.312	9.271	0.771
25-35 years	8						
36-45 years	18						
46-55 years	39						
Above 55 years	26						
3. Education							
Primary school	33	6.119	0.401	9.257	0.050*	8.852	0.415
Secondary school	26						
High school	22						
College or higher	21						
4. Farm type							
GAP	84	3.818	0.158	1.996	0.288	6.934	0.049*
Non-GAP	18						
5. Farming experience							
Less than 2 years	8	2.738	0.581	1.025	0.886	4.946	0.461
2-5 years	13						
More than 5 years	83						
6. Number of honeybee hives							
1-50	7	6.067	0.627	4.544	0.840	12.396	0.328
51-100	18						
101-200	22						
201-300	21						
Above 300	34						
7. Source of GAP information							
Internet/social media	66	2.279	0.324	3.337	0.180	8.026	0.036*
No	32						
Radio	1	1.401	1.000	2.725	1.000	2.866	1.0000
No	102						
Television	12	1.455	0.446	0.409	1.0000	1.243	0.728
No	90						
Seminar	17	1.528	0.547	4.929	0.065	0.827	0.909
No	85						
Neighboring beekeepers	98	0.496	1.000	0.645	1.000	3.054	0.437
No	4						
Printed paper	29	1.111	0.577	4.264	0.097	7.700	0.038*
No	73						
Others	5	2.255	0.243	0.435	1.000	0.637	1.000
No	97						
8. Province							
Chiang Mai	70	1.385	0.551	3.380	0.204	3.426	0.322
Lamphun	32						

Table 3 Correlation between knowledge and attitude to practice

Correlation	Practice
	r
Knowledge score level	0.013
Attitude score level	0.020

DISCUSSION

KAP among beekeepers can vary based on socio-demographic characteristics such as gender, age, experience, and education, as reported in several studies on agriculture and livestock farmers (Laosutsan et al., 2019; Engebretson et al., 2022; Chumsang et al., 2024; Rakarkaraphokhin et al., 2025). In this present study, over 94% of beekeepers were male in the middle-aged to elderly group, aligning with the findings of other studies (Manowanna and Sirisunyaluck, 2017; Phumalai et al., 2018; Engebretson et al., 2022). Demographic characteristics such as gender and generation were found to have a potential influence on risk perception (Vercelli et al., 2021; El Agrebi et al., 2022).

An analysis of the demographic characteristics and KAP level revealed that the farm type and source of GAP information (e.g., social and printed media) had a statistically significant association with practices. Face-to-face communication remained the primary method for information exchange, in similarity to trends observed in other countries. Beekeepers typically receive information from other beekeepers, followed by the internet and social media platforms. However, online sources may not always provide accurate or reliable content, emphasizing the need for authorities to disseminate trustworthy information through appropriate channels (Engebretson et al., 2022). The multivariate analysis of significant variables indicated that farm type had a notable influence on beekeeper practices. This aligns with earlier research in Thailand showing that GAP-certified farms demonstrated better efficiency than non-certified ones (Schreinemachers et al., 2012). Similarly, Kulhanek (2021) found that beekeepers operating under GAP standards reported better outcomes in bee health and risk management.

Although beekeepers demonstrated strong knowledge in technical and structural areas such as equipment use, farm layout, and environmental management, notable gaps remained in bee health management, disease control, post-harvest handling, and record keeping. These results aligned with those of Manowanna and Sirisunyaluck (2017), who reported low application levels in drug and chemical administration and documentation practices. Studies on beekeepers in the United States (Kulhanek et al., 2021; Engebretson et al., 2022) revealed that bee health and bee diseases, e.g., mites, viruses, and bacteria were the greatest concerns affecting honey bee management. Record management was identified as the lowest-scoring area in both attitudes and practices, suggesting not only a knowledge gap but also possible resistance or a lack of awareness regarding its importance. While the overall attitudes toward GAP and quality practices were positive, particularly in relation to health, hygiene, and product quality, the deficiencies in documentation highlight a critical area for targeted training and behavior change interventions to promote accountability and traceability in honey production systems.

According to the results of this present study, farm location and structure had the lowest practice level among the evaluated topics, with only 42.16% of beekeepers consistently applying recommended practices with a mean score of 3.86 ± 1.29. This suggests that beekeepers may lack sufficient awareness, training, or resources to implement standards related to optimal farm siting and infrastructure. Contributing factors could include limited land access, financial constraints, or a perception that structural considerations are less critical than other aspects of beekeeping. Targeted training, localized guidelines, and support mechanisms such as technical assistance or subsidies may be needed to enhance the understanding and adoption of good practices in this area. Beekeepers may have difficulty with structural investments depending on their financial status. These areas may benefit from targeted capacity-building programs to strengthen the structural investments and documentation practices essential for traceability and farm audits. These findings suggest that while most beekeepers possess strong technical skills and routinely apply GAP principles in the production and harvesting stages, further improvements are needed in areas involving

infrastructure and formal recordkeeping to achieve full compliance with GAP standards.

Record keeping is a necessary element of good livestock business management. However, it remains a challenge among both agriculture and livestock farmers, especially smallholders (Laosutsan et al., 2019; Waktole and Eyerusalem, 2020; Kulhanek et al., 2021; Tackie et al., 2022). The results revealed that knowledge of record management ranked the lowest and exhibited the lowest mean scores for both attitudes and practices. This finding suggests that certain perceptual barriers may prevent beekeepers from effectively translating their knowledge into practical application. It is recommended that training or workshops on the importance of data recording be implemented. This is because knowledge of record keeping enhances its practice, positively affecting the performance of farm management and farm businesses.

Correlation analysis revealed that both knowledge and attitude scores significantly influenced the practice scores of beekeepers. This suggests that strong knowledge and positive attitudes can enhance practical behaviors among beekeepers. Similar findings were reported by Chumsang et al. (2024), who found a positive relationship between knowledge and attitudes and between attitudes and practices among smallholders of dairy farms.

One limitation of this study concerns the inability to conduct face-to-face interviews due to COVID-19 restrictions. This constraint may have limited the depth of qualitative insights. Additionally, the use of purposive sampling, while appropriate for targeting specific participant groups, may introduce selection bias and limit the generalizability of the findings. Future studies could benefit from employing a mixed-method approach combining both quantitative and qualitative analysis. Moreover, the use of probabilistic or stratified sampling methods could help minimize selection bias and improve the representativeness of the study population.

The findings from this study highlight important gaps in KAP among beekeepers in relation to GAP, particularly concerning food safety in honey production. Although many beekeepers demonstrate a generally positive attitude toward the importance of hygiene and quality standards, inconsistencies in practical applications, such as inadequate recordkeeping and poor farm management, pose potential risks to food safety. Limited knowledge and training in key areas, such as contamination prevention, environmental management, and safe equipment use, further contribute to these challenges. Strengthening food safety in the honey production chain requires targeted training programs and the reinforcement of GAP standards, particularly focusing on translating positive attitudes into consistent practices across all stages of beekeeping operations.

Nonetheless, the findings offer valuable insights for government agencies. These insights can inform policy and program development aimed at aligning GAP standards with beekeeper needs, ultimately enhancing honey quality, supporting exports, and promoting the professional development of the beekeeping sector.

CONCLUSIONS

This study revealed that most beekeepers possessed moderate knowledge and attitudes, and their practices generally aligned with GAP standards. Despite this, challenges remain, particularly in translating knowledge into consistent practice. Some beekeepers understand the importance of standards but do not consistently apply them, often due to limited perceived benefits or lack of incentives. To address this gap, government intervention is essential. Providing tangible benefits such as facilitating market access, especially in terms of exports, can serve as motivation for compliance with bee product standards. Furthermore, raising public and producer awareness about the value and differentiation of

certified honey versus uncertified products can promote the adoption of standards and enhance consumer trust in domestic and international markets.

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AUTHOR CONTRIBUTIONS

Atikun Bunket: Conceptualization (equal); Data Curation (lead); Formal Analysis (lead); Investigation (lead); Methodology (equal); resources (supporting); Validation (equal); Visualization (lead); Writing – Original Draft Preparation(lead); Writing – Review & Editing (equal). **Kannika Na Lampang:** Conceptualization (equal); Data Curation (supporting); Formal Analysis (supporting); Methodology (equal); Validation (equal); Writing – Review & Editing (equal). **Montira Intanon:** Conceptualization (equal); Methodology (equal); Validation (equal); Writing – Review & Editing (equal). **Warangkhana Chaisowwong**: Conceptualization (equal); Data Curation (supporting); Formal Analysis (supporting); Funding acquisition (lead); Investigation (supporting); Methodology (equal); Project administration (lead); Resources (lead); Supervision (lead); Validation (equal); Visualization (supporting); Writing – Original Draft Preparation(supporting); Writing – Review & Editing (equal).

CONFLICT OF INTEREST

The authors report no declarations of interest.

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