Evaluating farmer perspectives and preparedness for standardized cricket farming under Thai Agricultural Standards: A case study in Phitsanulok, lower northern Thailand

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ABSTRACT

Background and Objective: Cricket farming in Thailand supplements household income and supports sustainable protein sources. However, current practices lack established standards. This study examined personal information, farm management, certification attitudes, and readiness for Thai Agricultural Standards, focusing on a case study in Phitsanulok, lower northern Thailand.

Methodology: The study surveyed 30 cricket farmers in Phitsanulok using a questionnaire. The data were analyzed using frequencies, means, and standard deviations. Attitudes were assessed using t-tests, Mann-Whitney U tests, and Pearson correlation.

Main Results: The study unveiled diverse farmer demographics, with an average age of 38.73 ± 10.54 years and a broad age range (23 to 63 years). Education levels varied, with 50.00% holding associate's or bachelor's degrees, and 46.67% were actively involved in farming. Monthly income distribution revealed a demand for extra income across various professions. Farm ownership was predominantly individual (83.33%), and knowledge was acquired mainly through personal experience (53.33%) and government agencies (46.67%). The survey on cricket species, breeding methods, and feeding practices highlighted the diverse approaches employed in farming. Farmers exhibited varying attitudes toward farm certification standards, acknowledging their significance but expressing challenges despite recognizing the associated benefits. Variations were observed in the implementation of farm components, operations, animal health, environment, and data recording when compared to Thai Agricultural Standards. The income emerged as a pivotal influencer for attitudes toward farm certification standards ($P < 0.05$). The study provides insights for promoting adherence to standards in cricket farm management.

Conclusions: The study of cricket farmers in the area found an average age of 38.73 years, with most farms individually owned. Knowledge was primarily gained through experience and government resources. While farmers recognized the importance of certification, income significantly influenced their attitudes toward Thai Agricultural Standards. The findings highlight the need to promote standard compliance in cricket farming.

Keywords: Cricket farming, sustainable agriculture, economic benefits, agricultural standards

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INTRODUCTION

The Food and Agriculture Organization (FAO) supports cricket consumption to enhance global food security. Crickets, which are cost-effective and easy to farm, present a major opportunity for Thailand's insect industry. Demand for crickets is growing domestically and internationally, particularly in the European Union (EU), creating export opportunities. Thailand, a leader in cricket production, benefits from government policies that promote cricket farming to boost farmer incomes and provide affordable protein alternatives. Crickets' low space and water needs make them ideal for rural areas, offering additional income for farmers, especially during off-seasons like post-rice cultivation (Hanboonsong *et al*., 2013; Halloran *et al*., 2016; Halloran *et al*., 2018; National Bureau of Agricultural Commodity and Food Standards, 2018; Mungkung and Phetcharaburanin, 2023).

Farming practices in Thailand vary from small-scale family operations near homes to larger, more systematic farms or community enterprises (Halloran *et al*., 2017; Reverberi, 2020). This variety reflects the country's human resources potential for boosting cricket production. In 2023, Thailand produced a total of 2,044,950 kg of crickets with 1,725 farmers involved. The northeastern region led production with 60% of the total and 57.1% of the farmers. The northern region contributed 25.92% of the production and 21.39% of the farmers. The lower northern region added 24.54% to the production and had 12.75% of the farmers, while the upper northern region accounted for the remaining production and farmers (Information and Communication Technology Center [ICT], 2023).

Due to the escalating demand for high-protein foods and the rising popularity of health-conscious dietary trends, competition in the protein alternatives industry, including plant-based options, is intensifying. Consequently, the economic viability of insect farms may be impacted by the heightened competition from various alternative protein sources (Bashi *et al*., 2019). To enhance competition in cricket sales and marketing, it is essential to raise the standards of farmers or groups of entrepreneurs to have standardized production systems. Farmers who adhere to one of these farm standards, such as the good farming practice standard, will provide an opportunity for cricket products, whether crickets or various processed cricket products, to enter and expand in both domestic and international markets. This can lead to increased income and higher profits (Preteseille *et al*., 2018).

The Thai Ministry of Agriculture and Cooperatives, in partnership with relevant agencies, has established the Thai Agricultural Standard (TAS 8202-2017) for cricket farms to ensure safe and effective practices. The Department of Livestock Development certifies farms based on these standards, which include: (i) strategic farm design and layout, (ii) comprehensive farm management with a required operations manual and training, (iii) health measures for disease prevention and veterinary care, (iv) environmental management for waste disposal and sustainability, and (v) thorough data recording for at least three years (National Bureau of Agricultural Commodity and Food Standards, 2017). To foster economic growth and facilitate international market access, the government should encourage farmers to obtain certification. Compliance with stringent Good Agricultural Practices (GAP) standards in the EU and the United States (US) is essential for exporting edible insects, highlighting the importance of certification for industry expansion (International Platform of Insects for Food and Feed, 2023).

Phitsanulok province, situated in the lower northern region of Thailand, emerged as a leading cricket producer in 2023, with a total output of 220,440 kg (ICT, 2023). Measuring farmers' compliance with Thai Agricultural Standards is crucial for promoting standardized cricket farming, given its significant agricultural potential. Moreover, farmers' attitudes play a pivotal role in the success of these ventures. Studies indicate that risk aversion and resistance to change, especially among lower-income farmers, can impede the adoption of new farming practices (Khor *et al*., 2018; Zeweld *et al*., 2019).

Attitudes, which include an individual's feelings, beliefs, and responses toward various situations, are key to understanding the willingness of farmers to adopt standardized practices.

While attitudes are relatively stable, they can be influenced and changed through targeted education and knowledge-sharing efforts (Olufemi, 2012). Thus, aligning educational programs with farmers' existing work practices can increase the likelihood of successful implementation of standardized cricket farming. This, in turn, can lead to improved income for farmers when their farms meet certification standards.

Currently, Phitsanulok province lacks insights into farmers' attitudes and preparedness to comply with Thai Agricultural Standards for GAP related to the certification of cricket farming standards. Acquiring such information is crucial for planning production strategies, fostering development, and promoting cricket farming at the local level. This initiative aims to address poverty issues and enhance the quality of life for farmers by ensuring the appropriate rearing of crickets in the future.

MATERIALS AND METHODS

Study Area and Research Design

The study was conducted in Phitsanulok province, situated in the lower northern region of Thailand at approximately 16° 50' N latitude and 100° 15' E longitude. The study utilized a cross-sectional descriptive survey design deliberately chosen to explore various characteristics concurrently within the specified population, with a specific emphasis on agricultural work. This approach is particularly beneficial for providing an accurate snapshot of the present circumstances, as supported by previous studies (Schneider *et al*., 2018; Azam and Shaheen, 2019; Pereira *et al*., 2022). The data collection methods comprised closed-ended and open-ended questionnaires, along with interviews conducted with cricket farmers in Phitsanulok province, all conducted in December 2023. The focus of data collection encompassed personal information, farming administration, and management, as well as attitudes towards the certification standards and the preparedness of cricket farmers for Thai Agricultural Standards. This aligns with GAP standards in cricket farming (National Bureau of Agricultural Commodity and Food Standards, 2017), which areas such as farm components (location, farm layout, farm planning, buildings, and containers), farm operations (standard operating procedures, cricket management, container preparation, hiding materials, egg-laying containers, cricket harvesting, food and water management, water sources, feeding containers, food storage, personnel, health checks, cleaning and maintenance, and chemical use), animal health (disease prevention, disease management, and veterinary care), environment (waste management and water discharge), and data recording (record maintenance, personnel data, production data, disease control data, and record retention).

Ethical Consideration

Ethics approval was obtained in accordance with the declaration of the Human Research Ethics Committee, the Research and Development Institute at Pibulsongkram Rajabhat University (PSRU-EC No: 2023/052). The research primarily relied on observations, with no mention of participant names. Participants were explicitly informed that the survey was anonymous and voluntary, and all data were treated with confidentiality.

Inclusion Criteria and Exclusion Criteria

The inclusion criteria for this study comprised independent sellers or contributors to community enterprise groups involved in cricket farming in Phitsanulok province. Proficiency in communication skills, a willingness to share information, and active participation were fundamental requirements. Throughout the study, the researcher would explain and read each question aloud, particularly for those who could not read, enabling volunteers to select their responses. Conversely, the exclusion criteria encompassed individuals raising crickets solely for personal consumption, those without Thai nationality, and those unwilling to cooperate in completing the questionnaire. Additionally, individuals unable to answer all questions in the questionnaire were excluded from participation. This comprehensive set of criteria was designed to ensure that the study captured valuable insights from participants actively engaged in commercial cricket farming while excluding those not aligned with the study's objectives.

Study Population and Sample Size

The population used in this study consists of cricket farmers in Phitsanulok province, totaling 32 individuals (ICT, 2023). The sample group was selected using a simple random sample, and the sample size was determined to be 30 individuals with a confidence level of 95% (Krejcie and Morgan, 1970).

Data Collection Tools and Procedures

The research employed questionnaires as the primary data collection tool. The questionnaire consisted of closed-ended and open-ended questions, divided into four sections for individual interviews with members of the community enterprise group, covering various aspects: (i) personal information encompassing details such as job position on the farm, age, sex, educational qualifications, primary occupation, and monthly income from the main occupation, (ii) farming administration and management details such as farm operation duration, the number of members within the farm, ownership structure of the farm, the size of the area for farming operations, land rights, sources of knowledge in cricket farming cricket breeds raised, the species of crickets raised, the number of containers for raising, cricket yield, selective breeding of cricket breeds, the number of production cycles obtained from the use of the same breeding set, duration of rearing until marketable for sale, primary feed used for rearing and supplementary plant-based feed used for rearing, (iii) information regarding farmers' attitudes toward farm certification standards comprising knowledge and understanding of farm certification standards, the complexity and challenge in the process of applying for farm certification, the crucial role of farm certification in cricket farming, the detailed, comprehensive, and clear assessment criteria, the potential difficulty in making adjustments to meet certification standards, the certification duration (every 3 years), the positive contribution of farm certification to the environment and consumers, and how farm certification helps increase income from cricket farming, and (iv) preparedness for assessment in accordance with the Thai Agricultural Standard for GAP in cricket farms comprising farm components, farm management, animal health, environmental management, and data recording.

Quality Assessment of Research Tool

In collaboration with content and language experts, the quality of the questionnaire was reviewed, and each of its four sections was examined using the Index of Item Objective Congruence (IOC). Items that met the criteria within the 0.67–1.00 score range were chosen. Reviews by three experts confirmed that all items created to measure the constructs received an IOC rating above 0.67. A trial was conducted with 30 out of 32 farmers to test the reliability of the research instruments. The population data was sourced from the Livestock Data in Thailand for the Year 2023 (ICT, 2023). The Cronbach's alpha coefficient calculated was 0.96, demonstrating high reliability.

Data Analysis

The questionnaire used for the study consisted of four sections, with frequencies, means, and standard deviations reported. Section 3 employed a numerical rating scale, with mean values calculated and compared against interpretation criteria: 1.0–1.8 (strongly disagree), 1.9–2.6 (disagree), 2.7–3.4 (neutral), 3.5–4.2 (agree), and 4.3–5.0 (strongly agree), following Likert (1932), Boone and Boone (2012), and Sifanu *et al*. (2023) guidelines. Data analysis was carried out using Microsoft Excel (Office 365) at Pibulsongkram Rajabhat University, focusing on farmers' attitudes and preparedness to comply with Thai Agricultural Standards for GAP in cricket farming. The collected data were categorized, and the Shapiro-Wilk test was performed to examine normality at a 5% significance level. The t-tests and Mann-Whitney U test were used to compare independent samples based on sex, education, and income. The Pearson correlation coefficient was applied to examine the relationship between age, attitudes, and preparedness, with a 95% significance level.

The dependent variables were converted into numerical form: attitudes were rated on a scale from 1 (strongly disagree) to 5 (strongly agree), and preparedness for GAP was scaled from 0 (not

implemented) to 1 (implemented). Educational qualifications were categorized as "high school or below" and "undergraduate or above". Income data were divided into four ranges: below 5,000 THB, 5,000 to 7,000 THB, under 10,000 THB, and above 10,000 THB per month. For regression analysis, income was grouped into two categories: "not over 10,000 THB" and "over 10,000 THB". The relationship between attitude scores and a set of independent variables, including two quantitative variables (age and farming experience) and three qualitative variables represented as dummy variables (education, sex, and income), was examined using multiple regression analysis. Five independent factors were initially analyzed to assess their potential impact on the dependent variable. The stepwise method, which combines both backward and forward selection approaches, was used for variable selection in the regression equation. Initial analysis using Pearson's correlation coefficient revealed that only the income variable showed a statistically significant correlation with the attitude score. All statistical analyses were conducted using SPSS Statistics (Version 17.0).

RESULTS AND DISCUSSION

Cricket farming offers several advantages over traditional livestock such as broiler chickens, pigs, and cattle. Crickets have a short life cycle (6–8 weeks), high reproductive rates, and are easy to breed, requiring minimal space and resources. They are highly productive, yielding more edible mass with lower feed and water consumption, making them cost-effective. Nutritionally, crickets are rich in protein (74.91%), fat (6.80%), carbohydrates (8.91%), ash (4.84%), and fiber (8.08%), making them a nutritious and sustainable food source. Therefore, cricket farming provides a viable alternative for sustainable protein production for farmers (Hanboonsong and Durst, 2020; Kulsarin *et al*., 2021; Yaemkong *et al*., 2024).

The current market trend for edible insects has expanded, presenting an opportunity for Thai farmers to export insects globally. However, for cricket farming to enter the international market, the first step is to pass the GAP standard, as it is an internationally accepted baseline. Therefore, studying farm management readiness and farmer perspectives regarding preparedness for standardized cricket farming under Thai Agricultural Standards is crucial for developing a sustainable agricultural economy in Thailand. In this study, Phitsanulok, located in the lower northern region of Thailand, was selected as a case study. The results of the study are as follows:

Farmer's Personal Information

From collecting personal information from 30 cricket farmers in Phitsanulok province, it was found that the age range spanned from 23 to 63 years, with an average age of 38.73 ± 10.54 years. This data suggests that the age of cricket farmers in the surveyed area exhibited diversity within this agricultural community. A prior study examining the impact of cricket cultivation training in the Chiang Klang district, Nan province, situated in the northern region of Thailand, found that farmers (52.90%) in that area were predominantly aged between 31–45 years (Kulsarin *et al*., 2021). In addition, the survey revealed that 73.33% of the respondents who provided information were male. These farmers predominantly held associate or bachelor's degrees (50.00%) and were primarily engaged in farming activities (46.67%). The findings of this study align with research conducted on cricket farms in Nong Khai province, located in northeastern Thailand, where the majority of farmers (72.80%) were male (Panyasit *et al*., 2022).

Additionally, the educational level of cricket farmers in Phitsanulok was noted to be higher than in other areas of the same region. Specifically, in Chiang Klang district, Nan province, the majority of farmers (28.00%) had primary education (Kulsarin *et al*., 2021), exceeding the education levels of cricket farmers in the northeastern region, where the majority (60.40%) had education levels at the elementary level (Panyasit *et al*., 2022). In this study, the largest proportion of cricket farmers (46.67%) were engaged in agriculture, while others were employed in the civil service (23.33%), self-employment (13.33%), hired labor (13.33%), and private business (3.33%). Income data divided into four ranges revealed

that most farmers (53.33%) earned under 10,000 THB per month, while 46.67% reported monthly earnings above 10,000 THB. Notably, none of the participants reported incomes below 5,000 THB or within the 5,000 to 7,000 THB range. This finding aligns with a study on cricket farmers in Nan province in the northern region (51.40%) and Khon Kaen province in northeastern Thailand, which also reported that the main occupation of cricket farmers is farming, particularly rice cultivation. Farmers in both studies supplement their income by raising crickets while awaiting the harvest of rice (Kanjina *et al*., 2019; Kulsarin *et al*., 2021). The relatively short duration of cricket farming, approximately 40-45 days, compared to the longer cycle of rice cultivation, approximately 120 days, allows for this dual-income strategy. Most farmers in Nong Khai province who participated in cricket farming had a monthly income in the range of 20,001 to 30,000 THB, which was 29.00% higher than the income of farmers in the study area (Panyasit *et al*., 2022). The findings indicate that personal factors such as age, gender, education, and income are diverse in the agricultural community of cricket farmers. This diversity underscores that cricket farming is not confined to any specific demographic but rather depends on individual economic motivations.

Cricket Farming Administration and Management

The study on cricket farm management found that most farms are family-run, with 83.33% managed by a single owner in collaboration with family members, while only 3.34% are managed as community enterprises. Data collection involved 76.67% from farm owners and family members, ensuring reliable information, with 23.33% from farm employees. In terms of knowledge acquisition, farmers predominantly learned through hands-on experimentation (53.33%), engaging in trial and error, and supplemented this with self-study via the Internet (100%). This highlights the ability of farmers in the area to independently access information, often surpassing their counterparts in other regions. As a result, they rely less on government sources for knowledge. This is in contrast to a study in Nan province, where farmers with lower education levels tended to rely more on government agencies for learning (Kulsarin *et al*., 2021). This indicates a growing trend of self-sufficiency in acquiring farming knowledge.

The average duration of cricket farming in this study was 2.93 ± 2.07 years, contrasting with northeastern Thailand farmers who had an average of 29.26 ± 10.11 years of experience (Panyasit *et al*., 2022). This result is more aligned with central northeastern farmers, where 57.50% had 2–4 years of experience (Arunsangseesod *et al*., 2021), and 52.90% of northern farmers had 1–5 years of experience (Kulsarin *et al*., 2021). On average, 2.67 ± 0.99 workers were involved in cricket farming, with family members contributing 90% of the labor, consistent with findings from Nong Khai province, where farmers prefer using family labor (Panyasit *et al*., 2022). This reliance on family labor reflects the farming community's focus on low-cost, sustainable operations.

Regarding the species of crickets farmed, four species were identified. The house cricket (*Acheta domesticus*) was the most common, comprising 41.94% of the farmed crickets, followed by the black field cricket (*Gryllus bimaculatus*) at 33.87%, the red field cricket (*Gryllus testaceus*) at 22.58%, and the short-tail cricket (*Brachytrupes portentosa*) at 1.61%. On average, each farm raised two species and used about 19 containers. This contrasts with findings in the central northeastern region, where *G. bimaculatus* was the most commonly raised species (53.49%; Arunsangseesod *et al*., 2021). Regarding farming duration, 60% of farmers spent 40–45 days farming crickets, aligning with the guidelines from the Guidance on Sustainable Cricket Farming (Hanboonsong and Durst, 2020). The average yield was 14.23 ± 3.45 kg per container, differing from previous studies due to species and feed variations (Oonincx *et al*., 2019). Inbreeding, while economically beneficial, posed risks such as reduced lifespan and fewer offspring compared to outbred crickets (Sakaluk *et al*., 2019). Therefore, while inbreeding may offer short-term financial benefits, it is important to consider the long-term risks associated with reduced reproductive success and lifespan.

In terms of feeding, the majority of farmers (83.33%) used ready-made cricket feed, which is widely available and specifically designed for crickets. This preference aligns with other studies that report farmers' preference for specialized cricket feed over general poultry food (Arunsangseesod *et al*., 2021). Additionally, farmers supplemented their crickets' diet with locally available plants like potato leaves, pumpkin, papaya, mulberry leaves, banana trees, and fresh vegetables. This practice reduces reliance on external feed, as these plants are often by-products of other agricultural activities or community waste, making them a cost-effective option. These findings align with previous research on the use of plant-based supplements in cricket farming (Fuah *et al*., 2015; Bawa *et al*., 2020; Mungkung and Phetcharaburanin, 2023). This study highlights the challenges farmers face in adhering to GAP principles and suggests that focusing on specific components of GAP cricket farming could lead to more targeted policy recommendations. A deeper analysis of these challenges would strengthen the study's impact and support more effective policy solutions.

A comparative analysis of cricket farming in Thailand reveals that farmers in Nan province, Northern Thailand, face challenges such as limited knowledge, diseases, low egg hatching rates, uneven growth, and high feed costs, with prices controlled by intermediaries, suggesting the need for disease prevention, farmer cooperatives, and price insurance schemes (Kulsarin *et al*., 2021). In contrast, cricket farming in Khon Kaen province, Northeastern Thailand, thrives due to simple methods, community unity, reliable production, strong buyer relationships, and the use of repurposed materials, with no major issues reported (Kanjina *et al*., 2019). Meanwhile, in Nakhonsithammarat province, Southern Thailand, farms primarily raising two-spotted crickets (*Gryllus bimaculatus*) rely on commercial and supplementary feeds, selling mostly as bait or food, but face challenges like COVID-19 impacts and occasional premature deaths, despite generally meeting hygiene standards (Cheechang and Sakulsawasdiphan, 2023).

Cricket Farmers' Attitudes Towards Applying for Farm Certification Standards

Farmers' attitudes toward farm certification standards had an average score of 3.35 ± 0.77, indicating agreement. Of the eight issues examined, five were rated positively (3.80 to 4.10), while three, including the farm improvement process, certification requests, and the three-year certification period, were met with disagreement (Table 1). This suggests that some practices may be considered impractical by farmers. Despite recognizing the importance of farm certification for producing high-quality, environmentally friendly crickets, farmers faced difficulties with processing and post-processing requirements. This aligns with studies showing that over 97% of respondents in Kathmandu Valley, Nepal, agreed that complex organic farming standards present significant challenges (Nandwani *et al*., 2021). While Phitsanulok province ranks highest in cricket production capacity among the 17 northern provinces of Thailand (ICT, 2023), certified farms remain scarce, a challenge also noted in the United Kingdom, where the understanding and practices of insect farmers were often neglected (Bear, 2021). This highlights the ongoing barriers to widespread certification adoption in cricket farming.

Despite farmers' awareness of the benefits of certification, the survey unveiled unfavorable sentiments about conventional agricultural operations. These findings can serve as a starting point for improving the provision of knowledge by relevant agencies on farm improvement. The lack of knowledge was identified as a driver of public fear and general negative attitudes towards modern production (Clark *et al*., 2016). To address this, providing clear guidance on the benefits and necessity of certification is essential. Motivating farmers with potential revenue, leadership roles, and community benefits could encourage certification efforts. Streamlining the certification process may also help shift attitudes and promote the adoption of Thai Agricultural Standards for GAP.

Table 1 The data on attitudes toward farm certification standards

Item	Average ± SD	Interpretation
1. You possess a strong knowledge and comprehension of farm certification standards.	4.10 ± 0.61	Agree
2. The process for requesting farm certification is simple; it is not difficult or complicated.	2.50 ± 0.57	Disagree
3. Farm certification is crucial for cricket farming.	3.83 ± 1.15	Agree
4. The assessment criteria are detailed, comprehensive, and clear.	3.80 ± 0.66	Agree
5. Improving the farm to meet the certification criteria set by the Department of Livestock Development is considered easy.	2.23 ± 0.43	Disagree
6. A certification period of only three years is deemed suitable for farm certification.	2.60 ± 0.67	Disagree
7. Farm certification contributes positively to the environment and consumers.	3.97 ± 0.72	Agree
8. Farm certification helps increase income from cricket farming.	3.80 ± 1.16	Agree
Overall average	3.35 ± 0.77	Agree

Note: The sample size utilized in this study consisted of a total of 30 individuals engaged in cricket farming. Strongly agree corresponds to a score between 4.21 and 5.00, agree corresponds to a score between 3.41 and 4.20, neutral corresponds to a score between 2.61 and 3.40, disagree corresponds to a score between 1.81 and 2.60, and strongly disagree corresponds to a score between 1.00 and 1.80.

Checking the Preparedness of Cricket Farmers for Thai Agricultural Standards

The results from the analysis of cricket farms using the Thai Agricultural Standard for GAP revealed mixed outcomes. In farm components, farmers met three out of five requirements, with areas like farm planning and buildings needing improvement. In farm operations, eight out of 14 items were implemented, including key areas such as container preparation, food and water management, and cleaning, but six items were incomplete (Table 2). Animal health was mostly satisfactory, with full disease management in place, though disease prevention and veterinary care require improvements. Environmental practices were good in waste management, but water discharge met only 36.67% of the criteria. Regarding data recording, 63.30% of farmers kept records on personnel, production, and disease control, while only 40% maintained records for the required three years. While positive trends were noted, significant improvements are needed in data recording and environmental practices. To improve cricket farming efficiency in Thailand based on GAP, it is essential for farmers to adopt data recording practices, including tracking income and expenses, as this is key to guiding production and maximizing profits. However, many farmers, especially those in livestock farming, neglect to record their data, which leads to a lack of understanding of production costs and profitability (Mwanga *et al*., 2020; Wulandari *et al*., 2023). As a result, they may be unaware of issues affecting their returns. The government should provide training and support to help farmers implement effective data recording

and accounting systems. This will enable farmers to monitor their finances, identify problems, and plan more effectively to reduce costs and boost productivity. By adopting proper data recording, farmers can improve decision-making, enhance farm management, and ultimately increase profitability (Aladejebi and Oladimeji, 2019; Omotesho *et al*., 2022).

According to a study by Cheechang and Sakulsawasdiphan (2023), small farms typically have lower production and hygiene standards than large farms, often due to limited resources and knowledge. Larger farms can invest in better practices, leading to higher product quality and more consistent yields. Farm standard certification helps improve product quality and market access, resulting in higher income. However, low-income farmers face more challenges, such as limited access to resources and technical knowledge, which hinder their ability to meet certification standards and improve productivity, ultimately affecting their future income (Yeamkong *et al*., 2010a; 2010b; Koonawootrittriron *et al*., 2012; Utaranakorn and Mawongwai, 2021).

Table 2 Information obtained from the study regarding preparedness for Thai Agricultural Standards

Item	Percentage	
	Not implemented	Implemented
Farm components		
1.1 Location: The farm, situated in a contamination-free zone, ensures safety for crickets and consumers alike	0.00	100.00
1.2 Farm layout: Farm size fosters cricket health, and eco-friendly surroundings, ensuring environmental sustainability	0.00	100.00
1.3 Farm Planning: Clear layout for rearing, storage, and living areas designated	60.00	40.00
1.4 Buildings: Robust structures with ventilation, preventing entry of cricket pests	50.00	50.00
1.5 Containers: Containers built with durable, easily maintained materials for efficient cleaning	0.00	100.00
Farm operations		
2.1 Standard operating procedures: Comprehensive farm operation guidelines encompass cricket-rearing systems, food and water management, cleanliness, health care, environmental stewardship, and data recording	50.00	50.00
2.2 Cricket management: Selection of high-quality cricket breeds	36.67	63.30
2.3 Container preparation: Adequate preparation of rearing containers	0.00	100.00
2.4 Hiding materials: Use clean hiding materials that do not pose risks to crickets	0.00	100.00
2.5 Egg-laying containers: Clean containers mitigate insect and consumer risks	0.00	100.00
2.6 Cricket harvesting: Proper management of harvesting to prevent contamination	0.00	100.00
2.7 Food and water management: Quality control for feed and water	0.00	100.00

Table 2 Cont.

Item	Percentage	
	Not implemented	Implemented
2.8 Water sources: Clean water sources for the farm, free from contaminants	0.00	100.00
2.9 Feeding containers: Clean containers suitable for the quantity and age of crickets	0.00	100.00
2.10 Food storage: Safe storage of food to prevent contamination and spoilage	23.33	76.67
2.11 Personnel: Knowledgeable personnel trained in proper farming practices	33.33	66.67
2.12 Health checks: Regular health check-ups for farm personnel	33.33	66.67
2.13 Cleaning and maintenance: Regular cleaning and maintenance of facilities, ensuring safety for crickets and workers	0.00	100.00
2.14 Chemical use: Safe use of registered chemicals and pesticides	36.67	63.30
Animal health		
3.1 Disease prevention: Measures for disease prevention and control, including data recording of entries and exits to and from the farm	36.67	63.30
3.2 Disease management: Adherence to laws for disease prevention	0.00	100.00
3.3 Veterinary care: Guided by professionals, ensuring compliance with standards	63.33	36.67
Environment		
4.1 Waste management: Proper disposal of waste, manure, and cricket droppings	0.00	100.00
4.2 Water discharge: Ensure proper wastewater treatment before discharge	63.33	36.67
Data recording		
5.1 Record maintenance: Regular recording of operational outcomes crucial for health, production, and disease control	36.67	63.30
5.2 Personnel data: Inclusion of personnel management data	36.67	63.30
5.3 Production data: Information on production, including species, production models, farm management, and outcomes	36.67	63.30
5.4 Disease control data: Data on disease prevention, treatment, medication, and chemical use	36.67	63.30
5.5 Record retention: Retaining records for a minimum of three years	60.00	40.00
Total	23.91	76.08

Note: The sample size utilized in this study consisted of a total of 30 individuals engaged in cricket farming.

Farmers must improve their practices to meet GAP standards. By focusing on key components of GAP in cricket farming, they can create new opportunities, reduce challenges, and achieve more sustainable outcomes. The GAP standard offers direct rewards, and by successfully implementing it on their farms, farmers can increase the proportion of high-quality produce (Thang, 2018). Preparing for GAP will also support the development of cricket farms into organic systems similar to organic livestock. The welfare status of organic livestock, including dairy cattle, beef cattle, sheep, pigs, laying hens, and broilers, is generally regarded as good when compared to animal health and welfare standards. Organic livestock production systems offer certain advantages in terms of animal health and welfare (Manuelian *et al*., 2020; Åkerfeldt *et al*., 2021).

Analyzing the Role of Farmers' Personal Factors in Attitudes and Preparedness for Thai Agricultural Standards

The study found that, despite a small sample size, the data showed a normal distribution (Shapiro-Wilk test). The t-tests indicated no significant differences in attitudes based on sex and education, but the Mann-Whitney U test revealed a significant relationship between income and attitudes, highlighting income's influence (Table 3). Further analysis using t-tests for sex, education, and income showed no significant differences in overall preparedness for Thai Agricultural Standards (Table 4). These results are consistent with the study on preparedness in each component of Thai Agricultural Standards, where similar findings emerged (Table 5). The Pearson correlation coefficient also found no significant correlation between age and attitudes or preparedness (Table 6).

Table 3 Statistical testing for the information regarding farmers' attitudes

Variable	Independent samples t-test	Mann-Whitney U test	P-value
Sex	0.238	-	0.814
Education	-0.982	-	0.344
Income	-	163.50*	0.030*

Note: * Indicates values significant at $P < 0.05$.

Table 4 Statistical testing for the overall study regarding preparedness for Thai Agricultural Standards

Variable	Independent samples t-test	Mann-Whitney U test
Sex	0.391	0.699
Education	1.230	0.229
Income	0.618	0.541

The study examined how attitude scores relate to five independent variables: age, farming experience, education, sex, and income. Multiple regression analysis was used to explore these relationships. The results showed that income was the only variable with a significant correlation to attitudes ($P = 0.018$), as indicated by the Pearson correlation analysis. Specifically, income had a statistically significant impact on attitudes, meaning that individuals with higher incomes tended to have different attitudes compared to those with lower incomes. In contrast, the other variables did not show significant correlations with attitudes ($P > 0.05$), suggesting that these factors do not have

a meaningful effect on attitudes in this study (Table 7). The subsequent multiple regression analysis yielded the following model:

$$\hat{Y} = 3.242 + 0.240(\text{Income})$$

From the regression model, it was observed that only the dummy variable representing high income was retained in the final equation, with a regression coefficient of 0.240. This indicates that, on average, individuals with high income exhibit an attitude score 42.8% higher than those with low income, controlling for other factors in the model. The correlation coefficient was 0.428, and the coefficient of determination (R^2) was 0.183, meaning that the independent variable explains 18.3% of the variance in attitude scores. These findings were consistent with the adjusted R^2 value of 0.154, which accounts for the number of predictors in the model and reflects a slight decrease. The standard error of the estimate was 0.261, indicating a relatively accurate model. The regression model was thoroughly evaluated against fundamental statistical assumptions. The analysis confirmed that the mean of the residuals was zero (t-test, P = 1), the residuals were independent (Durbin-Watson statistic = 1.598), homoscedasticity (constant variance of residuals) was satisfied, and the residuals followed a normal distribution (Shapiro-Wilk test, P = 0.394). All assumptions were adequately met, ensuring the model's robustness and validity. Thus, the resultant multiple regression model is suitable for accurate estimation and prediction of attitude scores.

Table 5 Statistical testing for each study regarding preparedness for Thai Agricultural Standards for Good Agricultural Practices

Factor	Mann-Whitney U Test	P-value
Farm components		
Sex	73.00	0.504
Education	106.50	0.950
Income	124.00	0.637
Farm operations		
Sex	83.50	0.836
Education	94.00	0.573
Income	118.00	0.822
Animal health		
Sex	88.00	1.000
Education	89.00	0.439
Income	112.00	1.000
Environment		
Sex	87.00	0.982
Education	84.00	0.325
Income	110.00	0.951
Data recording		
Sex	75.50	0.565
Education	83.00	0.305
Income	76.00	0.142

These results contrast with previous studies that identified age, gender, education, and income as influencing factors in farmers' adoption of organic farming (Isin *et al*., 2007; Sapbamrer and Thammachai, 2021). Previous research, rooted in traditional knowledge and agricultural experience in pest management in Thailand, suggests that farmers often overlook certain practices due to challenges in implementation, despite recognizing their benefits (Timprasert *et al*., 2014; Riwthong *et al*., 2017). Additionally, it was found that the collective experience of households in Ninh Thuan, Vietnam, negatively influenced their decisions to adopt GAP farming. At a 95% significance level, it can be concluded that most farmers in agricultural production primarily rely on their own experience (Thang, 2018). These findings suggest income significantly influences farmers' attitudes and preparedness for GAP, indicating it is a key factor for guiding support strategies. To boost GAP adoption and compliance, future policies should prioritize financial support to improve farmers' access to GAP standards.

Table 6 The Pearson correlation coefficient between age and the farmers' attitudes scores, as well as preparedness for the Thai Agricultural Standard

Factor	Pearson correlation coefficient	P-value
Farmers' attitudes	-0.169	0.373
Overall, preparedness for TAS	0.247	0.188
Farm components	0.120	0.528
Farm operations	0.114	0.548
Animal health	0.173	0.361
Environment	0.146	0.440
Data recording	0.267	0.154

Table 7 The Pearson correlation coefficient between attitude scores and a set of independent variables

Independent variable	Pearson correlation coefficient	P-value
Age	-0.169	0.373
Education	0.348	0.059
Farming experience	-0.310	0.095
Sex	0.045	0.814
Income	0.428*	0.018

Note: * Indicates values significant at $P < 0.05$.

Suggestions for adapting the cricket certification process for small-scale farmers include reducing unnecessary requirements and creating flexible criteria for different farm sizes, especially for farmers with limited resources. Simple, user-friendly manuals and tools should be developed to assist farmers through the certification process. Technology, such as mobile apps, can help with data recording and document submission, reducing paperwork and inspections. Training programs should focus on helping farmers meet standards. Financial support, like low-interest loans, can assist farmers in upgrading their farms. Increased participation in certification systems can enhance market credibility, boost exports, and meet the global demand for sustainable protein. Policymakers should create laws

that make certification systems adaptable for all farm sizes and foster collaboration between government, private, and international organizations to align with global standards. Adapting the certification process will make it easier for small-scale farmers to comply, promote sustainable cricket farming, and enhance its global competitiveness. This study offers valuable guidance for policymakers in designing systems that address both local and global needs.

CONCLUSIONS

In conclusion, the study on cricket farming in Phitsanulok province explored various aspects, including farmers' personal information, farming administration, management, attitudes toward farm certification standards, and readiness for Thai Agricultural Standards. The results revealed that fundamental personal factors, such as gender, age, education, and income, did not serve as specific prerequisites for entering cricket farming, making it accessible to individuals from diverse backgrounds seeking to augment their income. While farmers expressed agreement with certification standards and a desire to meet production benchmarks, the study identified persistent complications in enhancing farms and navigating the certification process. Stringent criteria could potentially lead to negative attitudes during the certification process concerning Thai Agricultural Standards. These findings underscore the nuanced attitudes of Thai farmers toward agricultural standards, revealing complexities even among individuals with a good understanding of associated benefits and risks, despite their high level of education.

In the context of future research, it is imperative to emphasize the significance of disseminating effective knowledge related to the Thai Agricultural Standard for GAP and advocating for comprehensive data recording within the domain of cricket farming for farmers. These initiatives play a pivotal role in fostering sustainability within the cricket farming sector, thereby contributing to the improvement of practices in Phitsanulok province. Furthermore, they serve as a guiding framework for establishing standardized cricket farms in various regions across the country.

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CONFLICTS OF INTEREST

All authors declare that they have no conflicts of interest.

REFERENCES

Åkerfeldt, M.P., S. Gunnarsson, G. Bernes and I. Blanco-Penedo. 2021. Health and welfare in organic livestock production systems—a systematic mapping of current knowledge. Org. Agr. 11: 105–132. https://doi.org/10.1007/s13165-020-00334-y.

Aladejebi, O. and J.A. Oladimeji. 2019. The impact of record keeping on the performance of selected small and medium enterprises in Lagos metropolis. J. Small Bus. Entrep. Dev. 7(1): 28–40. https://doi.org/10.15640/jsbed.v7n1a3.

Arunsangseesod, O., A. Chantiratikul, K. Pimrueng, S. Khamtasila and N. Choowong. 2021. Production and marketing of cricket farms in the central part of northeastern Thailand. Khon Kaen Agr. J. 49(Suppl. 1): 636–641.

Azam, M.S. and M. Shaheen. 2019. Decisional factors driving farmers to adopt organic farming in India: A cross-sectional study. Int. J. Soc. Econ. 46(4): 562–580. https://doi.org/10.1108/IJSE-05-2018-0282.

Bashi, Z., R. McCullough, L. Ong and M. Ramirez. 2019. Alternative Proteins: The Race for Market Share Is On. McKinsey & Company, Denver, USA.

Bawa, M., S. Songsermpong, C. Kaewtapee and W. Chanput. 2020. Effect of diet on the growth performance, feed conversion and nutrient content of the house cricket. J. Insect Sci. 20(2): 10. https://doi.org/10.1093/jisesa/ieaa014.

Bear, C. 2021. Making insects tick: Responsibility, attentiveness and care in edible insect farming. Environ. Plan. E Nat. Space. 4(3): 1010–1030. https://doi.org/10.1177/2514848620945321.

Boone, H.N. and D.A. Boone. 2012. Analyzing Likert data. J. Ext. 50(2): 48. https://doi.org/10.34068/joe.50.02.48.

Cheechang, S. and K. Sakulsawasdiphan. 2023. Survey of production and hygienic assessment of edible insect rearing in Nakhonsithammarat province. Thai J. Agric. Sci. 4(Suppl. 1): 669–678.

Clark, B., G.B. Stewart, L.A. Panzone, I. Kyriazakis and L.J. Frewer. 2016. A systematic review of public attitudes, perceptions and behaviours towards production diseases associated with farm animal welfare. J. Agric. Environ. Ethics. 29(3): 455–478. https://doi.org/10.1007/s10806-016-9615-x.

Fuah, A.M., H.C.H. Siregar and Y.C. Endrawati. 2015. Cricket farming for animal protein as a profitable business for small farmers in Indonesia. J. Agric. Sci. Technol. A. 5(4): 296–304. https://doi.org/10.17265/2161-6256/2015.04.008.

Halloran, A., N. Roos and Y. Hanboonsong. 2017. Cricket farming as a livelihood strategy in Thailand. Geogr. J. 183(1): 112–124. https://doi.org/10.1111/geoj.12184.

Halloran, A., N. Roos, R. Flore and Y. Hanboonsong. 2016. The development of the edible cricket industry in Thailand. J. Insects Food Feed. 2(2): 91–100. https://doi.org/10.3920/JIFF2015.0091.

Halloran, A., R.C. Megido, J. Oloo, T. Weigel, P. Nsevolo and F. Francis. 2018. Comparative aspects of cricket farming in Thailand, Cambodia, Lao People's Democratic Republic, Democratic Republic of the Congo and Kenya. J. Insects Food Feed. 4(2): 101–114. https://doi.org/10.3920/JIFF2017.0016.

Hanboonsong, Y. and P. Durst. 2020. Guidance on Sustainable Cricket Farming – A Practical Manual. FAO, Bangkok, Thailand.

Hanboonsong, Y., T. Jamjanya and P.B. Durst. 2013. Six-legged Livestock: Edible Insect Farming, Collecting and Marketing in Thailand. FAO, Regional Office for Asia and the Pacific, Bangkok, Thailand.

ICT (Information and Communication Technology Center). 2023. Livestock Data in Thailand for the Year 2023. Department of Livestock Development, Bangkok, Thailand.

IPIFF (International Platform of Insects for Food and Feed). 2023. EU Legislation: Insects as novel foods – an overview. Available Source: https://ipiff.org/insects-novel-food-eu-legislation. May 15, 2024.

Isin, F., T. Cukur and G. Armagan. 2007. Factors affecting the adoption of the organic dried fig agriculture system in Turkey. J. Appl. Sci. 7(5): 748–754. https://doi.org/10.3923/jas.2007.748.754.

Kanjina, C., S. Simaraks, S. Laohasiriwong and S. Choenkwan. 2019. Commercial cricket raising system by farmers in a village of Khon Kaen province. Khon Kaen Agr. J. 47(Suppl. 1): 225–232.

Khor, L.Y., S. Ufer, T. Nielsen and M. Zeller. 2018. Impact of risk aversion on fertiliser use: Evidence from Vietnam. Oxf. Dev. Stud. 46(4): 483–496. https://doi.org/10.1080/13600818.2018.1445212.

Koonawootrittriron, S., M.A. Elzo, S. Yeamkong and T. Suwanasopee. 2012. A comparative study on dairy production and revenue of the dairy farms supported by a private organization with those supported by a dairy cooperative in Central Thailand. Livest. Res. Rural Dev. 24(4): 61.

Krejcie, R.V. and D.W. Morgan. 1970. Determining sample size for research activities. Educ. Psychol. Meas. 30(3): 607–610. https://doi.org/10.1177/001316447003000308.

Kulsarin, K., J. Chalermphol, R. Sirisunyaluck and P. Suttiprapan. 2021. Effect of cricket culture training on trainees' knowledge, at Chiang Klang district, Nan province. J. Agric. 37(3): 317–326.

Likert, R. 1932. A technique for the measurement of attitudes. Arch. Psychol. 22(140): 1–55.

Manuelian, C.L., M. Penasa, L. da Costa, S. Burbi, F. Righi and M. De Marchi. 2020. Organic livestock production: A bibliometric review. Animals 10(4): 618. https://doi.org/10.3390/ani10040618.

Mungkung, R. and T. Phetcharaburanin. 2023. Food for the future: Sustainability assessment of cricket products for policy decisions to move toward sustainable agriculture in Thailand. J. Insects Food Feed. 9(9): 1223–1234. https://doi.org/10.3920/JIFF2021.0182.

Mwanga, G., E. Mbega, Z. Yonah and M.G.G. Chagunda. 2020. How information communication technology can enhance evidence-based decisions and farm-to-fork animal traceability for livestock farmers. Sci. World J. 2020: 1279569. https://doi.org/10.1155/2020/1279569.

Nandwani, D., D. Jamarkattel, K.R. Dahal, R. Poudel, S. Giri and T.N. Joshi. 2021. Attitudes of fruit and vegetable farmers towards organic farming in Kathmandu valley, Nepal. Sustainability 13(7): 3888. https://doi.org/10.3390/su13073888.

National Bureau of Agricultural Commodity and Food Standards. 2017. Good Agricultural Practices for Cricket Farm. Ministry of Agriculture and Cooperatives, Bangkok, Thailand.

National Bureau of Agricultural Commodity and Food Standards. 2018. Annual Report 2018: National Bureau of Agricultural Commodity and Food Standards. Ministry of Agriculture and Cooperatives, Bangkok, Thailand.

Olufemi, T.D. 2012. Theories of attitudes, pp. 61–78. *In*: C.D. Logan and M.I. Hodges, (Eds.), Psychology of Attitudes. Nova Science Publishers, Inc., New York, USA.

Omotesho, K.F., P.A. Fatodu and T.B. Ajibade. 2022. Farm record keeping behaviour of rural farming youths in Ekiti State, Nigeria. Sarhad J. Agric. 38(1): 92–102. https://dx.doi.org/10.17582/journal.sja/2022/38.1.92.102.

Oonincx, D.G.A.B., S. van Broekhoven, A. van Huis and J.J.A. van Loon. 2019. Correction: Feed conversion, survival and development, and composition of four insect species on diets composed of food by-products. PLoS One. 14: e0222043. https://doi.org/10.1371/journal.pone.0222043.

Panyasit, K., M. Singhavara and S. Nonthapot. 2022. Acceptance of commercial cricket cultivation technology in Nong Khai province, Thailand. Int. J. Innov. Res. Sci. Stud. 5(3): 226–235. https://doi.org/10.53894/ijirss.v5i3.657.

Pereira, J.M.V., D. Bruno, M.I. Marcondes and F.C. Ferreira. 2022. Use of beef semen on dairy farms: A cross-sectional study on attitudes of farmers toward breeding strategies. Front. Anim. Sci. 2: 785253. https://doi.org/10.3389/fanim.2021.785253.

Preteseille, N., A. Deguerry, M. Reverberi and T. Weigel. 2018. Insects in Thailand: National leadership and regional development, from standards to regulations through association, pp. 435–442. *In*: A. Halloran, R. Flore, P. Vantomme and N. Roos, (Eds.), Edible Insects in Sustainable Food Systems. Springer, Cham, Switzerland.

Reverberi, M. 2020. Edible insects: Cricket farming and processing as an emerging market. J. Insects Food Feed. 6(2): 211–220. https://doi.org/10.3920/JIFF2019.0052.

Riwthong, S., P. Schreinemachers, C. Grovermann and T. Berger. 2017. Agricultural commercialization: Risk perceptions, risk management and the role of pesticides in Thailand. Kasetsart J. Soc. Sci. 38(3): 264–272.

Sakaluk, S.K., J. Oldzej, C.J. Poppe, J.L. Harper, I.G. Rines, K.J. Hampton, K.R. Duffield, J. Hunt and B.M. Sadd. 2019. Effects of inbreeding on life-history traits and sexual competency in decorated crickets. Anim. Behav. 155: 241–248. https://doi.org/10.1016/j.anbehav.2019.05.027.

Sapbamrer, R. and A. Thammachai. 2021. A systematic review of factors influencing farmers' adoption of organic farming. Sustainability 13(7): 3842. https://doi.org/10.3390/su13073842.

Schneider, S., F. Salm, S. Vincze, A. Moeser, I. Petruschke, K. Schmücker, N. Ludwig, R. Hanke, C. Schröder, A. Gropmann, M. Behnke, A. Lubke-Becker, L.H. Wieler, S. Hagel, M.W. Pletz, J. Gensichen, P. Gastmeier and RAI Study Group. 2018. Perceptions and attitudes regarding antibiotic resistance in Germany: A cross-sectoral survey amongst physicians, veterinarians, farmers and the general public. J. Antimicrob. Chemother. 73(7): 1984–1988. https://doi.org/10.1093/jac/dky100.

Sifanu, M., T.K. Taylor, K.K. Kalebaila, P. Hayumbu, L. Nabiwa and S.J.L. Linde. 2023. Knowledge, attitude, behavior practices and compliance of workers exposed to respirable dust in a Zambian copper mine. Int. J. Environ. Res. Public Health. 20(18): 6785. https://doi.org/10.3390/ijerph20186785.

Thang, D.Q. 2018. Analyzing the impact of select factors on investment decisions for agricultural development under the GAP of households in Ninh Thuan, Vietnam. IJECM 6(1): 355–365.

Timprasert, S., A. Datta and S.L. Ranamukhaarachchi. 2014. Factors determining adoption of integrated pest management by vegetable growers in Nakhon Ratchasima province, Thailand. Crop Prot. 62: 32–39. https://doi.org/10.1016/j.cropro.2014.04.008.

Utaranakorn, P. and Y. Mawongwai. 2021. Measurement of technical efficiency of cricket farming of farmers in Nam Phong district, Khon Kaen province by data envelopment analysis approach. Khon Kaen Agr. J. 49(1): 167–178. https://doi.org/10.14456/kaj.2021.14.

Wulandari, E., T. Karyani, E. Ernah and R.T.P. Alamsyah. 2023. What makes farmers record farm financial transactions? Empirical evidence from potato farmers in Indonesia. Int. J. Financial Stud. 11(1): 19. https://doi.org/10.3390/ijfs11010019.

Yaemkong, S., T. Incharoen, N. Rattanachak and T. Jongjitvimol. 2024. Comparative analysis of diet effects on growth performance and nutrient composition in house cricket, *Acheta domestica* as an alternative protein source in Thailand. Cogent Food Agric. 10(1): 2339543 https://doi.org/10.1080/23311932.2024.2339543.

Yeamkong, S., S. Koonawootrittriron, M.A. Elzo and T. Suwanasopee. 2010a. Milk quantity, quality and revenue in dairy farms supported by a private organization in Central Thailand. Livest. Res. Rural Dev. 22(2): 33.

Yeamkong, S., S. Koonawootrittriron, M.A. Elzo and T. Suwanasopee. 2010b. Effect of experience, education, record keeping, labor and decision making on monthly milk yield and revenue of dairy farms supported by a private organization in Central Thailand. Asian-Aust. J. Anim. Sci. 23(6): 814–824.

Zeweld, W., G. Van Huylenbroeck, G. Tesfay and S. Speelman. 2019. Impacts of socio-psychological factors on smallholder farmers' risk attitudes: Empirical evidence and implications. Agrekon 58(2): 253–279.