Knowledge and Understanding of Agricultural Carbon Credits of Thai Farmers: A Study in Thailand

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Article Info
ISSN (online): 2583-8261
Volume: 04
Issue: 03
May-June 2025
Received: 10-04-2025
Accepted: 02-05-2025
Page No: 147-150

Abstract
This study aims (1) to examine the knowledge and understanding of agricultural carbon credits among farmers in Lan Saka District, Nakhon Si Thammarat Province, and (2) to investigate the influence of personal factors and agricultural learning experiences on such knowledge and understanding. A quantitative research methodology was employed, using a structured questionnaire to collect data from a sample of 400 farmers residing in Lan Saka District. Descriptive statistics such as frequency, percentage, mean, and standard deviation were used, along with inferential statistics including Independent Samples t-test and One-Way Analysis of Variance (ANOVA). The findings revealed that the majority of respondents were female, aged between 30 and 40 years, had completed secondary education, and earned a monthly income between 15,000–30,000 THB. Most households consisted of 2–4 members, cultivated land ranging from 21–30 rai, grew 2–3 types of crops, and held land under Nor Sor 3 Kor land title documents. The hypothesis testing indicated that personal factors such as gender, annual income, household size, and farm size were not significantly associated with differences in knowledge and understanding of agricultural carbon credits. However, age, education level, crop type, and form of land ownership were significantly associated with different levels of understanding ($p < 0.05$). Furthermore, different levels of agricultural learning experiences were found to significantly affect farmers' knowledge and understanding of agricultural carbon credits ($p< 0.05$). Farmers with high levels of learning experience demonstrated significantly greater knowledge and understanding than those with moderate or low levels of experience.

Keywords: Farmers, Knowledge and Understanding, Learning Experience, Agricultural Carbon Credits

Introduction

Climate change is an escalating global crisis driven by the accumulation of greenhouse gases in the atmosphere—particularly carbon dioxide (CO_2) and methane (CH_4)—largely due to human activities such as fossil fuel combustion, industrial processes, and unsustainable agricultural practices. These emissions contribute to global warming and intensify natural disasters such as heatwaves, wildfires, storms, droughts, and floods, while also threatening biodiversity. In response to this growing threat, the international community has mobilized under the United Nations Framework Convention on Climate Change (UNFCCC), leading to legally binding agreements such as the Kyoto Protocol and the Paris Agreement, aimed at limiting global emissions to prevent severe harm to humanity. As a developing country particularly vulnerable to the effects of climate change, Thailand has implemented a series of mitigation and adaptation strategies, including the Climate Change Master Plan, the National

Adaptation Plan (NAP), and commitments under the Nationally Determined Contributions (NDCs). Among the mechanisms adopted is the Thailand Voluntary Emission Reduction Program (T-VER), managed by the Thailand Greenhouse Gas Management Organization (TGO), which promotes the reduction and sequestration of greenhouse gases across all sectors, including agriculture. Under this scheme, participants can generate carbon credits for trade or offsetting purposes.

Thai farmers are a key stakeholder group in advancing the low-carbon economy, and agricultural carbon credit systems offer both environmental and economic benefits. This study focuses on farmers in Lan Saka District, Nakhon Si Thammarat Province, a region noted for its extensive farmland, excellent air quality, and rich natural resources. The study aims to examine their level of knowledge and understanding of agricultural carbon credits and to explore how personal characteristics and agricultural learning experiences influence this understanding. By identifying these relationships, the research seeks to inform strategies for enhancing farmers' capacity to adopt sustainable practices, reduce production costs, and generate supplemental income through carbon credit markets—ultimately contributing to Thailand's long-term goals for environmental balance and climate resilience.

Literature Review

To foster a comprehensive understanding of agricultural carbon credit literacy, it is essential to define the concepts of knowledge and understanding as interpreted through relevant studies and theoretical frameworks. Knowledge and understanding are considered cognitive processes encompassing perception, memory, analysis, and application, which are fundamental to individual learning and behavioral development (Bloom *et al*., 1971; Klopfer, 1971) [1, 4]. Knowledge refers to foundational behaviors resulting from learning, such as the recall of facts or theories (Prapa-pen Suwan, 1977), while understanding involves the ability to explain or communicate this knowledge accurately and meaningfully (Suwat Niyomkha, 1988; Paisan Wangpanich, 1983) [6, 12]. Bloom (1980, as cited in Sangchan Sophakan, 2007) [1] classified cognitive abilities into six hierarchical levels: knowledge, comprehension, application, analysis, synthesis, and evaluation. This taxonomy provides a suitable framework for assessing farmers' knowledge and understanding of agricultural carbon credits. Furthermore, knowledge and understanding are influenced by personal factors such as education, experience, and socio-economic status, as well as environmental factors such as family, peer groups, and media exposure (Sanphawut Phiphatphan, 1995, as cited in Sayamon Suebnueang, 2014). These factors collectively shape environmental learning, especially in the context of climate change impacts on agriculture.

Agricultural carbon credits are mechanisms designed to incentivize farmers to engage in climate-smart agriculture practices that mitigate greenhouse gas emissions. These practices include carbon sequestration in biomass and soil through activities such as afforestation, reduced tillage, and the use of organic fertilizers (Gupta, 2024) [3]. Not only do these practices support global climate goals, but they also offer farmers additional income through participation in voluntary carbon markets (Lelechenko, 2024) [5]. GIZ (2024) [2] highlights that when farmers effectively implement certified greenhouse gas reduction strategies, they stand to benefit both economically and environmentally. In Thailand, the T-VER (Thailand Voluntary Emission Reduction Program), administered by the Thailand Greenhouse Gas Management Organization (Public Organization), provides a structured and verifiable framework for agricultural sectors to participate in carbon credit generation and trading.

Based on the theoretical and empirical foundations presented above, the following hypotheses were formulated to guide this study:

- Farmers with different personal characteristics will exhibit significantly different levels of knowledge and understanding regarding agricultural carbon credits.
- Farmers with differing levels of agricultural learning experience will exhibit significantly different levels of knowledge and understanding regarding agricultural carbon credits.

Research Methodology

This study, titled "Knowledge and Understanding of Agricultural Carbon Credits among Farmers in Lansaka District, Nakhon Si Thammarat Province," employed a quantitative research design. The target population comprised farmers residing and cultivating crops in Lansaka District. As the total population size and proportion were unknown, the sample size was determined using Cochran's formula (1977), resulting in a calculated sample size of 384 participants. However, the study utilized a total of 400 participants to enhance representativeness. The sampling technique applied was non-probability sampling, specifically convenience sampling. Data collection was conducted using a structured questionnaire with close-ended items, which participants completed by themselves.

The collected data were analyzed using both descriptive and inferential statistics. Descriptive statistics included frequency, percentage, mean, and standard deviation. Inferential statistical methods included the Independent Samples t-test and One-Way Analysis of Variance (ANOVA) to test the research hypotheses.

Research Findings

The analysis of personal factors, including gender, age, highest level of education, average annual income, household size, cultivated land area, types of crops grown, and land tenure status, was conducted among 400 farmers residing in Lansaka District. The majority of respondents were female (n = 265, 66.2%). Most were aged between 30 and 40 years (n = 148, 37%), had completed secondary education (n = 161, 40.3%), and had an average monthly income ranging from 15,000 to 30,000 THB (n = 213, 53.2%). In terms of household composition, most respondents reported having 2 to 4 family members (n = 234, 58.5%), owned agricultural land ranging from 21 to 30 rai (38.5%), and cultivated 2–3 types of crops (n = 271, 67.7%). Regarding land tenure, nearly half held a Nor Sor 3 Kor land title document (n = 186, 46.5%).

Farmers' learning experiences were assessed across eight types of agricultural activities. The activity with the highest rate of "regular participation" was learning via websites or social media (14.8%), followed by participation in productivity enhancement and cost-reduction programs offered by government agencies (10.5%). The most frequently selected "occasional participation" activities were

learning through radio or television (89.2%) and reading books or printed materials (88.0%). Conversely, the activities with the highest rates of "non-participation" were monthly farmer meetings (16.2%) and productivity development programs provided by community scholars or public agencies (14.5%). Detailed results are presented in Table 1.

Table 1: Frequency and Percentage Distribution of Farmers by Type of Agricultural Learning Experience

Learning Activities	Regular Participation	Occasional Participation	Never Participated	Total
1. Books or printed media	30 (7.5%)	352 (88.0%)	18 (4.5%)	400 (100%)
2. Radio or television	25 (6.3%)	357 (89.2%)	18 (4.5%)	400 (100%)
3. Websites or social media	59 (14.8%)	314 (78.4%)	27 (6.8%)	400 (100%)
4. Monthly farmers' meetings	23 (5.8%)	312 (78.0%)	65 (16.2%)	400 (100%)
5. Organic farming promotion by community experts or government agencies	33 (8.3%)	319 (79.7%)	48 (12.0%)	400 (100%)
6. Productivity enhancement and cost reduction programs by local experts/government	42 (10.5%)	300 (75.0%)	58 (14.5%)	400 (100%)
7. Agricultural technology transfer activities	34 (8.5%)	319 (79.7%)	47 (11.8%)	400 (100%)
8. Activities on carbon credits and environmental conservation	10 (2.5%)	341 (85.2%)	49 (12.3%)	400 (100%)

The assessment of the levels of agricultural learning experience among the sampled farmers revealed that the majority exhibited a moderate level of experience (n = 315, 78.8%). This was followed by a low level of experience (n = 48, 12.0%), and a high level of experience (n = 37, 9.2%), respectively. Detailed results are presented in Table 2.

Table 2: Frequency and Percentage Distribution by Level of Agricultural Learning Experience

Level of Agricultural Learning Experience	Number	Percentage (%)
Low	48	12.0
Moderate	315	78.8
High	37	9.2
Total	400	100.0

The overall level of farmers' knowledge and understanding regarding agricultural carbon credits in Lansaka District, Nakhon Si Thammarat Province, was found to be moderate, with a mean score of 2.75. When examined by sub-dimension, the highest mean score was observed in knowledge and understanding of agricultural carbon credit programs (mean = 3.00), followed by relevant government agencies and institutions promoting carbon credits (mean = 2.77), and basic knowledge of carbon credits (mean = 2.71). The lowest score was found in the dimension of carbon credit markets, which was rated at a low level (mean = 2.52). Detailed results are presented in Table 3.

Table 3: Means and Standard Deviations of Knowledge and Understanding of Agricultural Carbon Credits

Aspect of Knowledge and Understanding	Mean ($\bar{X}$)	S.D.	Interpretation
1. Basic knowledge of carbon credits	2.71	0.716	Moderate
2. Knowledge of responsible and promoting agencies	2.77	0.826	Moderate
3. Knowledge of agricultural carbon credit projects	3.00	0.957	Moderate
4. Knowledge of carbon credit markets	2.52	0.782	Low
Overall	2.75	0.748	Moderate

Discussion

The study found that knowledge and understanding of agricultural carbon credits did not significantly differ by gender, average monthly income, household size, or cultivated land area. However, statistically significant differences were observed when considering age, highest educational attainment, types of crops cultivated, and land tenure status. Farmers aged between 40 and 50 years demonstrated higher levels of knowledge and understanding than other age groups. This cohort remains active in the labor force and is more likely to engage with information technology in their work—especially in communication and information retrieval—thereby enhancing their capacity to acquire knowledge. Farmers with a bachelor's degree exhibited higher levels of knowledge and understanding compared to those with only primary or secondary education. This finding may be attributed to the cognitive and analytical skills developed through higher education, which facilitate more effective engagement with contemporary technological and informational resources. The results align with the findings of Sirichai Pongvichai (2008), who emphasized the role of education in enhancing analytical thinking, perception, and information evaluation—core components of effective learning. In terms of crop diversification, farmers cultivating more than three crop types showed significantly higher levels of knowledge and understanding than those practicing monoculture. This suggests that diversified farming may be positively associated with familiarity and engagement with agricultural carbon credit systems. Such farmers may also have greater exposure to external support programs or technical extension services. Additionally, the complexity of managing diverse crops likely necessitates more strategic resource management—including water, fertilizer, and labor—which, in turn, drives continuous learning and information-seeking behaviors.

Finally, farmers holding land under official documentation, specifically the Nor Sor *3* Kor (NS*3*K) land tenure issued by the government, demonstrated greater knowledge and understanding of agricultural carbon credits than those with other forms of landholding. This may reflect a higher level of interaction with formal administrative processes, governmental agencies, and agricultural development programs, thereby facilitating improved awareness and engagement with sustainability mechanisms such as carbon credit initiatives. Differences in agricultural learning experiences among farmers were found to have a statistically significant impact on their levels of knowledge and understanding regarding agricultural carbon credits at the 0.05 level. Farmers who reported a high level of learning experience exhibited significantly greater knowledge and

understanding than those with moderate or low levels of experience. This underscores the importance of active engagement in agricultural learning processes—such as participating in training programs, pursuing self-directed learning, or exchanging knowledge with fellow farmers—as critical drivers in developing comprehension of complex topics like agricultural carbon credits, which intersect environmental, economic, and policy domains.

These findings are consistent with the theoretical perspective proposed by Sappawut Pipatphan (1995, p. 13, cited in Sayamon Suebnueang, 2014, p. 23), which posits that "experience is a fundamental component in the formation of knowledge and understanding." That is, when individuals have opportunities to engage with real-world situations, apply practical skills, and draw upon various information sources, they are more likely to develop stable and in-depth conceptual understanding. Consequently, efforts to promote knowledge about agricultural carbon credits should emphasize the design of experiential learning programs that offer continuous, hands-on opportunities for farmers. Such initiatives will be instrumental in elevating awareness and fostering sustainable, long-term comprehension of carbon credit systems in the agricultural sector.

Conclusion

The findings indicate that the overall knowledge and understanding of agricultural carbon credits among farmers in Lansaka District, Nakhon Si Thammarat Province remains at a moderate level. When examined by specific dimensions, the area in which farmers demonstrated the least understanding was the carbon credit market. Therefore, it is essential to prioritize education on carbon markets for farmers. Educational interventions should be tailored to the specific characteristics of agricultural communities, emphasizing practical, accessible communication methods that are contextually appropriate. In addition, efforts should be made to facilitate access to information from relevant institutions and to establish continuous local-level support mechanisms. It is also recommended that government agencies invest in the development of technology and innovation—such as artificial intelligence (AI)—to provide efficient evaluation and advisory services related to carbon credits. Equitable access to carbon credit programs should be promoted, particularly for farmers in remote areas. Furthermore, future research should investigate the long-term impacts of farmer participation in carbon credit systems on income and production behavior. Such evidence will be critical for informing sustainable policy development and appropriate institutional support in advancing low-carbon agricultural practices.

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