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Farmers' production management in organic agriculture with a Participatory Guarantee System (PGS) in the Northeast of Thailand

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Abstract

Background and Objective: Organic agriculture is increasingly popular in Thailand, driven by concerns over chemical agriculture. This study explores the significance of farmers' knowledge and opinions in enhancing production management within organic agriculture, utilizing the Participatory Guarantee System (PGS). The research objectives were meant to describe the demographic characteristics of farmers, examine the knowledge and opinion on organic agriculture with PGS, production support required by farmers, evaluate production management, and determine the factors related to production management in organic agriculture with PGS of farmers.

Methodology: A quantitative approach was employed, involving structured interviews with 178 organic farmers affiliated with PGS from the Land Development Department's database. Data were analyzed using descriptive statistics and correlation coefficients.

Main Results: Age, knowledge of organic agriculture, and knowledge of PGS were positively related to production management effectiveness [correlation coefficients of 0.154 ($P = 0.040$), 0.427 ($P = 0.001$), and 0.340 ($P = 0.001$)]. Most farmers demonstrated high knowledge levels regarding organic agriculture principles and PGS (average scores of 12.18 and 13.01 out of 15), along with positive opinions towards organic practices (average score of 4.96). However, production management effectiveness was moderate for 93.3% of farmers, while only 6.7% performed at a high level.

Conclusions: The findings underscore the critical role of knowledge in improving production management among organic farmers using PGS in Northeast Thailand. Despite a generally favorable view of organic agriculture with PGS, misconceptions about specific practices remain, indicating a need for targeted educational efforts to enhance understanding and engagement among farmers. Addressing challenges related to resource scarcity and market competition is also essential for further growth in this sector.

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INTRODUCTION

In the past, Thai farmers practiced agriculture that relied on ecological systems and local wisdom, aligning with organic agriculture principles. However, starting in 1957, the World Bank's recommendation to the government of Thailand led to policies aimed at increasing agricultural productivity to support exports. This resulted in a shift of agriculture practices from a self-sustainable way to heavy reliance on external production factors like chemical fertilizers and pesticides, followed by deforestation to gain more farming area, which caused adverse economic, social, and environmental impacts (Office of the Royal Development Projects Board, 2008). The shift to chemical agriculture has severely degraded soil health and reduced crop yields, forcing farmers to use more chemicals, thus perpetuating a cycle of soil degradation. Despite producing large quantities of agricultural products, farmers' net income has decreased due to high production costs and low global market prices. Many farmers are now trapped in debt and poverty (Sirisuwan, 2017). Recent awareness of the negative impacts of chemical agriculture has prompted a shift back to organic practices. However, organic agriculture in Thailand is currently facing significant constraints. Farmers often perceive organic agriculture as yielding lower returns compared to conventional methods, which discourages wider adoption. So, the study about factors related to the adoption of organic agriculture is important.

Regarding the global organic market, it was estimated to be worth approximately US$105.73 billion. The United States of America, Germany, and France were the three largest markets for organic food (FiBL Statistics, 2020). The Thai government has initiated an Organic Agriculture Action Plan 2023–2027 that emphasizes sustainable practices aligned with the Sufficiency Economy Philosophy. This plan aims to increase organic farming areas significantly and promote knowledge sharing among farmers (National Organic Agriculture Committee, 2022). Despite government initiatives promoting organic agriculture, especially organic rice production, the sector remains relatively small compared to conventional farming practices. Between 2017 and 2019, there was a reported increase in the number of organic farmers and the area dedicated to organic agriculture. By 2019, Thailand had approximately 44,418 organic farmers and 119 organic farmer groups managing around 531,618 rai of land. However, this represents merely 0.004% of the total number of farmers and 0.002% of agricultural land in Thailand. Additionally, the complexities associated with third-party certification pose challenges for smallholder farmers, particularly in developing countries where governmental support is often inadequate. To mitigate these issues, the Participatory Guarantee System (PGS) has been introduced as an alternative to traditional certification methods. The International Federation of Organic Agriculture Movements (IFOAM) has supported the development of Participatory Guarantee Systems (PGS) since 2004 (Pongsrihadulchai, 2020). The PGS are locally focused quality assurance systems. They certify producers based on the active participation of stakeholders and are built on a foundation of trust, social networks, and knowledge exchange (IFOAM, 2008). This system emphasizes local participation and trust, making it more accessible for smallholders. The Thai Organic Agriculture Foundation (TOAF), in collaboration with various government agencies, has implemented the PGS to promote organic agriculture practices and enhance accessibility for farmers in Thailand (Amthed and Thunmathiwat, 2021). The TOAF-PGS organic agriculture pilot project was implemented under the Letter of Agreement (LOA: TA8163-REG) between Thailand's Ministry of Agriculture and Cooperatives (MOAC) and the Asian Development Bank (ADB). The Land Development Department (LDD) was designated as the implementing and coordinating body of the project. It was jointly carried out by the LDD and the TOAF between June 2015 and December 2016. This pilot project was implemented successfully as required in the agreement and still carries out the PGS programs in all regions of the country (Pongsrihadulchai, 2020).

From the literature reviews, Azam and Banumathi (2015) stated that educational attainment, age of the farmers and gender have positively influenced the adoption of organic agriculture. Pradhan and Reddy (2017) also found that education, annual income, organic farming experience, use of mass media, institutional approach towards promoting organic farming, and innovation proneness were positively correlated and significant. In contrast, farm size was negatively and significantly correlated with adopting organic agriculture. Prashanth *et al*. (2012) stated that participation in training helps farmers increase their knowledge through formal and informal education and apply the information in their field. A study by Genius *et al*. (2006) mentioned that farmers who sought agricultural information via extension agents had a higher probability of shifting to organic methods than farmers who did not seek such information. Premsuk *et al*. (2022) also found that Farmers' knowledge about organic agriculture significantly influences their decision to adopt PGS, those with higher levels of knowledge are more likely to engage with PGS initiatives.

The specific objectives of this study were to describe the demographic characteristics of farmers, examine their knowledge and opinions on organic agriculture with PGS, assess the production support required, evaluate their production management practices, and determine the factors related to production management in organic agriculture with PGS among farmers in Northeast Thailand.

MATERIALS AND METHODS

The Land Development Department (LDD) has been assigned the primary responsibility for driving the national agenda on organic agriculture since 2005. The total number of registered organic agriculture with PGS farmers in LDD's database (2023) is 3,009 around the country. The study was conducted in the Northeast of Thailand, where most farmers live.

Sampling Procedure

The study population comprised 3,009 farmers in LDD's database. The sampling method utilized in this study was purposive sampling, specifically focusing on the Northeast of Thailand, which has the largest population of farmers, totalling 1,318 individuals from 16 provinces.

To refine the sample, Neuman (1991) suggested a rule of thumb ratio of 30% sample size for small populations (under 1,000). In this study, a simple random sampling method was employed to select 8 provinces, representing 50% of the total 16 provinces available. Subsequently, within each selected province, farmers were randomly chosen using simple random sampling again with a focus on probability proportional to size, which ensured that the number of farmers from each province accurately reflected the population size within that province in relation to the total population of the Northeastern region. Ultimately, a total of 178 farmers were selected as samples with a 95% confidence level by Arkin (1974) (Table 1).

$$n = \frac{p\,(1\text{-}p)}{(SE\,/\,t)^2 + [\,p(1\text{-}p)\,/\,N\,]}$$

where *p* is the proportion of the event expected to occur = 0.98, *t* is the confidence level for the independent variable at 95% = 1.96, *SE* is the margin of error ± 2 = 0.02, *N* is the population size = 3,009, n is the sample size = 178.

Primary data were collected through personal interviews with 178 farmers using the structured interview format as an instrument for data collection, which was validated by three senior colleagues in this field of study. A trial was conducted to assess the reliability of various variables using a sample of 30 farmers with characteristics similar to those of the target population. The knowledge variable was evaluated using the Kuder-Richardson formula 20 (KR-20), yielding a reliability coefficient of 0.783. In contrast, the opinion and production management variables were measured using Cronbach's alpha coefficient (α), with values of 0.986 and 0.810, respectively. The instrument was structured in line with the study objectives and adheres to the PGS operation manual (TOAF, 2017), principles of Organic Farming and Processing (Organic Agriculture Certification Thailand, 2016), and the Thai Agricultural Standard: TAS 9000-2021 (Ministry of Agriculture and Cooperatives, 2021) which are adapted to suit the contexts of smallholder farmers in various regions of Thailand.

For secondary data collection, relevant academic documents, research reports, articles, and journals were reviewed. The study was conducted between November 2023 to October 2024.

Data obtained were analysed using descriptive statistics (average, frequency, and percentage) to describe the farmers' basic demographic characteristics and examine various activities performed by the farmers.

Table 1 Population and sample size categorized by province

Province	Population	Sample size
Surin	197	36
Amnat Charoen	128	24
Yasothon	276	51
Si Sa Ket	90	17
Kalasin	94	17
Khon Kaen	79	14
Buriram	35	6
Roi Et	68	13
Total	967	178

Measurement of Variables

Knowledge

The assessment of knowledge regarding organic agriculture principles and PGS was conducted using 15 closed-ended questions for each area. A correct response was assigned a score of 1, while an incorrect response received a score of 0. Farmers' knowledge was categorized into 3 levels based on scoring criteria. A score of 11 to 15 points indicates a high level of knowledge. A score of 6 to 10 points indicates a moderate level of knowledge. A score of 0 to 5 points indicates a low level of knowledge.

Opinion

The assessment of opinion regarding organic agriculture with PGS was conducted using 20 closed-ended questions. Opinion is defined using the Likert scale method, which consists of five levels ranging from 1 to 5, where 1 = least agree, 2 = slightly agree, 3 = moderate agree, 4 = much agree, and 5 = strongly agree. Farmers' opinions were categorized into 5 levels based on average scoring criteria. The average score of 4.21–5.00 means strongly agree, 3.41–4.20 means much agree, 2.61–3.40 means moderate agree, 1.81–2.60 means slightly agree, and 1.00–1.80 means the least agree.

Production management

The evaluation of farmers' production management was established using a checklist of 32 activities that reflected proper management practices in organic agriculture with PGS, where a score of 1 represented adherence to management practice and a score of 0 indicated non-adherence. The evaluation criteria categorized the production management level into 3 levels corresponding to the farmers' average score. The average score of 21.33–32.00 means high production management, 10.67–21.32 means moderate production management, and 0.00–10.66 means low production management.

Production support required

The open-ended question collected farmers' production support requirements. The frequency of responses for each production support required is determined. The minimum count threshold is based on the production support required mentioned by at least 5% of the respondents.

Hypothesis testing

The relationship among farmers' basic demographic characteristics, their knowledge of organic agriculture principles, their knowledge of PGS, their opinion on organic agriculture with PGS, and their production management practices was analysed using Pearson's correlation coefficient.

RESULTS AND DISCUSSION

Basic Demographic Characteristics

Most farmers are aged between 51 and 60 years, accounting for 47.8%, followed by those over 60 years at 27.4% (Table 2). The average age is 56.8 years, with the oldest being 85 years old and the youngest at 40 years old. This finding agrees with the Kalasin Provincial Statistical Office (2023), which reported the average age of farmers in Kalasin at 57.9 years. The majority of the farmers (68.0%) have completed primary education. Angkasakulkiat *et al*. (2017) reported that the majority of farmers in Si Sa Ket (53.43%) also completed primary education. Azam and Banumathi (2015) also found that the educational attainment and age of the farmers have positively influenced the adoption of organic agriculture in Nalanda, India.

The average experience in organic agriculture among farmers is approximately 9.3 years, with a maximum of 40 years and a minimum of 1 year. A study by Liao *et al*. (2022) examined using the Knowledge, Attitude, and Practice (KAP) model to assess sustainable agriculture in Thailand. Their study found that most farmers (74.0%) had farming experience exceeding 16 years. It is noteworthy that organic agriculture with PGS represents a subset of sustainable agriculture, which indicates that it has drawn attention from a less-experienced group of farmers in the Northeast of Thailand.

The farmers have an average household size of 5 members, with the smallest household consisting of 1 member and the largest having 11 members. An average of 3 family members were employed in their organic agriculture, while 73.0% of farmers employed between 1–2 family members in their farm, with a minimum of 1 member and a maximum of 9 members.

Many farmers, specifically 65.2%, did not hire labor for agricultural activities. Among those who employ labor, the maximum number of hired workers reported was 10. In contrast, the National Statistical Office (2018) indicates that 63.9% of all farmers in the Northeast region of Thailand do hire labor, while 36.1% do not. This difference aligns with the variation in average cultivation area between two groups: organic agriculture with PGS farmers, who cultivate an average of 11.4 rai, and non-sustainable agriculture farmers in the Northeast, whose average cultivation area was 20.85 rai. About 45.5% of farmers attended PGS group meetings every three months (four times a year), with an average attendance of about 6.7 times yearly.

Basic demographic characteristics of farmers in this study, compared to the previous study from the literature reviews, showed that there is a possibility of good adoption of organic agriculture practices, which may lead to a high level of farmers' production management in organic agriculture with PGS.

Knowledge of Organic Agriculture Principles and PGS

The farmers' knowledge level of organic agriculture principles was high, with 87.6% achieving an average score of 12.18 out of 15 points (Table 3). Additionally, it was found that nearly all farmers (99.4%)

Table 2 Frequency and percentage of farmers classified by basic demographic characteristics (n = 178)

Basic demographic characteristics	Frequency	Percentage
Age (year)		
< 41	1	0.6
41–50	43	24.2
51–60	85	47.8
> 60	49	27.4
Min = 40 years, Max = 85 years, $\bar{x}$ = 56.8 years		
Level of education		
No education	3	1.7
Elementary school	121	68.0
Above elementary school	54	30.3
Experience in organic agriculture (year)		
< 3	14	7.9
3–5	47	26.4
6–10	77	43.3
> 10	40	22.4
Min = 1 year, Max = 40 years, $\bar{x}$ = 9.3 years		
Household size (person)		
1–2	32	7.9
3–4	86	26.4
5–6	43	43.3
> 6	17	9.5
Min = 1 person, Max = 11 persons, $\bar{x}$ = 5 persons		

Table 2 Cont.

Basic demographic characteristics	Frequency	Percentage
Self-employment (person)		
1–2	130	73.0
3–4	38	21.4
> 4	10	5.6
Min = 1 person, Max = 9 persons, $\bar{x}$ = 3 persons		
Hired labor (person)		
0	116	65.2
1–2	52	29.2
3–4	8	4.5
> 4	2	1.1
Min = 0 person, Max = 10 persons, $\bar{x}$ = 1 person		
Farm size (rai)		
< 6	48	27.0
6–10	67	37.6
11–15	26	14.6
16–20	20	11.2
> 20	17	9.6
Min = 2 rai, Max = 70 rai, $\bar{x}$ = 11.4 rai		
PGS group meeting attendance (time/year)		
2 (every 6 months)	3	1.7
3 (every 4 months)	4	2.2
4 (every 3 months)	81	45.5
6 (every 2 months)	35	19.7
12 (every month)	55	30.9
Min = 2 times, Max = 12 times, $\bar{x}$ = 6.7 times		

Note: Data collected by field survey in 2024.

Table 3 Frequency and percentage of farmers classified by knowledge in organic agriculture and PGS (n = 178)

Knowledge level	Frequency	Percentage
Organic agriculture principles		
Low level (0–5 points)	0	0
Moderate level (6–10 points)	22	12.4
High level (11–15 points)	156	87.6
Min = 8 points, Max = 14 points, $\bar{x}$ = 12.18 points		
Participatory Guarantee System (PGS)		
Low level (0–5 points)	0	0
Moderate level (6–10 points)	1	0.6
High level (11–15 points)	177	99.4
Min = 10 points, Max = 15 points, $\bar{x}$ = 13.01 points		

Note: Data collected by field survey in 2024.

had a high level of knowledge of PGS, with an average score of 13.01 points, as shown in Table 3. This finding agrees with a study by Liao *et al*. (2022), which showed that most surveyed farmers have good levels of sustainable agriculture knowledge. However, there were still several misconceptions regarding both the organic agriculture principles and PGS. These included misunderstandings about the production of crops using hydroponic systems within the PGS framework, the rotation of roles and responsibilities within PGS groups, and the farm inspection. These factors are crucial for achieving successful production management of organic agriculture with PGS.

Opinion on Organic Agriculture with PGS

The study on farmers' opinions on organic agriculture with PGS revealed that the majority strongly agreed with all statements at an average score of 4.96. However, in one question, which addressed whether organic agriculture makes farming easier, 84.8% of farmers strongly agreed. Still, the sum of farmers who felt least agreed or slightly agreed was 13.5%, with an average score of 4.53, as shown in Table 4. This finding agrees with the study by Thaveethavornsawat and Siriwong (2022), which showed that farmers strongly agreed to accept organic rice farming in Nonghee district, Roi Et province.

Farmers' Production Management in Organic Agriculture with PGS

Table 5 showed the evaluation of the farmers' production management in organic agriculture with PGS focused on three sections as detailed below:

Input

The result shows strong foundational practices, with nearly all farmers receiving organic agriculture knowledge through government agencies, private sectors, and media outlets. While 55.1% relied on personal funds and 44.9% used loans for financing, all adhere to land-use regulations and prioritize organic plant/animal breeds. However, soil analysis remains a critical gap. Most farmers collected samples but depend entirely on the Land Development Department for analysis, undermining self-reliance principles. This may stem from insufficient awareness of soil analysis benefits or high costs. Water sufficiency was achieved by 86% of farmers, though this contrasts sharply with later process-stage water management issues.

Process

All farmers were able to manage surroundings with buffer areas according to organic agriculture principles. 82.6% of farmers enhanced soil organic matter, 92.1% applied organic fertilizers, 96.1% used green manure crops, and all farmers introduced beneficial microorganisms into the soil with biofertilizers, demonstrating robust soil health practices. However, water quality monitoring was alarmingly limited: only 11.8% measured pH levels, 1.1% assessed electrical conductivity, and none employed pathogen-control methods like pond dredging. Additionally, only 9.6% of farmers incorporated microorganisms into their water management practices. The lack of engagement in water quality management practices may be attributed to two causes. Firstly, they may not have experienced significant issues arising from their current water usage, which could lead to a sense of complacency regarding water quality monitoring. Secondly, they may not understand the importance of measuring pH and EC levels, both of which are crucial for nutrient absorption in plants. Poor water quality can adversely affect soil health, nutrient availability, and overall crop productivity. Furthermore, contaminated water sources can facilitate the spread of plant pathogens, increasing the risk of crop diseases that threaten agricultural yields. Similarly, crop protection and pest management was also limited. Only 18.0% of farmers engaged in cultural control to maintain and improve the environmental

Table 4 Frequency and percentage of farmers classified by opinion in organic agriculture with PGS (n = 178)

Opinion in organic agriculture with PGS	Least agree (%)	Slightly agree (%)	Moderate agree (%)	Much agree (%)	Strongly agree (%)	$\bar{x}$ Meaning
1. Organic agriculture can reduce agricultural production costs.	0 (0.0)	0 (0.0)	2 (1.1)	3 (1.7)	173 (97.2)	4.96 Strongly agree
2. Organic production increases income.	0 (0.0)	0 (0.0)	0 (0.0)	4 (2.2)	174 (97.8)	4.98 Strongly agree
3. Organic production enhances diversity in agricultural activities.	0 (0.0)	0 (0.0)	0 (0.0)	5 (2.8)	173 (97.2)	4.97 Strongly agree
4. Organic production creates added value throughout the supply chain.	0 (0.0)	0 (0.0)	0 (0.0)	8 (4.5)	170 (95.5)	4.96 Strongly agree
5. Organic agriculture makes farming easier.	6 (3.4)	18 (10.1)	2 (1.1)	1 (0.6)	151 (84.8)	4.53 Strongly agree
6. Organic agriculture with the PGS system creates a local organic agricultural market.	0 (0.0)	0 (0.0)	4 (2.2)	1 (0.6)	173 (97.2)	4.95 Strongly agree
7. Organic agriculture improves the lives and living conditions of farmers.	0 (0.0)	0 (0.0)	1 (0.6)	1 (0.6)	176 (98.9)	4.98 Strongly agree
8. Organic production leads to the development of agricultural careers.	0 (0.0)	0 (0.0)	1 (0.6)	2 (1.1)	175 (98.3)	4.98 Strongly agree
9. Organic production can serve as a source of learning and agrotourism.	0 (0.0)	0 (0.0)	0 (0.0)	19 (10.7)	159 (89.3)	4.89 Strongly agree
10. Organic production provides farmers with safe food sources and good health.	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.6)	177 (99.4)	4.99 Strongly agree
11. Group-based organic production increases opportunities for mutual assistance.	0 (0.0)	0 (0.0)	0 (1.1)	1 (0.6)	177 (99.4)	4.99 Strongly agree
12. Group-based organic production strengthens farmer networks.	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.6)	177 (99.4)	4.99 Strongly agree

Table 4 Cont.

Opinion in organic agriculture with PGS	Least agree (%)	Slightly agree (%)	Moderate agree (%)	Much agree (%)	Strongly agree (%)	$\bar{x}$ Meaning
13. The development of new-generation farmers ensures the sustainability of organic groups.	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	178 (100)	5.00 Strongly agree
14. Members of the group learn, understand the group's culture, and share responsibility for their work.	0 (0.0)	0 (0.0)	1 (0.6)	1 (0.6)	176 (98.9)	4.98 Strongly agree
15. Sustainable organic groups have successful models to emulate.	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.6)	177 (99.4)	4.98 Strongly agree
16. Organic production promotes biodiversity at the community level.	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.6)	177 (99.4)	4.98 Strongly agree
17. Organic agriculture helps restore soil fertility and water quality.	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	178 (100)	5.00 Strongly agree
18. Organic agriculture is an environmentally friendly farming system.	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	178 (100)	5.00 Strongly agree
19. Natural resources are utilized for maximum benefit, balance, and sustainability.	0 (0.0)	0 (0.0)	1 (0.6)	1 (0.6)	176 (98.9)	4.98 Strongly agree
20. Members prioritize water quality, air quality, and environmental quality.	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.6)	177 (99.4)	4.99 Strongly agree
Overall average) $\bar{x}$ = 4.96 (strongly agree)						

Note: $\bar{x}$ = 1.00–1.80 (least agree), $\bar{x}$ = 1.81–2.60 (slightly agree), $\bar{x}$ = 2.61–3.40 (moderate agree), $\bar{x}$ = 3.41–4.20 (much agree), $\bar{x}$ = 4.21–5.00 (strongly agree)

Data collected by field survey in 2024.

conditions for plants. In terms of using biopesticides for pest management, only 15.7% utilized products like *Trichoderma* and *Bacillus thuringiensis* (BT). Cultural control practices are crucial for organic agriculture. These practices involve managing the environment to make it less conducive to the growth of pests and diseases. Neglecting these measures can lead to the emergence of diseases or pest outbreaks, making it challenging to control and resolve such issues, which directly impact both the quantity and quality of the production. So, farmers' awareness should be raised up. Most farmers practiced soil coverage using rice straw or plant residues to minimize evaporation.

On the organizational front, all farmers adhered to the principles of PGS about participation in group processes, participating in activities such as defining group vision, attending meetings, establishing rules, undergoing training, planning production management, conducting inspections, and sharing knowledge. About the documentation and data record, only 22.5% of farmers completed application forms for participation in the PGS system. While 45.5% maintained records of quantity/quality of produce, inspection plans for fellow farmers' plots, assessment forms for agricultural plots, and summary evaluations. About 32.0% kept records of past documents, renewal plans for certification, and continuous operational strategies for their groups. Lastly, most farmers used an online platform to register for PGS certification.

Output

Most farmers (82.0%) clearly separated and stored their organic produce. However, only a small percentage (30.3%) identified certification symbols or labels for organic production on their packaging. From a marketing view, the result shows effective market integration, with 87.1% enabling consumer inspections and 91% selling through organic networks. However, only 30.3% displayed certification labels, potentially limiting market recognition.

Overall, 93.3% of farmers operated at moderate management levels, with just 6.7% achieving high levels, indicating systemic opportunities for improvement in technical practices and quality assurance protocols.

Table 5 Frequency and percentage of farmers classified by production management in organic agriculture with PGS (n = 178)

Production management in organic agriculture with PGS	Practice (%)	Not practice (%)
Input		
1. Knowledge		
1.1 Knowledge acquisition in organic agriculture and PGS through government agencies, private sector, and educational institutions	178 (100)	0 (0.0)
1.2 Knowledge acquisition in organic agriculture and PGS through media such as television, radio, and the internet	177 (99.4)	1 (0.6)
2. Funding management	178 (100)	0 (0.0)
3. Land usage for organic system	178 (100)	0 (0.0)
4. Soil sampling and analysis		
4.1 Soil sampling	174 (97.8)	4 (2.2)
4.2 Soil analysis	3 (1.7)	175 (98.3)
5. Water supply management	153 (86.0)	25 (14.0)
6. Use of organic plant or animal breeds	178 (100)	0 (0.0)
Process		

Table 5 Cont.

Production management in organic agriculture with PGS	Practice (%)	Not practice (%)
7. Buffer zone management	178 (100)	0 (0.0)
8. Soil management		
8.1 Soil structure: adding organic matter such as fresh rice husks, burned rice husks, or composted rice husks.	147 (82.6)	31 (17.4)
8.2 Soil nutrient: enhancing soil nutrients by applying fertilizers such as manure, compost, or green manure.	164 (92.1)	14 (7.9)
8.3 Soil fertility: increasing soil fertility by sowing green manure seeds like velvet bean or legumes.	171 (96.1)	7 (3.9)
8.4 Use of biofertilizers: increasing the quantity and types of beneficial microorganisms that promote plant growth.	178 (100)	0 (0.0)
9. Water quality management		
9.1 Measurement of pH: assessing the acidity-alkalinity properties of water.	21 (11.8)	157 (98.2)
9.2 Measurement of Electrical Conductivity (EC): evaluating the electrical conductivity of water.	2 (1.1)	176 (98.9)
9.3 Addition of microorganisms to water: adding bio-fermented liquid to ponds.	17 (9.6)	161 (90.4)
9.4 Dredging the bottom of ponds: removing sludge from the bottom to eliminate the waste at the bottom of the pond.	0 (0.0)	178 (100.0)
9.5 Drying the bottom of ponds: exposing the pond bottom to sunlight to kill pathogens.	0 (0.0)	178 (100.0)
10. Reducing soil humidity evaporation: covering the soil with rice straw or plant residues, among other methods.	165 (92.7)	13 (7.3)
11. Crop protection and pest management		
11.1 Cultural control: improvement of the environmental conditions of plants such as pruning, weed removal.	32 (18.0)	146 (82.0)
11.2 Use of biopesticides: preventing, and eliminating plant diseases by biofertilizers, such as *Trichoderma*, *Bacillus subtilis* (BS)	28 (15.7)	150 (84.3)
12. Animal protection and pest management (*)		
12.1 Use of biopesticides: managing animal pests by organic biofertilizers (*)	3 (4.3)	67 (95.7)
12.2 Use of organic animal feed: usage of product from or ganic materials (*)	43 (61.4)	27 (38.6)
13. Participation in group processes	178 (100)	0 (0.0)
14. Documentation and data recording		
14.1 PGS application forms, production plans, plot maps, and plot history.	40 (22.5)	138 (77.5)
14.2 Records of quantity/quality of product, inspection plans, agricultural plot assessment forms, and summary evaluations.	81 (45.5)	97 (54.5)

Table 5 Cont.

Production management in organic agriculture with PGS	Practice (%)	Not practice (%)
14.3 Historical documents, renewal plans for member certification, and continuous operational strategies for the group.	57(32.0)	121 (68.0)
15. Use of online registration for PGS certification	134 (92.7)	44 (7.3)
Output		
16. Harvesting and post-harvest management		
16.1 Separation and storage of organic produce from chemical or buffer zone plant produce.	146 (82.0)	32 (18.0)
16.2 Identification of certification symbols/labels for organic production on packaging.	54 (30.3)	124 (69.7)
17. Marketing		
17.1 Provide opportunities for consumers to participate in visiting/inspecting the production process.	155 (87.1)	23 (12.9)
17.2 Collaboration of selling their organic products in organic network.	162 (91.0)	16 (9.0)

Note: Data collected by field survey in 2024. *Only farmers with livestock.

Hypothesis Testing

Three hypotheses were made as follows (Table 6):

H1: The basic demographic characteristics of the farmers are related to their production management in organic agriculture with PGS.

The result reveals a weak but statistically significant positive correlation between farmers' age and production management quality (r = 0.154; P = 0.040), suggesting older farmers may have marginally better implementation capabilities.

Older farmers often possess extensive local wisdom, knowledge, and experience that can help them manage agricultural production more effectively than younger farmers. Additionally, their strong relationships with extension service officers may further contribute to their success. By providing older farmers with accessible educational initiatives and user-friendly tools—such as simple soil testing kits and practical pest management guides—they can enhance their organic farming skills. This, in turn, enables them to serve as mentors and role models for younger generations of farmers, fostering the widespread and sustainable adoption of organic agricultural practices across all age groups within their communities.

H2: The knowledge of organic agriculture principles and knowledge of PGS of the farmers is related to their production management in organic agriculture with PGS.

The result shows that farmers' knowledge is critical. Understanding of organic agriculture principles correlates moderately with management outcomes (r = 0.427; P = 0.001), while PGS-specific knowledge shows a smaller but still significant positive relationship (r = 0.340; P = 0.001).

The transfer of knowledge about organic agriculture principles and PGS was primarily facilitated by extension officers. Onsite activities might play a crucial role in helping farmers acquire the knowledge and skills needed to confidently adopt and implement organic agriculture practices with PGS. This, in turn, can lead to improved production management. Ongoing support for knowledge sharing via accessible training tools, extension services, and farmer networks should address specific misconceptions to help allay concerns about productivity, reduce overreliance on conventional inputs, and smooth the transition toward organic approaches (Ladinig, 2021).

H3: The opinion on organic agriculture with PGS of the farmers is related to their production management in organic agriculture with PGS.

The result presents a notable contrast - farmers' personal opinions on organic agriculture with PGS showed no statistical correlation with actual management practices, suggesting attitudes toward the certification system don't translate to operational implementation quality.

Interestingly, farmers' opinions, though largely positive, did not exhibit a significant relationship with farmers' production management level. This suggests that while favourable opinion may encourage initial engagement with organic agriculture, practical support such as access to essential resources, appropriate technologies, and robust extension services plays a more decisive role in shaping effective farmers' production management. For instance, previous research has indicated that stronger institutional support, resource networks, and participatory decision-making processes can help farmers overcome technical barriers and bolster collective motivation (Luttikholt, 2007).

Production Support Required by Farmers

Out of 178 farmers, 58 respondents provided data about the production support required, which makes the minimum count threshold at 3. Data are presented in order of frequency.

Table 6 Factors related to farmers' production management (n = 178)

Factors related to farmers' production management	r_{xy}	P-value
Age	0.154	0.040
Level of education	0.097	0.266
Experience in organic farming	0.123	0.102
Household size	-0.097	0.196
Self-employment	0.049	0.512
Hired labor	-0.137	0.068
Farm size	0.095	0.208
Group meeting attendance frequency	0.066	0.379
Knowledge of organic agriculture principles	0.427	0.001
Knowledge of PGS	0.340	0.001

Note: r_{xy} is Pearson product moment correlation coefficient.

Water management emerges as the top concern, with 21 farmers emphasizing the need for adequate water resources. Soil quality improvement follows closely, as mentioned by 18 farmers, highlighting the fundamental importance of these two factors in organic farming. Production input support, including organic fertilizers and green manure, is the third most cited need (17 responses), closely followed by the timely provision of seeds (10 responses). Quality management and certification processes are also significant concerns (9 responses), indicating a desire for maintaining high standards and market credibility.

Economic aspects feature prominently, with farmers calling for differentiated pricing for organic products and clear separation from conventional produce in the marketplace (8 responses). There's also a notable interest in innovation, with 7 farmers requesting support for new organic farming techniques.

Less frequently mentioned but still significant are the development of water sources like groundwater (4 responses), increased government funding for organic agriculture (3 responses), simplification of certification processes (3 responses), and support for diversifying into areas like product processing (3 responses). These findings underscore the multifaceted nature of organic farming challenges, spanning resource management, economic considerations, and regulatory processes, all of which require targeted support to ensure the sector's sustainable growth.

While most participants displayed high levels of knowledge and opinion toward organic agriculture with PGS, certain misconceptions persisted, particularly around certification nuances and core PGS practices. These insights echo research indicating that continuous education, peer learning, and farmer-to-farmer knowledge exchange can directly boost the adoption and retention of organic farming methods (Kirchner, 2014). Additionally, studies have shown that PGS enhances trust, transparency, and community cohesion, thereby facilitating collaborative approaches to addressing challenges such as water resource shortages, soil quality constraints, and certification complexities. In line with other studies highlighting the importance of low-cost, community-driven certification systems, PGS was seen to not only reduce logistical barriers but also strengthen social ties and trust among stakeholders (Home *et al*., 2017). Ultimately, policy interventions that grant premium pricing for organic produce simplify administrative procedures and ensure adequate funding and infrastructural development will encourage new adopters and reinforce long-term commitment to PGS-based agriculture (Luttikholt, 2007).

CONCLUSIONS

The findings from this study underscore how farmers' age, knowledge of organic agriculture principles, and knowledge of PGS together play a pivotal role in shaping effective farmers' production management. Through robust local networks and continuous training sessions tailored to the PGS framework, integrated with dynamic training programs that enhance farmers' technical capacities, confidence, and problem-solving skills, farmers can adapt more effectively to organic standards while maintaining profitability and ensuring ecological sustainability. Sustained collaboration among farmers, extension workers, local institutions, and policymakers is therefore essential to provide comprehensive support systems, from water resource management to equitable market opportunities.

Moving forward, ongoing support for knowledge sharing, extension services, and farmer networks would strengthen the PGS communities and smooth the transition toward organic approaches. Together with the attention from policy makers focusing on premium pricing for organic produce, simplify administrative procedures, ensuring adequate funding, and infrastructure will encourage new adopters and reinforce long-term commitment to PGS-based agriculture. By addressing these knowledge and resource gaps, stakeholders can enhance both the sustainability and scalability of organic agriculture in Thailand, paving the way for broader policy uptake and socioeconomic gains in the region.

Future research might focus on longitudinal comparative studies to track how demographic shifts, evolving policies, and technological innovations impact PGS success over time, ultimately offering comprehensive guidance for farmers, policymakers, and broader agricultural communities striving to build more resilient agro-ecosystems.

INFORMED CONSENT STATEMENT

All participants provided written informed consent before enrolment in the study. This study was reviewed and approved by LDD (Land Development Department). All procedures performed involving human participants were in accordance with LDD standards.

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CONFLICT OF INTEREST

All authors declare that they have no conflicts of interest.

REFERENCES

Amthed, A. and D.P. Thunmathiwat. 2021. Participatory guarantee system for organic agriculture, way to sustainable agricultural society. King Mongkut's Agr. J. 39(3): 248–256.

Angkasakulkiat, S., S. Anusontpornperm, S. Thanachit and T. Sriwongchai. 2017. Relationship between gender, age and education factors, and the operation of the Community Rice Seed Extension and Production Center in Si Sa Ket province. Khon Kaen Agr. J. 45(2): 341–350.

Arkin, H. 1974. Handbook of Sampling for Auditing and Accounting. Mc Graw Hill, Inc., New York, USA.

Azam, M.S. and M. Banumathi. 2015. The role of demographic factors in adopting organic farming: A logistic model approach. Int. J. Adv. Res. 3(8): 713–720.

FiBL Statistics. 2020. Data on Organic Area Worldwide. Available Source: https://www.fibl.org/fileadmin/documents/shop/5011-organic-world-2020.pdf. May 15, 2024.

Genius, M., C.J. Pantzios and V. Tzouvelekas. 2006. Information acquisition and adoption of organic farming practices. J. Agric. Resour. Econ. 31(1): 93–113.

Home, R., H. Bouagnimbeck, R. Ugas, M. Arbenz and M. Stolze. 2017. Participatory guarantee systems: Organic certification to empower farmers and strengthen communities. Agroecol. Sustain. Food Syst. 41(5): 526–545. https://doi.org/10.1080/21683565.2017.1279702.

IFOAM. 2008. Participatory Guarantee Systems (PGS). Available Source: https://www.ifoam.bio/our-work/how/standards-certification/participatory-guarantee-systems. May 15, 2024.

Kalasin Provincial Statistical Office. 2023. Further Analysis Report (Provincial Level) of the 2023 Agricultural Census Project, Kalasin Province. Available Source: https://kalasin.nso.go.th/images/E-book/ag_census_66_thematics_report.pdf. June 10, 2024.

Kirchner, C. 2014. Sharing knowledge in participatory guarantee systems (PGS). How PGS can intensify knowledge exchange between farmers. IFOAM Organic World Congress. Available Source: https://orgprints.org/id/eprint/23255/7/23255.pdf. May 20, 2024.

Ladinig, M. 2021. Organic farm knowledge - exchange knowledge, enhance organic farming. Available Source: https://www.foodsystemchange.org/learn/projects/detail/organic-farm-knowledge-exchange-knowledge-enhance-organic-farming. July 12, 2024.

Liao, X., T.P.L Nguyen and N. Sasaki. 2022. Use of the knowledge, attitude, and practice (KAP) model to examine sustainable agriculture in Thailand. Reg. Sustain. 3(1): 41–52. https://doi.org/10.1016/j.regsus.2022.03.005.

Luttikholt, L.W.M. 2007. Principles of organic agriculture as formulated by the international federation of organic agriculture movements. NJAS Wageningen J. Life Sci. 54(4): 347–360. https://doi.org/10.1016/S1573-5214(07)80008-X.

Ministry of Agriculture and Cooperatives. 2021. Thai Agricultural Standard: TAS 9000-2021. Available Source: https://acfs-backend.acfs.go.th/storage/ProductStandards/Files/20240529155100_828699.pdf. May 15, 2024.

National Organic Agriculture Committee. 2022. Organic Agriculture Action Plan 2023–2027. Available Source: https://www.mhesi.go.th/index.php/all-media/book/8857-2566-2570.html. June 10, 2024.

National Statistical Office. 2018. The 2018 Agriculture Intercensal Survey Northeastern Region. Available Source: https://www.nso.go.th/nsoweb/storage/survey_detail/2023/20230430172410_56538.pdf. July 4, 2024.

Neuman, W.L. 1991. Social Research Methods: Qualitative and Quantitative Approaches. Allyn and Bacon, Massachusetts, USA.

Office of the Royal Development Projects Board. 2008. Testing and Development of Organic Agriculture. Available Source: https://bit.ly/4dM0cfp. May 15, 2024.

Organic Agriculture Certification Thailand. 2016. ACT Organic Standards. Available Source: https://www.ldd.go.th/Web_PGS/data/standart/03_standart.pdf. June 10, 2024.

Pongsrihadulchai, A. 2020. PGS: Roadmap to promote organic agriculture for smallholders in Thailand Available Source: https://ap.fftc.org.tw/article/1869. July 4, 2024.

Pradhan, M., B. Tripura, T.K. Mondal, R.R. Darnnel and J. Murasing. 2017. Factors influencing the adoption of organic farming by the farmers of North district of Sikkim. Int. J. Adv. Sci. Res. Dev. 4(2): 1–7.

Prashanth, P. and M.M. Reddy. 2012. Factors influencing the adoption of organic farming by the farmers of Karimnagar district of Andhra Pradesh. Int. J. Farm Sci. 2(2): 123–128.

Premsuk, C., P. Thongdeerert and P. Sriboonruang. 2022. Adoption of the Participatory Guarantee System (PGS) Phra Nakhon Si Ayutthaya of organic farmers. Journal for Developing the Social and Community. 9(2): 109–122.

Sirisuwan, S. 2017. Organic agriculture: An alternative and a survival strategy for Thai farmers. Available Source: https://siamrath.co.th/n/12607. July 12, 2024.

Thaveethavornsawat, S. and O. Siriwong. 2022. Farmers' views on acceptance of organic farming in Nong Hi district, Roi Et. Journal of Humanities and Social Sciences Bansomdejchaopraya Rajabhat University. 16(1): 69–85. https://doi.nrct.go.th/admin/doc/doc_610018.pdf.