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Management of GI-certified agricultural products and their contribution to household income in rural thailand

Daroonwan Kamthonkiat

Department of Geography, Thammasat University, Klong Luang, Pathumthani, 12121, Thailand.

✉ daroonwan.k@arts.tu.ac.th

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ABSTRACT

This research looks at how Geographical Indication (GI)-certified agricultural products are managed in Thailand. It focuses on the sales and production cycles, the income they bring in, and the main problems they face. Using a mixed-methods approach, surveys and interviews were conducted with representatives of 77 GI-certified products categorized into rice (10), foods (15), and plant fruits and vegetables (52). Four management patterns emerged: one production and one selling season (25 products), one production with multiple selling seasons (15), two production and selling cycles (19), and multiple cycles (18). Contributions to household income were classified into four levels: Low (19), Medium (18), High (13), and Maximum (27). A Chi-Square test revealed no significant association between management patterns and income levels. Producers identified critical barriers, including limited market access and climate variability, which affected product quantity and quality. Many expressed low confidence in product reputation, citing the inability to secure price premiums over non-GI products. The study underscores the need for targeted policies to address market access, climate resilience, and product reputation. These findings provide valuable insights for GI authorities, policymakers, and stakeholders to sustain GI management, enhance rural incomes, and align with Sustainable Development Goals. The results are broadly applicable to other developing countries reliant on agricultural GIs.

Contribution/Originality: This study explores the management practices and income contributions of GI-certified agricultural products among rural producers with over five years of experience. It identifies barriers to sustaining GI production and highlights opportunities to boost household incomes through certification. Aligned with the Sustainable Development Goals, the findings offer insights for refining policies and strategies in Thailand and other developing countries, especially in the ASEAN region.

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1. INTRODUCTION

Geographic Indications (GIs) became more well-known internationally in the twentieth century. In 1995, the World Trade Organization (WTO) Trade-Related Aspects of Intellectual Property Rights (TRIPS) agreement included GIs (Article 22), which was a significant milestone.

The TRIPS Agreement requires member nations to recognize and protect GIs as part of the larger framework of intellectual property rights. GIs are especially important for agricultural products since their characteristics—whether soil quality, climate conditions, or traditional farming methods—are frequently inextricably linked to the location where they are produced. GIs depend on this link between the product and its origin, which indicates that the product has unique qualities that cannot be replicated again. GIs are currently incorporated into many countries' intellectual property regimes, particularly in agricultural and food-related industries in the European Union (EU), and are spreading globally (Moschini, Menapace, & Pick, 2008; World Intellectual Property Organization (WIPO), 2021).

Several researchers used literature reviews, systematic reviews, meta-analyses, and statistical models to examine the effects of GIs on rural and economic development (Cei, Defrancesco, & Stefani, 2018; De Filippis, Giua, Salvatici, & Vaquero-Piñeiro, 2022; Li, Ban, Ge, Qi, & Fan, 2024; Török, Jantyik, Maró, & Moir, 2020; Yin et al., 2024) The relationship between GI products and incomes was first investigated in the European Union (EU) for wine, cheese, and olives (Crescenzi, De Filippis, Giua, & Vaquero-Piñeiro, 2022; Poetschki, Peerlings, & Dries, 2021) and then expanded to other regions and certified crops such as fruit crops, rice, coffee, beans, and so on (Dogan, 2024; Ingole, Kumar, Jadhav, & Kulkarni, 2023; Petruang & Napasintuwong, 2022). Many articles have found that GIs have a favorable impact on the environment and consequently on sustainable development (Cardoso, Lourenzani, Caldas, Bernardo, & Bernardo, 2022; Eliasson, 2022; Ingole et al., 2023; Li et al., 2024; Sgroi, 2021; Ty & Devaraja, 2024). Although the issues that farmers and local communities confront in managing GIs, as well as the complexity of marketing products in local and global markets, have been investigated, research in developing nations has been limited. GI registration in ASEAN countries has increased dramatically over the last decade, and it is becoming increasingly significant in the context of international trade and local sustainability, particularly in Thailand, which has built its own GI systems (World Intellectual Property Organization (WIPO), 2023). As with research in other parts of the world, many studies on GIs in ASEAN focus on legislation, marketing, or consumer attitudes, with few emphasizing the real-world issues faced by producers (Bramley & Bienabe, 2012; Datta, Manchikanti, & Bhattacharya, 2024; Delphine, 2020; European Union Intellectual Property Office (EUIPO), 2019; Ha, 2017; Hanh, Anh, Van Tuan, & Hai, 2021; Ngokkuen & Grote, 2013; Tianprasit, 2016).

Examining producers' perspectives and management practices is vital for understanding the challenges and benefits of GI-certified products. This study investigates the management practices and income contributions of GI-certified agricultural products among rural producers with at least five years of experience, including the pre-COVID-19 period. Focusing on raw and processed agricultural commodities marketed for human or animal consumption (Food and Agriculture Organization (FAO) & World Health Organization (WHO), 2001) the research identifies barriers to sustaining GI production and explores opportunities to enhance household incomes through certification. The study supports the Sustainable Development Goals (SDGs) by promoting economic growth and agricultural sustainability (SDG 1: No Poverty, SDG 2: Zero Hunger), sustainable agriculture (SDG 12: Responsible Consumption and Production), and economic empowerment (SDG 8: Decent Work and Economic Growth) (United Nations, n.d). The findings offer actionable insights for refining policies, trade strategies, and agricultural development initiatives in Thailand while providing broader relevance for other developing countries, particularly in the ASEAN region, facing similar agricultural challenges.

2. MATERIALS AND METHODS

2.1. GI-Certified Product Selection

This study refers simply to GI-certified products, also known as GI-tagged or GI-labeled products. Thailand's GI scheme supports through registration, control system, marketing, and promotion and was initiated by the Department of Intellectual Property (DIP) under the Ministry of Commerce in 2004. Eligible categories include agricultural and industrial products, as well as handicrafts (Department of Intellectual Property (DIP), 2019). As of July 2024, 206 products across Thailand's 77 provinces were registered, classified into six categories: rice (23 products), foods (41 products), plant fruits and vegetables (PFV, 103 products), silks and cottons (16 products), handicrafts (21 products), and wine and spirits (2 products) (Department of Intellectual Property (DIP), 2024). Agricultural products—comprising rice, foods, and PFV—are the most economically impactful. This study identified 92 agricultural GI products registered before 2018, using records from the Department of Intellectual Property (DIP). Ethical approval was obtained from the Human Research Ethics Committee of the institute (Reference ID: 091/2564). Contact information for certified producers was collected from provincial commerce and agriculture offices. A purposive sampling method, in consultation with local experts, was used to select producers with significant experience in managing GI products. Selection criteria included involvement in GI production during normal conditions (pre-COVID-19), throughout the pandemic (2020–2022), and during periods of climate variability. One certified producer per GI product was targeted, aiming to cover at least 50% of the registered products across all Thai regions. Data collection focused on annual production and sales cycles, as well as the contribution of GI products to household income, with updates reflecting conditions as of 2023.

2.2. Data Collection

This study employed a mixed-methods approach, integrating quantitative surveys with qualitative interviews and field observations to provide a comprehensive understanding of the management of GI-certified agricultural products. Data were collected from rural producers who had been involved with GI certification for at least five years, including the period before the COVID-19 pandemic. Ethical approval for the study was obtained from the institutional ethics committee in 2021. Due to restrictions during the COVID-19 pandemic, data collection was adapted to include online

and phone interviews. Field surveys were conducted at production sites when travel restrictions were lifted, with data collection spanning from 2021 to 2023. Semi-structured, in-depth interviews were used to capture personal experiences, challenges, and benefits associated with GI certification.

Quantitative data included measurable household income levels and production and sales cycles (P-S), while qualitative data provided insights into producers' perspectives. The provincial administrative boundaries of Thailand (scale 1:50,000) from the Ministry of Interior were utilized to map production sites and the number of production and sales cycles (Px-Sx). These geospatial data supported the visualization of production patterns and their regional distribution.

2.3. Data Analysis

Descriptive statistics were applied to summarize household income derived from GI-certified products and the number of production and sales cycles. The income levels earned by producers from their GI products were categorized into four groups:

- Low level: Households where 25% or less of their total income is derived from GI-certified products.
- Medium level: Households where 26% to 50% of their total income is derived from GI-certified products.
- High level: Households where 51% to 75% of their total income is derived from GI-certified products.
- Maximum level: Households where 76% to 100% of their total income is derived from GI-certified products.

This classification provides insights into the distribution of income derived from GI products across the three product groups: Rice, Foods, and Plant Fruits and Vegetables (PFV). A Chi-Square test for independence (nonparametric test) was used to examine the statistical association between income levels and product groups:

- *Null hypothesis (H_0): There is no significant association between income levels and product groups.*
- *Alternative hypothesis (H_1): There is a significant association between income levels and product groups.*

For GI management, the number of production and sales cycles per year (Px-Sx), as reported by producers and observed during field visits, was categorized. A Chi-Square test for independence was also applied to determine whether the distribution of income groups differed significantly across GI management practices:

- *Null hypothesis (H_0): There is no significant association between income levels and GI management (Px-Sx).*
- *Alternative hypothesis (H_1): There is a significant association between income levels and GI management (Px-Sx).*

The goal of these statistical studies is to find out if there are big differences in how income is distributed between product groups and GI management practices. If there are, that would tell us a lot about how GI certification affects the economy and how long it lasts.

To ascertain the relationship between two variables, apply the Chi-Square test of independence using the following steps and equations (Turney, 2023):

Step 1: Create a Contingency Table and Calculate Expected Frequencies

A contingency table is constructed to display the observed frequencies of the two variables. The expected frequencies (E) are calculated using the following formula:

$$E = \frac{(row\ total) \times (colume\ total)}{grand\ total} \quad (1)$$

Step 2: Calculate the Chi-Square Statistic

The Chi-Square statistic (X^2) is computed using Pearson's Chi-Square formula:

$$X^2 = \Sigma \frac{(O-E)^2}{E} \quad (2)$$

Where:

- X^2: Chi-Square test statistic.
- Σ: Summation operator (indicating "sum of").
- O: Observed frequency.
- E: Expected frequency.

Step 3: Calculate the Critical Value (CV).

To calculate the Critical Value (CV), two parameters are required:

- Degree of freedom (*df*):
  df = (number of variable 1 group - 1) x (number of variable 2 groups - 1)
- Significance level (**α**): Typically set at 0.05.

Step 4: Compare the Chi-Square Statistic to the Critical Value (CV) and Make a Decision.

- If the Chi-Square value (X^2) is greater than the CV, mean the difference between the observed and expected distributions is statistically significant, and the null hypothesis (H_0) is rejected, indicating a relationship between the variables.
- If X^2 is less than the CV, the difference is not statistically significant, and the null hypothesis is not rejected.

In addition, the p-value is calculated to assess probability of the observed data occurring under the null hypothesis.

- If $p < \alpha$, reject the null hypothesis.
- If $p > \alpha$, fail to reject the null hypothesis.

The Chi-Square test results are reported in the following format:

X^2 (degrees of freedom, N = sample size) = chi-square value, $p = p$-value).

Only issues brought up by at least 30% of the producers will be shown in order to find out what they think about the reputation and public awareness of their GI products, as well as the problems and issues that come with the

development of agricultural GI products. The levels of barriers or problems are classified into four categories: None (no barriers identified), low (minimal impact), medium (moderate impact), and high (significant impact).

This research method made sure that both numerical trends and subjective experiences were carefully looked at. This gave us a deeper understanding of the pros, cons, opportunities, and results of GI certification for Thai rural producers.

3. RESULTS

Based on the interviews and field visits to GI production sites, the results are presented in three parts:

- GI Management: This section focuses on the number of production and sales cycles for each product group, distributed across various regions of Thailand.
- Contribution to Household Income: The analysis examines the contribution of GI products to household income and assesses the statistical association between income levels and product groups, as well as GI management practices, using the Chi-Square test of independence.
- Producers' Perspectives: A summary of producers' views on the public awareness of their GI products, along with the barriers and challenges they face in developing their GI-certified agricultural products, is provided.

3.1. GI Management

This study assessed GI management by examining the average number of production and sales cycles (Px-Sx) per year, as reported by producers and observed in the field.

A total of 77 agricultural GI-certified products/producers were analyzed, representing approximately 83% of the 92 products registered and protected prior to the COVID-19 pandemic.

The production sites were distributed across all regions of Thailand as follows: 23 products originated in the Central (C) region, 13 in the North (N), 12 in the Northeast (NE), 7 in the East (E), 15 in the South (S), and 7 in the West (W).

Figure 1 categorizes the observed products into three groups—Rice, Foods, and Plant Fruits and Vegetables (PFV)—with their distribution by region detailed below:

- Rice Products (10)
  - Regional distribution: 5 in NE, 2 in N, 2 in S, and 1 in C.
  - Notable examples include *Thung Kula Rong-Hai Thai Hom Mali Rice* (a soft, fragrant jasmine rice grown in Northeastern Thailand) and *Sangyod Muang Phatthalung Rice* (a soft, aromatic brown rice from Phatthalung Province, Southern Thailand). Both products are protected or registered in the European Union (EU) and multiple Asian countries.
- Food Products (15)
  - Regional distribution: 3 in C, 3 in N, 3 in NE, 3 in S, and 3 in W.
  - Notable examples include *Doi Tung Coffee* (grown at 800–1,200 meters above sea level in Chiang Rai Province under the Doi Tung Development Project) and *Doi Chang Coffee* (grown at 1,000–1,200 meters above sea level in Doi Chang village, Chiang Rai Province). Both coffees are protected or registered in the EU and several Asian countries.
- Plant Fruits and Vegetables (PFV) Products (52)
  - Regional distribution: 19 in C, 7 in E, 8 in N, 4 in NE, 10 in S, and 4 in W.
  - Some fruit types were registered multiple times, including 9 durians, 9 pineapples, 7 pomelos, 4 bananas, 4 coconuts, 4 lychees, and 2 mangoes. *Durian Prachin*, *Phetchabun Sweet Tamarind*, *Ratchaburi Aromatic Coconut*, *Pakpanang Tubtimsiam Pomelo*, *Huaymon Pineapple*, and *Nam Dok Mai Sakeao Mango* are some of the GI-labeled PFV products that have been protected or applied for in the EU and Asian countries.

Based on production and sales cycles, this study further categorized GI management patterns into four types:

- P1-S1 (One production/crop per year, one selling period/season): This category includes 25 products, such as 9 durians, 4 lychees, and other fruits like rambutan, longan, orange, and tamarind.
- P2-S2 (Two productions/crops per year, two selling periods/seasons): This category includes 19 products, such as 9 pineapples, 7 pomelos, 2 mangoes, and rose apples.
- P1-SM (One production/crop per year, multiple selling periods/seasons): This category includes 15 products, including 10 rainfed rice products and 2 coffee products.
- PM-SM (Multiple productions/crops per year, multiple selling periods/seasons): This category includes 18 products, such as 4 bananas, 4 coconuts, and various foods.

The interviewed producers were categorized into three age groups: 13 were of middle working age (30–44 years), 39 were of late working age (45–59 years), and 25 were seniors (60 years and older). In terms of educational attainment, approximately 61% of the producers had education levels below a bachelor's degree, 34% held a bachelor's degree, and the remaining producers had education levels higher than a bachelor's degree.

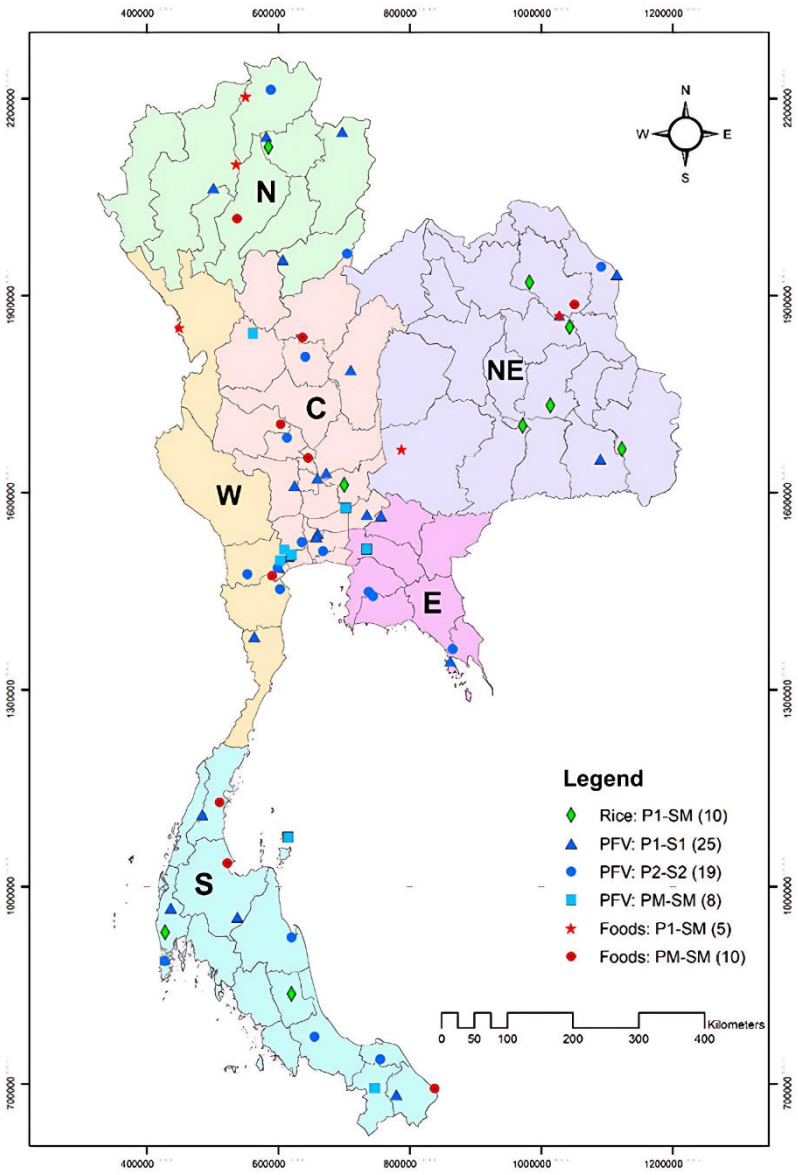

Figure 1. Agricultural GI products and GI management in Thailand.

3.2. The Contribution of GI Products to Household Income

The contribution of GI products to household income, or GI dependency, is detailed in Table 1 and summarized as follows:

- Low Level (19 products)

Producers in this group exhibit a low dependency on GI products, with income supplemented by various sources. Eleven producers earned their living from high-demand fruits, vegetables, rubber, oil palm, and other agricultural products. Four producers operated businesses outside the agricultural sector, such as construction or car care. A few were full-time employees with additional income from various agricultural and non-agricultural sources. This group comprised 5 middle-working-age producers (30–44 years), 5 late-working-age producers (45–59 years), and 9 seniors (60 years and older).

- Medium Level (18 products)

About 66% of producers in this group (12 out of 18) earned half of their annual household income from other crops. Three producers relied on pensions from government organizations, while the remaining producers were employed outside the agricultural sector. This group included 2 middle-working-age producers, 11 late-working-age producers, and 5 seniors.

- High Level (13 products)

Producers in this group displayed high dependency on GI products, with most earning approximately a quarter of their annual household income from other crops. Four producers supplemented their income through non-agricultural activities. This group included 1 middle-working-age producer, 9 late-working-age producers, and 3 seniors.

- Maximum Level (27 products)

Producers in this group demonstrated the highest level of GI dependency. However, 20 producers experienced market uncertainties and received prices similar to non-GI-tagged products. Seven producers (involving 2 pomelos, coffee, durian, pineapple, tea, and beef) reported satisfaction with existing market channels and achieved advantageous market prices. This group comprised 5 middle-working-age producers, 14 late-working-age producers, and 8 seniors.

Table 1. Levels of household income contribution by GI products and other sources.

Other sources of income	Level of household income contributed by GI products				Total
	Low	Medium	High	Maximum	
None	0	0	0	27	27
Full-time	3	1	1	0	5
Pension	1	3	0	0	4
Other crops	11	12	9	0	32
Non-agri. business	4	2	3	0	9
Sum	19	18	13	27	77

In a study that looked at household income levels and how they related to GI product groups, it was found that most PFV and Foods products helped 25 households earn the most money. In contrast, most Rice products contributed to household incomes at low to medium levels. The contribution levels were associated with product groups and the production (P) and sales (S) cycles per year, as illustrated in Figure 2 and summarized below:

- Low Dependency (19 products)
  - Rice: 4 P1-SM products.
  - PFV: 11 products, comprising 7 P1-S1, 3 P2-S2, and 1 PM-SM.
  - Foods: 4 products, comprising 1 P1-SM and 3 PM-SM.
- Medium Dependency (18 products)
  - Rice: 3 P1-SM products.
  - PFV: 13 products, comprising 7 P1-S1, 4 P2-S2, and 2 PM-SM.
  - Foods: 2 products, comprising 1 P1-SM and 1 PM-SM.
- High Dependency (13 products)
  - Rice: 1 P1-SM product.
  - PFV: 10 products, comprising 7 P1-S1, 1 P2-S2, and 2 PM-SM.
  - Foods: 2 products, comprising 1 P1-SM and 1 PM-SM.
- Maximum Dependency (27 products)
  - Rice: 2 P1-SM products.
  - PFV: 18 products, comprising 4 P1-S1, 11 P2-S2, and 3 PM-SM.
  - Foods: 7 products, comprising 2 P1-SM and 5 PM-SM.

Among P1-S1 products, an equal number of 7 PFV products contributed to household income at low, medium, and high levels, while 4 PFV products contributed at the maximum level. Notably, most durians contributed to household incomes at high to maximum levels.

The P1-SM pattern refers to rainfed rice grown once a year. The harvested yields from this pattern were processed and packaged for prolonged sales throughout the year. Dependency on rice products within this pattern was primarily at Low to Medium levels. Five food products in the P1-SM category consisted mainly of coffee and beverage items. The P2-S2 pattern was exclusively observed among PFV products. Most of the pineapples in this group contributed to household income at a medium level. Two pomelo products contributed at a low level, while the remaining pomelo products contributed at the maximum level. The PM-SM pattern included various products, primarily foods such as processed meat, desserts, dried bananas, salted fish, and similar items. This pattern also included some PFV products, such as coconuts, bananas, and vegetables. Most of these products contributed to household incomes at maximum and low levels.

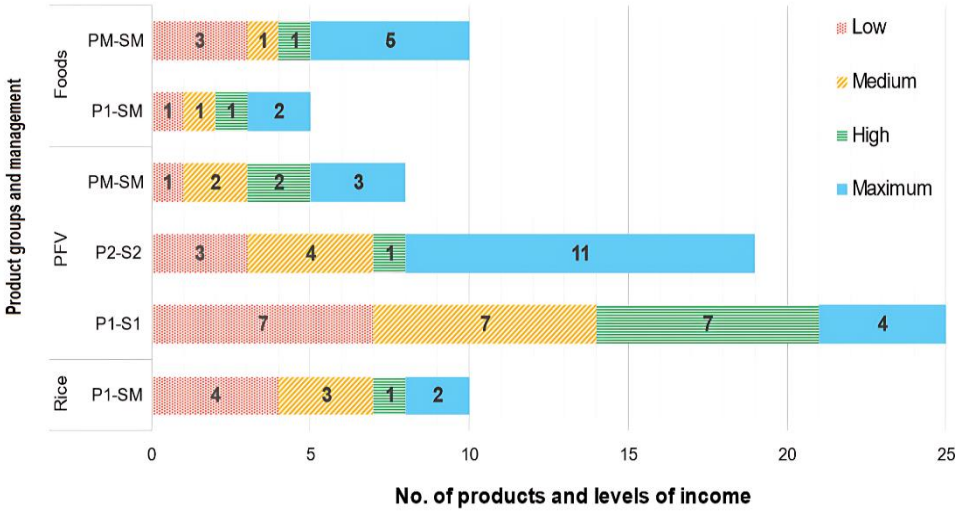

Figure 2. Levels of household income contributed by GI products linked with the product groups and management.

The statistical tests revealed the following findings:

- Association between Household Income Levels and Product Groups.

The Chi-Square test for independence shows that there is no significant link between the product groups and the amount of household income that GI-certified products contributed.

- Test Statistics: $X^2(6, N = 77) = 3.92, p = 0.69$
- Interpretation: The observed variations in income levels across rice, PFV, and foods are not statistically significant. This conclusion is that product group differences do not substantially influence the income dependency levels of households.

- Association between Household Income Levels and Management.

Another Chi-Square test was conducted to examine the relationship between income levels and production/sales cycle management (P-S patterns).

- Test Statistics: X^2 $(9, N = 77) = 11.54, p = 0.24$
- Interpretation: The income levels are not significantly associated with the management patterns. This implies that differences in production and sales cycles do not have a pronounced impact on the level of income derived from GI-certified products.

The results show that the amount of household income these products bring in is not greatly affected by the type of GI-certified product or the management. This outcome highlights the need for further investigation into other potential factors that might influence the economic impact of GI products.

3.3. Summary of Producers' Perspectives

This section provides insights derived from producers regarding the public's awareness of their GI products' reputation and barriers in managing GI certification. The producers expressed diverse views on how customers perceive the reputation and quality of their GI-certified products:

- Weak Confidence (58%).
- A majority of producers (45 producers/products/households) reported weak confidence in their GI product's reputation.
- Customers were not aware of the quality of GI certification and the factors that set it apart from non-GI products.
- Producers emphasized that public understanding of the added value of GI-certified products remains limited.

- Strong Confidence (42%).
  - A smaller group (32 producers/products) reported strong confidence in their product's reputation.
  - This group observed that customers recognized and appreciated higher-quality GI products, enabling them to achieve premium prices.
  - These producers attributed their success to targeted marketing efforts and favourable local or international markets.

These findings suggest that the effectiveness of GIs is influenced by both the intrinsic characteristics of the product and the specific local context in which it is produced.

Based on Table 2, households that relied heavily or exclusively on GI products for their livelihoods exhibited nearly equal levels of strong and weak confidence in their products' reputations. In contrast, households with low to medium dependence on GI products showed a significant disparity, with weak confidence outweighing strong confidence. Rice products, in particular, were consistently associated with weak confidence regarding their reputation, regardless of the level of household dependence on GI products. For households with low to medium reliance on PFV products, weak confidence was also more prevalent than strong confidence. Also, households with a high level of dependency were more likely to rate GI foods with weak confidence than with strong confidence. At other levels of dependency, ratings of weak and strong confidence were about the same.

Table 2. Confidence of GI product reputation classified by product groups and level of GI dependency.

Level of GI dependency	Product group	Confidence of product reputation		
		Strong	Weak	Grand total
Low	Rice	1	3	4
	PFV	4	7	11
	Foods	2	2	4
Low total	-	7	12	19
Medium	Rice	0	3	3
	PFV	4	9	13
	Foods	1	1	2
Medium total	-	5	13	18
High	Rice	0	1	1
	PFV	7	3	10
	Foods	0	2	2
High total	-	7	6	13
Maximum	Rice	0	2	2
	PFV	9	9	18
	Foods	4	3	7
Maximum total	-	13	14	27
Grand total	-	32	45	77

Among the 25% of households with low reliance on GI products, over 60% expressed weak confidence in their products' reputations. Of these, approximately half of the weak confidence ratings were associated with PFV products, a quarter with rice products, and 17% with food products, as illustrated in Figure 3.

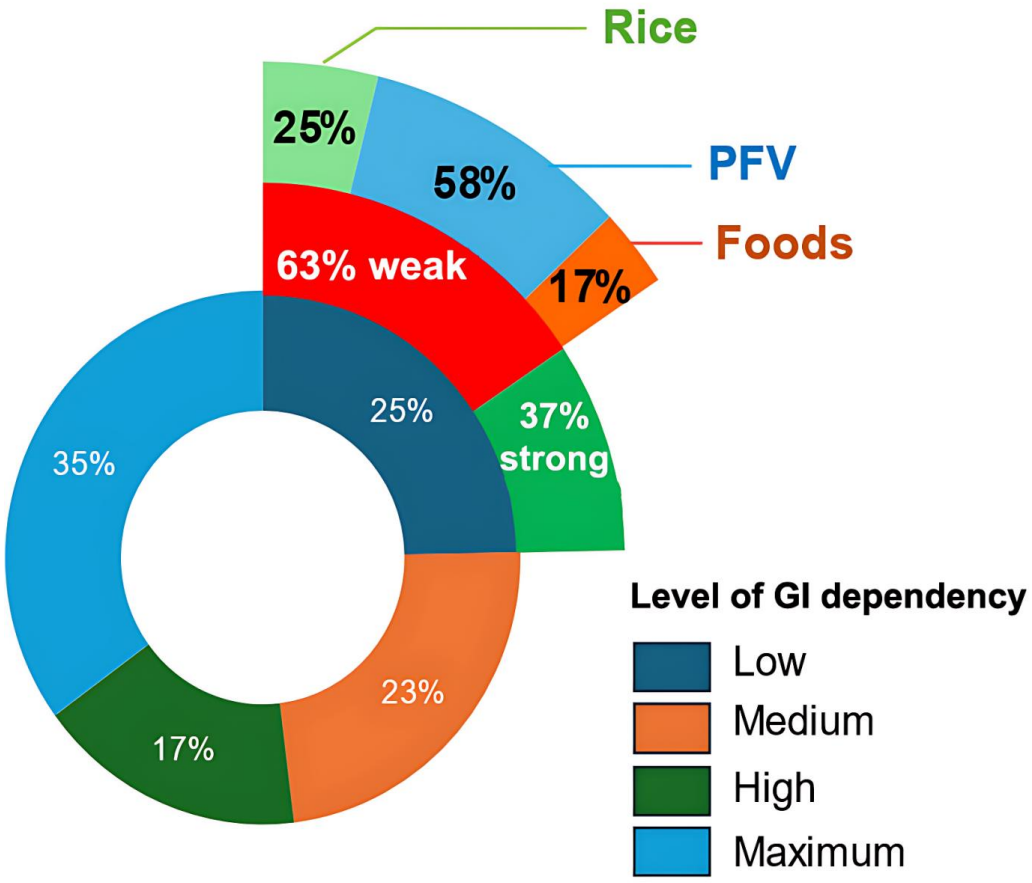

Figure 3. Confidence on GI products reputation in a group of low dependency.

The barriers encountered by at least 30% of producers in managing GI products are presented and categorized by product groups as percentages, as shown in Figure 4.

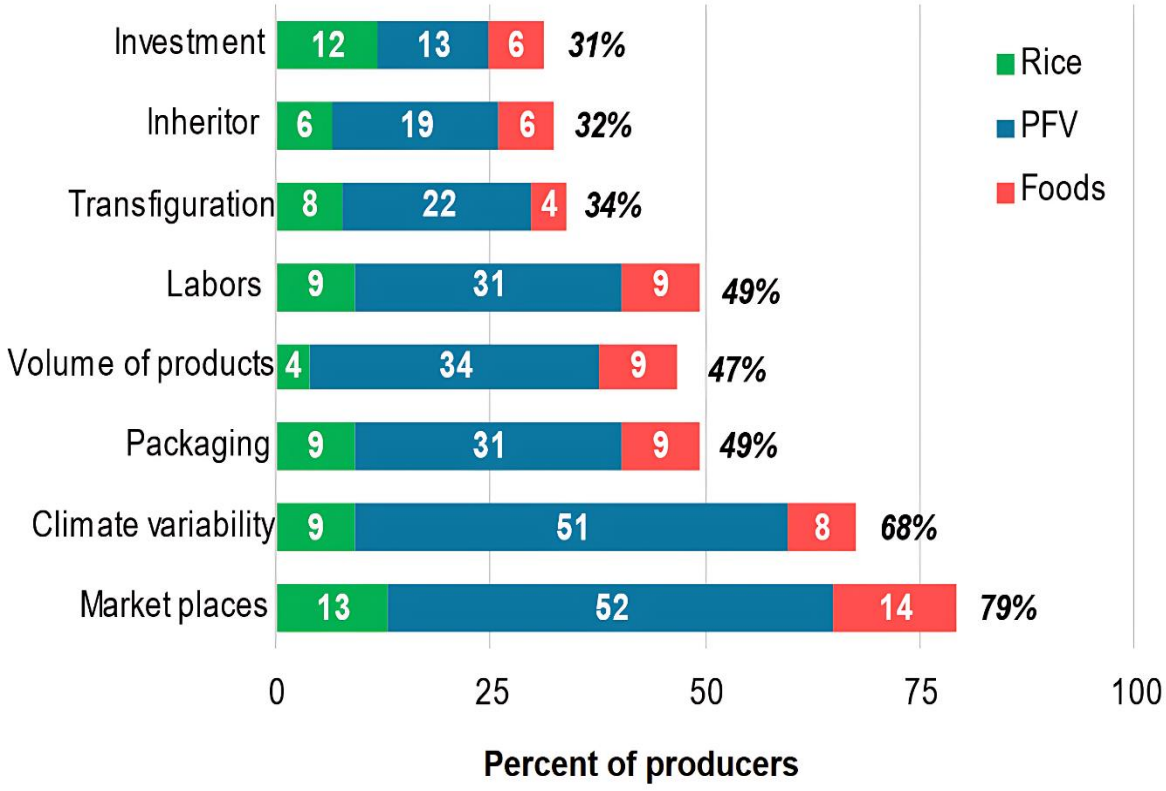

Figure 4. Barriers of GI management.

Two significant barriers to GI product management, reported by more than 50% of producers, are summarized below:

- Limited Market Places (approximately 79%, or 61 producers).

Despite the availability of GI markets, GI festivals, and specific product festivals (e.g., for coffee, rice, and durians) organized annually in the Bangkok Metropolitan area and select economic provinces, these events were often insufficient to address the needs of diverse GI products and producers, particularly those from remote rural areas. The Department of Intellectual Property (DIP), the Ministry of Commerce, and other relevant government and private sectors typically collaborated to organize these events. However, producers frequently cited limited marketplaces as a critical barrier to effective GI management. The timing and spatial constraints of these events often failed to accommodate the variety of GI products and producers. Producers who sold their products in non-specific markets faced challenges in realizing the premium pricing advantage associated with GI products.

Figure 5 illustrates the relationship between levels of GI dependency and the barriers to GI management. A high level of barriers was evident among PFV products, contributing to household incomes at medium to maximum levels (18 products). Many PFV producers reported difficulties participating in organized markets, as the events often did not align with their harvest periods, leaving them without products to sell. Others chose not to attend events located far from production sites due to the prohibitive costs of travel and accommodation. Furthermore, web-based marketing was not a viable option for many senior producers (over 60 years old), who were unfamiliar with such platforms. High barriers were also reported for rice and food products across all levels of dependency. Conversely, 16 PFV and food products were not affected by these challenges ("None" category).

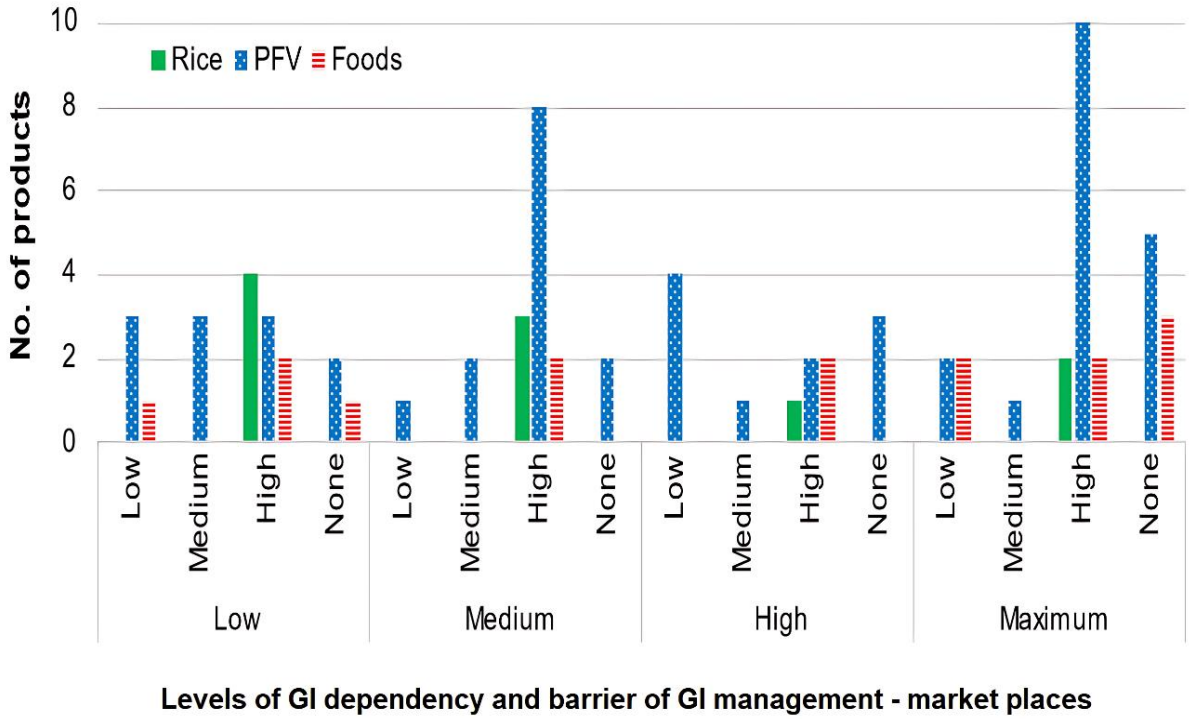

Figure 5. Levels of GI dependency and barrier - market places.

- Climate Variability (approximately 68%, or 52 producers).

Many production areas reported experiencing climate variability during the observation period, including droughts, floods, windstorms, and extreme weather. These conditions created significant challenges in maintaining the GI quality of products and adversely affected the fertility of production sites. More than half of the producers indicated that the frequency of climate variability had increased over the past decade.

In response, additional water sources were established in large-scale production areas of high-economic-value products such as rice, durians, pomelos, mangoes, and oranges. Despite these efforts, climate variability severely impacted PFV products at medium and maximum levels across all dependencies. Similarly, a high level of impact was reported for rice products with medium and high dependency levels.

Conversely, 60% of food products, 30% of rice products, and 25% of PFV products were unaffected by climate variability, as shown in Figure 6.

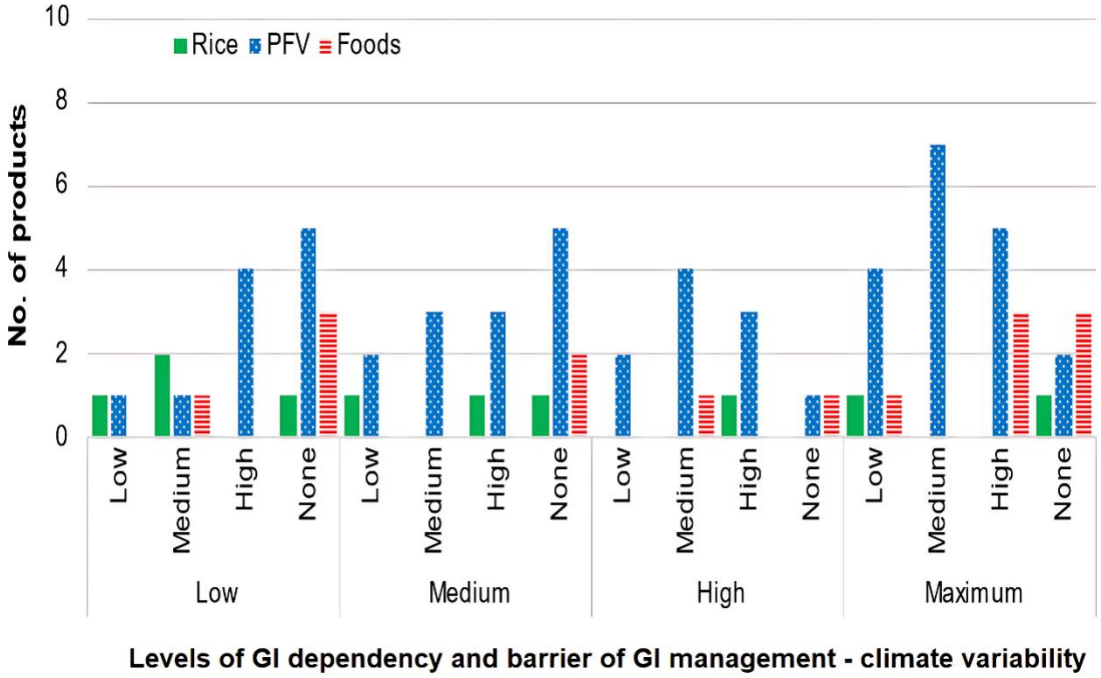

Figure 6. Levels of GI dependency and Barrier – climate variability.

Among the barriers mentioned by 30–50% of producers, two were rated equally by approximately 49% of producers: packaging and labour. These barriers are summarized below:

- Non-Attractive Packaging (reported by 49%, or 38 producers).

This issue had a medium to high impact, particularly on 46% of food products that contributed to household incomes at low, medium, and maximum levels. While about half of the food products were satisfied with their current packaging, which required considerable investment in terms of budget and time for development, significant challenges remained for other products.

Approximately 53% of PFV products did not prioritize packaging development, as these products were primarily sold wholesale to middlemen and rural markets. Producers relying on PFV products, such as pineapples, coconuts, durians, and pomelos, at medium and maximum dependency levels faced considerable difficulties in creating premium and durable packaging. This was especially true for thin-skinned fruits like mangoes, which required specialized protective packaging. Similarly, rice products across low to high dependency levels expressed a desire to enhance their packaging with more attractive designs and origin-specific information to meet market expectations.

- Lack of Labor (reported by approximately 49%, or 38 producers).

Labor shortages were reported mostly at medium to high levels of severity among nine maximum-dependency products (seven PFV, one rice, and one food product), followed by six medium-dependency products and four products each at high and low dependency levels. In contrast, half of the producers did not experience labour shortages, as their production relied on household members and local labourers within the same villages. Additionally, many unemployed villagers who had formerly worked outside their hometowns returned home during the COVID-19 pandemic, providing additional labour after numerous business closures caused by disease control measures. Producers of maximum-dependency products expressed greater concerns about labour shortages compared to those with lower dependency levels. The latter group instead focused on controlling production volume and budget during the pandemic and associated disease control measures.

- Insufficient Product Supply (reported by approximately 46%, or 36 producers).

This issue was reported at medium to high levels across all dependency groups, with the highest severity observed in low-dependency products and less impact on maximum-dependency products. In the low-dependency group, production of GI products was limited, as producers relied on other income sources for their livelihoods. For higher-dependency products, insufficient GI-standard products were often attributed to the increasingly variable climate in recent years. Additionally, some producers prioritized household capacities—operating within fixed budgets and limited household labour—over investing in larger-scale production to meet growing market demand. The medium to high severity of this issue was noted for 19 PFV products, six food products, and two rice products. Importantly, the problem of insufficient product supply in this study encompassed not only the quantity but also the quality and compliance with GI standards.

- Product Transfiguration (Reported by approximately 33%, or 26 producers).

Concerns about product transfiguration to add value and expand market channels were reported by 50% of rice products, 32% of PFV products, and 20% of food products. The issue was most severe among eight medium-dependency products (three rice and five PFV products) and four maximum-dependency products (all PFV). Producers identified the need for transfiguration techniques and ideas to enhance product value and extend shelf life. Those who were not benefiting from advantageous market prices or had produced a surplus exceeding market demand particularly emphasized this idea, Most producers in this group prioritized strengthening household income over adhering strictly

to the specific framework of their GI-tagged products. This approach reflected a focus on flexibility and adaptability to maximize economic benefits.

- Lack of Inheritors (Reported by approximately 32%, or 25 producers).

Concerns about the lack of inheritors were reported for 17 products (four rice, 10 PFV, and three food products) at medium to high levels of severity. When considering the dependency levels, two maximum-dependency products (PFV: pomelo and coconut), two high-dependency products, six medium-dependency products, and seven low-dependency products were affected. Four rice products from the Northeastern region of Thailand were particularly impacted by the lack of inheritors to manage future production. Two of these products were low-dependency (aromatic rice from Ubon Ratchathani Province and germinated brown rice from Sakon Nakhon Province), and two were medium-dependency (aromatic rice from Surin Province and sticky rice from Kalasin Province). In general, GI products are derived from good agricultural practices or specific production wisdom. However, many of the GI products in this group were managed by senior generations, creating a critical concern regarding the availability of inheritors to ensure continuity in management. Of the 25 producers who reported concerns about this issue, 13 were senior producers (over 60 years old), 9 were in the late working age range (45–59 years old), and 3 were in the middle working age range (30–44 years old).

- Lack of Investment (reported by approximately 31%, or 24 producers).

Reports raised concerns about capital shortages for six rise products and food products, with varying degrees of severity. When considering the dependency levels, four products were low-dependency, seven were medium-dependency, and five were maximum-dependency (including two bananas, one rice, one coconut, and one food product). Most producers in this group reported a need for capital to support various activities, including value-added processes (such as product transfiguration and packaging) and the development of production areas (e.g., levelling, zoning, and irrigation systems). The most significant products in this group were rice, bananas, and pineapples.

It was also observed that a lack of market channels and the impact of climate variability contributed to additional challenges in managing GI products.

4. DISCUSSION

Geographical Indications (GIs) provide significant benefits to producers, including enhanced market access, price premiums, and positive impacts on economic and rural development. This has been established by several studies, such as those by Li et al. (2024); Yin et al. (2024); De Filippis et al. (2022); Török et al. (2020) and Cei et al. (2018). Research by Crescenzi et al. (2022); Poetschki et al. (2021); Dogan (2024); Ingole et al. (2023) and Petruang and Napasintuwong (2022) has primarily focused on geographically specific products such as GI-certified wine, cheese, olives, rice, coffee, beans, and various fruits. These studies often rely on statistical data and economic benchmarks at regional or national levels, employing systematic review methods and models to analyze outcomes. However, these prior studies often overlook ground-level insights from rural producers and the diversity of GI products. This study sought to address this gap by examining the experiences of GI-certified producers managing agricultural products—specifically rice, plant fruits and vegetables (PFV), and food products—across Thailand. The analysis included producers engaged in GI product management before the COVID-19 pandemic, during the restrictive measures imposed by the pandemic, and within the "new normal" routines, as well as those grappling with the effects of recent climate variability. The study focused on contemporary management practices, including production and sales cycles and the contribution of GI products to household incomes over the past year. Additionally, it explored alternative income sources and the barriers to effective GI management as perceived by the producers.

Although the scope of this study differs from that of previous research, several findings align with the existing literature. Most producers expressed limited confidence in their products' reputations and reported that GI-certified products did not offer substantial benefits compared to their non-GI-certified counterparts. This finding suggests that the effectiveness of GIs is highly contingent on product characteristics and local contexts. For example, jasmine rice from Thailand's Northeastern region commands a premium price compared to jasmine rice from other regions, a trend mirrored in the GI registration of Sangyod rice in Southern Thailand. It was found by Cei et al. (2018) that producers in GI-designated areas benefit more from farming than those in non-GI areas. This was noted by cultivation compared to non-GI areas. This was noted by Petruang and Napasintuwong (2022).

Furthermore, weak product reputation and limited reliance on GI products can be attributed to inadequacies in policies aimed at protecting and promoting certified products and their producers. This observation aligns with the findings of Török et al. (2020); Cardoso et al. (2022); Eliasson (2022) and De Filippis et al. (2022) which emphasize the necessity of robust GI policies to achieve positive regional development outcomes. This study also highlighted the practice of integrating GI production with other income-generating agricultural activities, which contributes positively to household income security. Such practices align with the Food and Agriculture Organization's (FAO) principles of sustainable agriculture and several United Nations Sustainable Development Goals (SDGs). However, while diversification enhances immediate income stability, it does not necessarily ensure the long-term sustainability of GIs.

Despite its contributions, this study focused on a limited range of GI management factors. A more detailed investigation into production practices, technological adoption, investment strategies, and related management aspects would provide more profound insights. Furthermore, comprehensive studies on economic impacts, policy frameworks, and associated barriers are essential. Future research could adopt a focused approach by examining single products or comparing similar product types, such as pomelos, coconuts, durians, and pineapples. Alternatively, studies could encompass all GI-certified product types using systematic methodologies. Policymakers and GI-related authorities should prioritize obtaining insights directly from rural producers rather than solely emphasizing an increase in GI registrations. Such grassroots perspectives are invaluable for enhancing GI protection systems, strengthening rural economies, and ensuring the sustainability of GI products in Thailand and other countries relying on them.

5. CONCLUSION

Geographical Indications (GIs) have shown significant positive impacts on enhancing economic development, promoting soft power, and preserving specific know-how and natural resources, all of which align with the Sustainable Development Goals (SDGs). Consequently, GI registration has been actively encouraged in many countries, including Thailand. However, feedback and perspectives from producers on the aftermath of GI registration—critical for strengthening GI protection systems—remain limited. This research looked into GI management in terms of the time it takes to make and sells goods (Px-Sx) and the money that can be made from GI-certified crops in a year. A mixed-methods approach, combining surveys and interviews, was employed. The target group comprised GI-certified producers who had been involved in GI products for at least five years or prior to the COVID-19 pandemic.

A total of 77 GI-certified producers, representing 77 products across Thailand, were interviewed and categorized into three product groups: Rice, Foods, and Plant Fruits and Vegetables (PFV). The management of these products was classified into four patterns of production and sales: P1-S1, P1-SM, P2-S2, and PM-SM. The contribution of GI products to household income was divided into four levels: Low, Medium, High, and Maximum. Seasonal-based products (P1-S1) were most common in the PFV group (e.g., longan, durian, lychee). Products with one-time annual production but multiple sales opportunities (P1-SM) were predominantly rice and some food products. Products with multiple production and sales cycles within a year (PM-SM) were mostly food products and some PFV products, while biannual production and sales were limited to certain PFV products, such as pineapples, pomelos, and mangoes. Although these management patterns were linked to product types, a Chi-Square test for independence revealed no correlation between product groups and their contribution to household income. Similarly, no significant association was found between income contribution levels and production management patterns. Among the 77 producers, those with maximum dependency on GI products were predominantly in the late working age group compared to other generations. Additional sources of income, both within and outside the agricultural sector, revealed that producers prioritized income security over the sustainability of their GI products. From the producers' perspectives, the low or weak reputation of their products in domestic and international markets was a major concern. The main problems with managing GI were found to be limited market access and the effects of changing climates on both quantity and quality of GI products.

This study provides a comprehensive overview of the impact of GIs on rural household incomes and the sustainability risks associated with their production in Thailand. While GIs offer numerous advantages and have the potential to foster local economic development, realizing this potential requires careful consideration of factors beyond the GI label itself. The challenges faced by producers, particularly in developing regions, highlight the need for further research and targeted policy interventions to optimize GI benefits. For keeping GI protection systems going and making rural economies stronger, it's also important for people from production areas to national and regional levels to work together, in both the public and private sectors.

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