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# A hydroponic vegetable business management approach in holistic good agricultural practices in Thailand

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Good agricultural practices (GAP) are guidelines designed to ensure the production of high-quality agricultural products that meet specified standards while optimizing resource use. This study aimed to examine the challenges and success factors in implementing a holistic system of GAP in hydroponic vegetable business management and to enhance the efficiency of Thailand's policies on safe agricultural standards. In this study, a qualitative research methodology was used, using in-depth interviews, semi-structured interviews, and observations with 36 intermediaries and consumers in Thailand. Data analysis was conducted using descriptive statistics. The study revealed that key challenges to successful GAP implementation include unsupportive government policies and a lack of in-depth knowledge among farmers on how to effectively apply GAP principles. For successful implementation, it is crucial that farmers who lead these efforts thoroughly understand the methods and prioritize safe and proper farming practices. This knowledge can then be leveraged to prepare and educate farmers, producers, and entrepreneurs to produce high-quality agricultural products. GAP for crops include policies, benchmarks, and audit processes that adhere to international standards, providing a framework for controlling and promoting product quality throughout the agricultural production process, including post-certification maintenance. The study suggests that cooperation across all relevant sectors, from upstream to downstream, is essential for the successful implementation of GAP. Such collaboration would significantly enhance the quality and safety of Thailand's agricultural standards.

## KEYWORDS

good agricultural practices (GAP), safe agriculture system, hydroponic, business strategy, agricultural policy

## 1 Introduction

The production of agricultural products must adhere to quality and safety standards to ensure universal access to safe food. The COVID-19 pandemic has heightened the importance of hygiene practices in food culture (Reum et al., 2020) and sustainable development. Indicators are needed to assess progress toward sustainable agroecosystems,

encompassing environmental, economic, and social principles (Robert, 2020).

To mitigate the economic impact of crises (Duncan et al., 2021), Good Agricultural Practices (GAP) provide guidelines for farming that ensure high-quality products meet established safety standards. The use of chemicals in agriculture must be controlled according to safety standards to protect both producers and consumers. This principle, established by the Food and Agriculture Organization of the United Nations, forms the foundation of the GAP Program, which is implemented globally in accordance with GAP (Osman et al., 2020). Promoting knowledge and guidelines on the safe use of pesticides is a key aspect of this initiative (Istriningsih et al., 2022; Osman et al., 2020).

In hydroponics, manufacturers must carefully study the planting process, including analyzing plant growth, nutrient content, and the amount of light required by plants (Liang et al., 2022). Further research is needed to determine whether focusing on maintaining plant health rather than solely maximizing yield will lead to more disease-tolerant and ultimately more productive crops (Victor et al., 2022). For social benefits, raising awareness about product availability, including among consumer groups and in marketing, is essential (Osman et al., 2020). The impact of marketing channels and farm size also influences growers' decisions to comply with on-farm food safety practices.

In Thailand, GAP principles are applied to crops to ensure a safe production process that is free from pests and of a quality satisfactory to consumers. Managing the production process, including harvesting and post-harvest practices, involves adhering to international standards while considering environmental factors, health, safety, and the welfare of workers (Marine Sasha et al., 2016). Safe farming practices are a sustainable approach, and agricultural development plans need to be adapted to the national context. In the business sector, it is possible to link analysis with appropriate risks and manage and provide tools for good agricultural practices (Buscaroli et al., 2021).

A holistic approach to agricultural development emphasizes building strong communities aligned with national development guidelines. Farming families, as key social units, provide security in economic, social, and environmental aspects. The objective of this research is to study the challenges and success factors in the implementation of GAP in Thailand, to explore how to implement the GAP System holistically in the management of hydroponic vegetable businesses for safe production, and to strengthen the efficiency of policy management within the safe agricultural standard system in Thailand.

## 2 Materials and methods

A qualitative research methodology was used, with specific sampling based on the involvement of stakeholders in the hydroponic vegetable sector. The target groups were selected for convenience and relevance to the hydroponic vegetable business. The main informants included hydroponic vegetable farmers, intermediaries (such as traders, sellers in the market, and restaurant businesses), and consumers. The study focused on hydroponic salad vegetable farmers in Kalasin Province, Amnat Charoen Province, Nakhon Ratchasima Province, and Surat Thani Province, Thailand. In-depth interviews,

semi-structured interviews, and observations were conducted between March 2023 and June 2023.

Data were analyzed and explained using descriptive statistics and supply chain integration and management within the economic dimension. The study also proposed a policy for the implementation of a holistic GAP system. Additionally, a macro-level environmental analysis of the hydroponic vegetable business using political, economic, social, and technological (PEST) analysis was conducted, including an analysis of internal and external business factors.

## 3 Results and discussion

### 3.1 Problems and conditions for success in implementing a good agricultural practice system approach

Using information obtained from interviews with individuals involved in the hydroponic vegetable business, the data were divided into smaller sections for detailed analysis. The goal was to identify the causative factors contributing to the challenges and to find potential solutions. A general environmental analysis of the hydroponic vegetable business was conducted at the macro level, utilizing PEST analysis. This analysis considered four key factors, namely legal and political, economic, social and cultural, and technological aspects, along with the structure of internal and external business factors (Alexey and Zelentsova, 2021).

Legal and political factors such as the agricultural standards (GAP 9001-2021) for food crops and major agricultural policy issues, play a critical role in the implementation of GAP. These include guidelines for aid, promotions, and support budgets, all of which are influenced by the political situation. Agricultural policy accreditation and necessary policy amendments remain areas that require attention.

The continuity of the policy landscape is hindered by political instability, including delays in budget allocation at the ministry level, which directly and indirectly affect both legal and regulatory changes, ultimately hindering investment and business operations. Additionally, consumer protection laws introduce political risks that affect the planning and decision-making processes of hydroponic vegetable businesses (Interview with support unit, government agency, 12 May 2023).

The economic situation has significantly affected farmers, particularly with regard to production costs, including the rising prices of equipment and necessary materials. Therefore, adopting GAP has become a crucial strategy for producers to mitigate these costs, especially through the controlled use of necessary chemicals (Interview with support unit, government agency, 12 May 2023).

From the consumer perspective, the increasing cost of living has made shoppers more cautious in their purchasing decisions. Consumers are now opting for cheaper alternatives to hydroponic vegetables, prioritizing affordability over other factors (Consumer Interview, 31 May 2023).

Additionally, volatile economic activities and urban expansion have created further challenges for the economic system. The government's economic stimulus policies, which focus on trading goods at low prices, coupled with its controls on economic activities, have posed barriers for businesses seeking financial access (Interview with hydroponic vegetable producer, 1st June 2023).

The social and cultural impacts of the COVID-19 pandemic have caused significant changes, particularly in fostering greater health consciousness among the population. Consumers are now prioritizing the consumption of produce that is free from toxins and contaminants. Concerns about the safety of consumer goods have driven demand for higher production standards, which in turn have helped build consumer confidence. Shifts in consumer behavior, growing health concerns, advancements in information technology, and increased access to health information have contributed to a global trend focused on health and well-being. Cultural factors also play a role in shaping beliefs and values related to food consumption and influencing lifestyle choices aimed at improving quality of life. In this context, safe food production has become a priority, with producers needing to adhere to GAP to meet these evolving consumer expectations.

The government has a critical role in promoting and supporting effective communication to foster health-conscious consumption values. Encouraging consumers to adjust their behaviors in line with a health-conscious society is essential for creating lasting change (Interview with a support unit, a government agency, 12 May 2023).

With advancements in technology, smart farms, or smart agriculture, sales channels have expanded through online channels such as Facebook, Line, and others. Loss-reducing transportation technology calculates retention times and ensures timely distribution to prevent breakdowns. Digital marketing is also a key component of successful business operations. However, the main obstacle is the capacity and availability of resources to support digital marketing effectively (Trisha et al., 2024).

External factors for influencing product perception can be marketed through digital marketplaces that facilitate direct communication with consumers (Thamrin et al., 2022). Additionally, post-harvest technology is crucial before delivering products to target customers and for adoption in the manufacturing sector (Gusti Ketut Agung Ulupui et al., 2023). The points can be summarized as follows: (Figure 1).

Summary of problems and conditions for success in the implementation of GAP system guidelines.

General business environmental analysis using PEST analysis considers the following four factors:

**Legal and political aspects:** These aspects are rated at a high level ( $\bar{x}=3.54$ , S.D.=0.68). Key issues include agricultural product standards (9001-2021), GAP for food crops, agricultural policies, and guidelines for assistance and allocation of government promotional or support budgets.

**Economic aspects:** These aspects are also rated at a high level ( $\bar{x}=3.63$ , S.D.=0.77), largely due to the impact of the pandemic. The cost of living has risen, while market demand has decreased.

**Social and cultural aspects:** These aspects are rated at a low level ( $\bar{x}=2.03$ , S.D.=0.22). However, there is increasing attention to our health, with a focus on the availability of safe vegetables free from toxic contaminants.

**Technology aspects:** In terms of technology, the rating is also low ( $\bar{x}=2.21$ , S.D.=0.25), primarily due to limited access to smart farm technology, high implementation costs, and a lack of government support. On a positive note, sales channels have expanded through online platforms (Table 1).

The technological improvements needed under the PEST analysis framework should prioritize the economic aspect, followed by legal and political factors, technology, and social and cultural aspects. The country's economy is an urgent issue requiring attention from all sectors, as it directly and indirectly impacts the hydroponic vegetable business for both producers and consumers.

Regarding legal and political factors, the government must address issues related to access to crop production standards within the framework of GAP in accordance with international standards. This includes the formulation of laws, policies, and specific regulations for individual crops. Currently, Thailand's certification system operates based on plant groups, which may not be sufficient.

Social and cultural factors highlight the increasing focus on health and the need for societal adaptation in consumption habits. If GAP are applied to plant production to ensure standards and build

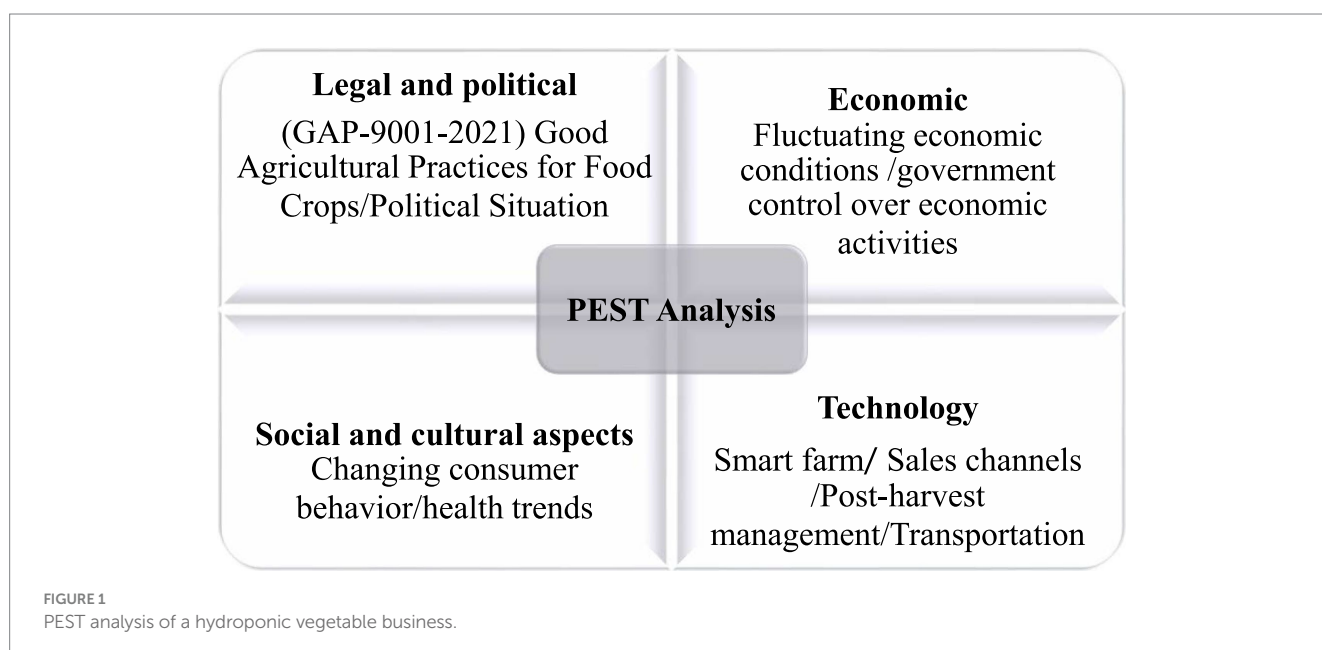


TABLE 1 PEST analysis of a hydroponic vegetable business.

PEST analysis	$\bar{x}$	S.D.	Level	Interpretation
Legal and political	3.54	0.68	High	2
Economic	3.63	0.77	High	1
Social and cultural aspects	2.03	0.22	Low	4
Technology	2.21	0.25	Low	3

Data were collected from interviews with key informants.

TABLE 2 Issues and conditions for success in implementing GAP.

Issues	Success conditions	Implementation guidelines
GAP requirements for food crops	Farmers, producers, and auditors	<ul style="list-style-type: none"> <li>Promote awareness and knowledge of good agricultural practices for crops.</li> <li>Encourage serious implementation by manufacturers.</li> <li>Build understanding and practical knowledge.</li> <li>Encourage farmers, producers, and entrepreneurs to produce quality agricultural products.</li> </ul>
Preparation before entering the GAP standard.	Farmers and producers	<ul style="list-style-type: none"> <li>Ensure the production process is safe for both producers and consumers.</li> </ul>
Standard certification	Auditors	<ul style="list-style-type: none"> <li>Develop and train auditors.</li> </ul>
GAP certification application process	Farmers, producers, and auditors	<ul style="list-style-type: none"> <li>Revise land title document requirements for GAP certification to improve access for manufacturers.</li> <li>Encourage cooperation among agencies responsible for standard certification.</li> </ul>
Cooperation of agencies for standard certification	Farmers, producers, and auditors	<ul style="list-style-type: none"> <li>Foster integrated cooperation among all sectors involved in standard certification.</li> <li>Ensure alignment of GAP rules, criteria, and assessment methods with international standards.</li> </ul>
GAP standards for implementation	Farmers and producers	<ul style="list-style-type: none"> <li>Maintain standards after certification.</li> <li>Adhere to good agricultural practices for safety.</li> <li>Ensure proper quality management of agricultural production.</li> <li>Optimize resource use.</li> </ul>

Data were collected from interviews with key informants.

consumer confidence, public health agencies should play a crucial role in promoting and disseminating knowledge.

In terms of technology, the main challenge is access to technological resources for business manufacturers. The cost of technology and data imports remains low compared to other countries, and there is a need for greater development in accessing and supporting technological resources.

A summary of general environmental factors reveals that the potential and appetite for hydroponic vegetable businesses within the safe agriculture system are likely to grow and expand as the economic situation improves. The focus on consuming toxin-free vegetables is increasing, and the population has access to communication technologies through many channels. Consumers are receiving more information regarding the benefits of consuming safer vegetables, which enhances production opportunities for entrepreneurs who can capitalize on this demand to generate income.

This includes an analysis of the sensitivity of hydroponic vegetable prices (Slaba, 2021). Market developments and their continued survival are never guaranteed (Rashiti and Skenderi, 2022), and factors such as pre- and post-sales services that affect consumer choices (Alenazi, 2021) can impact a business's ability to compete in the market. The research shows that small and medium-sized business owners and managers must stay alert to market challenges and shifts in order to remain competitive (Rashiti and Skenderi, 2022), which can also drive local economic growth. The findings further highlight the problems and conditions for the successful implementation of these practices (see Table 2).

Issues related to GAP requirements for food crops include standard certification procedures, preparation before entering the standard, and challenges with land title documents. Another important issue is the cooperation of agencies responsible for accreditation. The conditions for success rest on farmers and producers, who must comply with the standard requirements.

### 3.1.1 General environmental analysis of business

The integration of demand and supply management offers several benefits for a successful supply chain management system, including higher profitability, better customer loyalty, faster processing and delivery, reduced expenses, and improved efficiency (Caputo et al., 2004; Moh, 2023). Digital channels, such as social media and Internet advertising, provide additional benefits to consumers (Desku and Sadrija, 2023).

The Ministry of Agriculture and Cooperatives has announced the Agricultural Product Standard on GAP for Food Crops (GAP 9001-2021) to ensure that Thai food crops are recognized for their quality and food safety, with production processes that take into account the environment, health, and safety of both consumers and operators.

Preparing and developing farmers, producers, and entrepreneurs to understand and implement GAP ensures the production of quality agricultural products. GAP also offers a framework for efficient resource use and the appropriate management of agricultural production quality.

For successful implementation, farmers must first acquire knowledge about good farming standards and certification and

then apply that knowledge practically in their own plots. GAP serves as a tool to control and promote agricultural products to meet quality standards, ensuring safety and protecting consumers. This helps prevent damage to farmers, businesses, and the national economy (Interview with a support unit, government agency, 8 March 2023).

“How is the GAP crop growing, where does it start, and when applying for certification, relevant agencies must be involved in guiding to understand the regulations and requirements because there are quite a lot of requirements (Interview with a support unit, government agency, 8 March 2023).”

A key issue is the complexity of GAP certification, with many requirements that must be clearly communicated by relevant agencies to help farmers understand the regulations. Challenges arise in the practical application of GAP, particularly in record-keeping, which is seen as necessary but burdensome by producers as it increases their workload (Interview with producers and entrepreneurs, 8 March 2023).

### 3.1.2 Concluding points

The main issues with GAP implementation in Thailand stem from the requirements outlined in the Agricultural Commodity Standard Declaration.

To develop farmers, producers, and entrepreneurs, it is essential to provide them with the knowledge and skills required to produce high-quality agricultural products. GAP serves as a critical tool for controlling and promoting agricultural products to meet established quality standards for safety and consumer protection. By adhering to GAP, the risks of damage to farmers or businesses are reduced, safeguarding both agricultural products and the broader economic system of the country. Additionally, formulating environmental management strategies is crucial for achieving long-term business sustainability (Muafi and Uyun, 2021).

A key component of a successful business model is gaining a competitive advantage within the industry. Innovative business models can create new markets or enable companies to seize opportunities in existing ones. In formulating a strategy, it is important to evaluate the current business model and assess areas where development is needed (Purnamie et al., 2022).

However, the finding indicates that many farmers still lack entrepreneurial skills, which is one of the reasons why farmer empowerment initiatives have not been fully maximized. Cooperatives have the potential to enhance entrepreneurial capacity by leveraging existing social capital. Social capital for farmers is built upon three main components: networks, norms, and trust (Shahab et al., 2022).

## 3.2 GAP

To request GAP certification, individuals interested in applying can submit their applications to the Department of Agriculture or the Department of Agricultural Extension at any of their locations nationwide, free of charge. It is important to note that the agencies responsible for certifying GAPs incur operating costs during the certification process. The preparation process for certification is outlined in detail (see Figure 2).

The analysis evaluates the contributions of various innovative farming systems and technologies, particularly those supporting sustainability outcomes and environmental improvements (Rosegrant Mark et al., 2022).

## 3.3 Agricultural standards: GAP for food crops (9001-2021)

Key GAP requirements for food crops include ensuring the water used in hydroponic vegetable plots is regularly changed. If water is reused, a system must be in place to reduce microbial and chemical contamination. The water system should be cleaned before being released into the environment.

### 3.3.1 Safe agriculture system

The government aims to develop a comprehensive quality and safety certification system, promoting products that meet national standards. This includes raising awareness among producers and consumers about safe agriculture and expanding

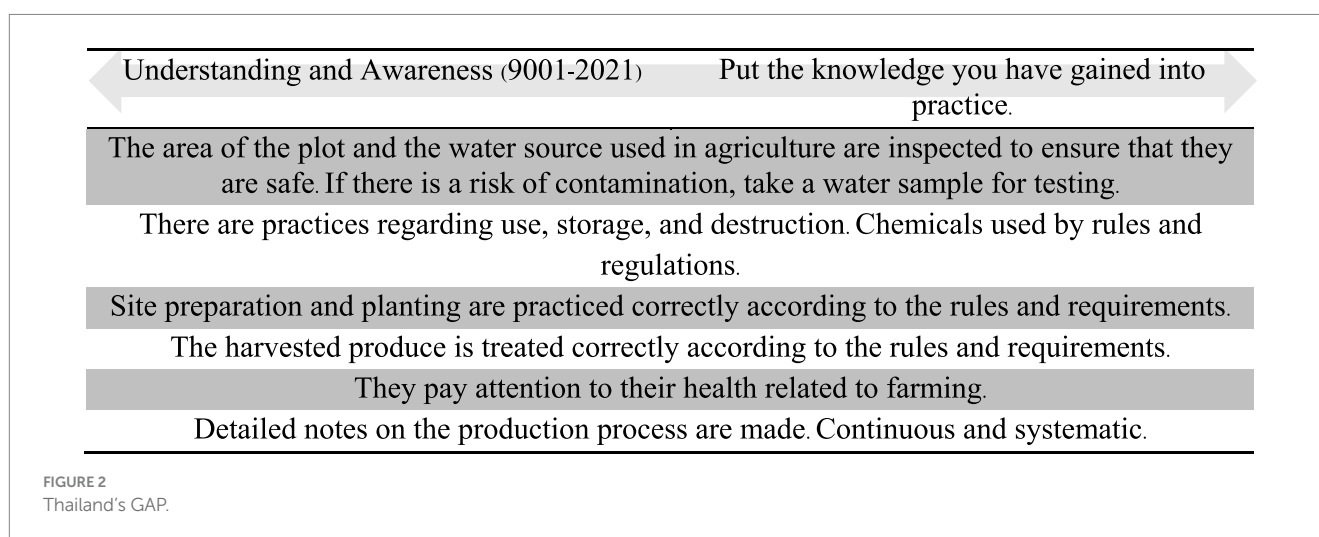


FIGURE 2  
Thailand's GAP.

sales channels to increase market reach. Local agencies play a crucial role in implementing these policies through multiple agencies (Interview with a support unit, Government Agency, 9th March 2023).

### 3.3.2 Key issues and conditions for success in implementing GAP

- **Agricultural Policy:** GAP should be applied comprehensively as a guideline across all sectors. Leaders in implementation, including farmers, producers, and entrepreneurs, lack the necessary knowledge and awareness to meet the criteria. There is also a poor understanding of the GAP certification application process.
- **Personnel:** There is a shortage of qualified staff to carry out the certification process.
- **Technology:** There is a lack of appropriate technology for certifying standard values suitable for inspection sites.
- **Analysis and Auditing:** Limited time for sample collection and transmission for contamination testing, as well as high costs for analyzing microbial contamination, heavy metals, and nitrate residues, present challenges. The auditing process, which must be scheduled around the applicant's production cycle, includes an examination of record-keeping documents.

The lack of product differentiation in lower-income nations complicates consumers' ability to select safe produce, leading to overuse. Ecolabeling, a voluntary certification process, helps separate produce based on its environmental impact to attract eco-conscious consumers. In order to reduce the environmental impact of vegetable production in Thailand, promoting alternative pest management techniques alongside ecolabeling is essential (Suwanna et al., 2022). Sustainable food production and environmental health depend on altering agricultural methods to achieve human health improvements (Adams Melanie et al., 2016).

### 3.3.3 Success conditions for GAP implementation

The following conditions must be met for successful GAP implementation:

- **Auditor Development:** Auditors must be continuously trained, with adjustments to guidelines and standards as necessary.
- **Certification Process:** The process should focus on maintaining the safety of both producers and consumers and include proper management of agricultural production quality.
- **Land Title Documentation:** Revisions should be made to land title document requirements to allow manufacturers easier access to GAP certification.

### 3.3.4 Post-certification maintenance

Standards for crops must be maintained post-certification with rules, criteria, and auditing methods that align with international principles.

Improving agricultural water management to address land degradation, food shortages, and climate change has drawn more

attention (Haileslassie et al., 2022). GAP is essential to sustainable farming, requiring integration and cooperation among all sectors involved in accreditation (Lambertus et al., 2018). Farms must increase their resilience to handle challenges related to the economy, environment, and society; adaptive governance plays a key role in helping farms attain this resilience (Manevska-Tasevska et al., 2021). The ultimate goal is to present a vision of sustainability that promotes perfect human and environmental health, supported by sustainable practices (Adams Melanie et al., 2016).

The policy recommendations for implementing safe agricultural product standards can be summarized in a policy diagram for the agricultural product standard system. Key guidelines for utilization are illustrated (see Figure 3).

The Ministry of Agriculture and Cooperatives proposes guidelines and promotes safe agriculture as a national agenda. It reviews policies and measures that hinder the advancement of the safe farming system and issues laws and regulations related to the promotion and development of safe agriculture. The Ministry supports ongoing and comprehensive research on plant species and plans policies to drive safe agricultural systems at the national, regional, and provincial levels.

In terms of Human Resource and Staff Development, the Ministry promotes knowledge for producers and develops a team of auditors to certify safe agricultural standards, ensuring there are enough auditors to manage the workload. This approach aims to increase the number of producers involved in safe agricultural systems.

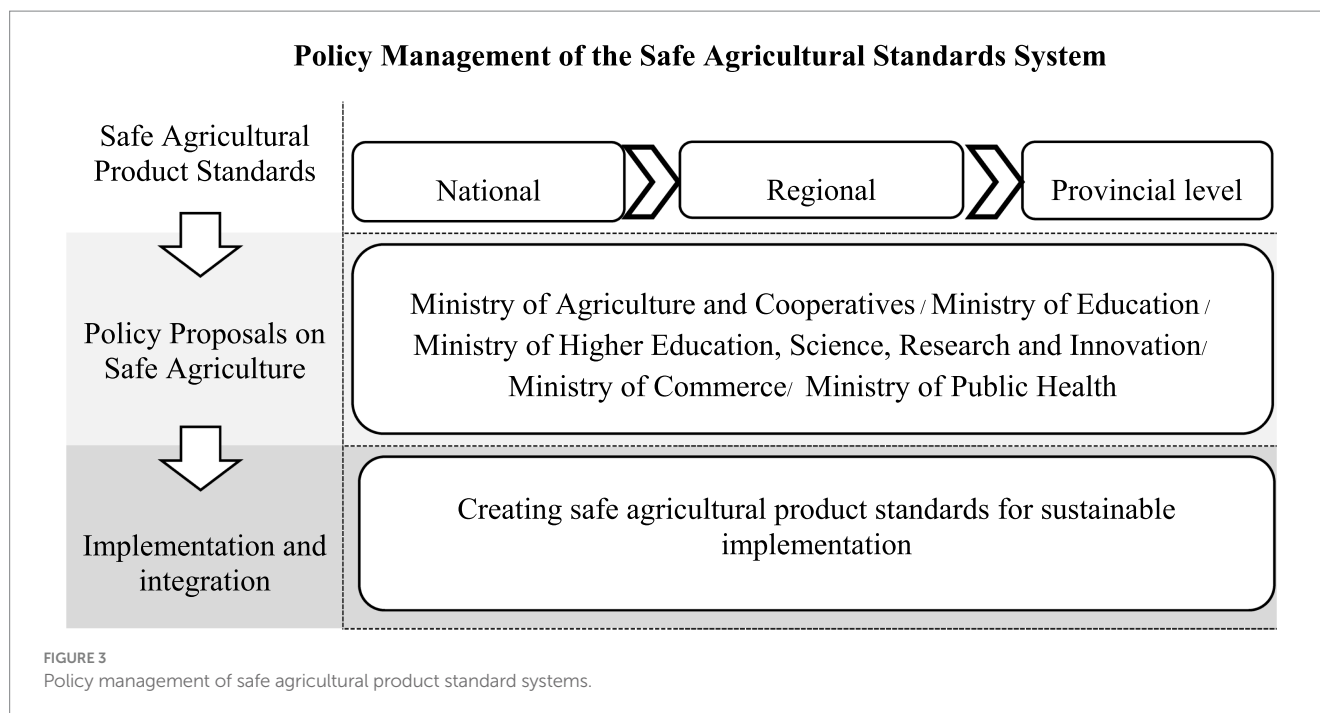
The Ministry also plans to develop a safe agricultural marketplace system, improve transportation, and establish safe agricultural distribution centers. Additionally, it seeks to integrate all sectors from national to regional and provincial levels to promote the development of a comprehensive, safe agricultural system.

The Ministry of Education promotes and implements teaching guidelines to incorporate subjects related to safe agricultural systems into the curriculum. The goal is to raise awareness, foster positive attitudes, and emphasize the importance of safe agriculture in ensuring a good quality of life. This initiative also aims to instill a sense of social responsibility and environmental awareness among students, educational institutions, and agencies across all sectors.

By offering additional courses or modules on safe agricultural production systems, the Ministry seeks to create a strong foundation of positive attitudes toward sustainable farming practices. These courses will emphasize the application of management knowledge, innovation, and technology in safe agricultural systems, ensuring that future producers are equipped with the skills and awareness needed to maintain safety throughout the entire agricultural supply chain.

### 3.3.5 The Ministry of Higher Education, Science, Research, and Innovation

The Ministry supports research in safe agricultural systems and encourages the application of innovative technologies derived from this research. By promoting and facilitating the development of production systems that prioritize safe agricultural practices, the Ministry allocates budgets for related research efforts. Additionally, it encourages universities to incorporate awareness, positive attitudes, and values around safe agriculture into their teaching and learning frameworks. This initiative aims to instill a sense



of social responsibility and environmental awareness in future generations.

### 3.3.6 The Ministry of Commerce

The Ministry proposes guidelines to advance trade and export policies both domestically and internationally. Policy planning is focused on driving safe agricultural systems, with budget allocations to departments responsible for implementing projects that bring tangible results. The Ministry also organizes national, regional, and provincial exhibitions to promote products from safe agricultural systems. It supports the creation of central markets and one-stop distribution centers for safe agricultural products, promoting knowledge and trade at all levels.

### 3.3.7 The Ministry of Public Health

The Ministry works to promote health policies that drive a safe consumption system. It allocates budgets to agencies responsible for preparing projects aligned with these policies. Additionally, the Ministry establishes working groups to promote the safe consumption of vegetables, raising awareness at national, regional, and community levels. Nutrition education is provided to prevent health problems, encouraging communities to consume a wider variety of vegetables and raising awareness about health issues related to food choices.

### 3.3.8 Provincial agriculture offices

These offices propose guidelines to integrate farmers and entrepreneurs from upstream, midstream, and downstream into a cohesive network. By educating farmers on safe agricultural practices, they strengthen farmer groups and promote the development of safe agricultural systems. These offices bring innovation and technology to assist in production, connect farmers with other agencies to expand markets and build trading

networks with the private sector. Additionally, they develop infrastructure and promote market management systems throughout the supply chain, supporting continuous marketing and producer development.

### 3.3.9 Provincial commercial offices and provincial chambers of commerce

These offices propose policies to promote intra-provincial trade by establishing central markets that serve as collection, storage, and distribution centers for safe agricultural products. Weekly or permanent markets are created to promote products produced in safe agricultural systems. They connect producers across the supply chain, from upstream to downstream, through exhibitions and provincial fairs, encouraging consumers to buy products from safe agricultural systems.

When ethical behavior and user behavior are combined, the development of agricultural technology can lead to increased productivity in the agricultural sector, which has the potential to reduce national poverty (Faiza et al., 2023). Our goal is to provide a clear summary that can be understood by the general public, policy officials, and non-experts in related fields (Adams Melanie et al., 2016).

### 3.3.10 Change theory

The theory of change involves collaboration across upstream, midstream, and downstream sectors to identify key issues, causes, and impacts, as well as ways to address problems collectively (Connell and Kubisch, 1998). One of the main challenges in achieving good agricultural production standards is the low entry of producers into the standardization process, particularly in hydroponic vegetable production. Farmers must adapt and be supported by the government and the supply chain to meet these standards. By improving market factors and integrating

standards, farmers can increase their income by providing added product value. Safe agricultural production builds consumer confidence, fostering sustainability for the country.

### 3.4 Guidelines for the implementation of a holistic GAP system in vegetable and hydroponic business management and strengthening the effectiveness of policy management of the safe agricultural product standard system in Thailand

#### 3.4.1 National level

To promote safe agriculture as a national agenda, the government should prioritize policy proposals that focus on the review, enhancement, and promotion of agricultural systems within the framework of GAP. This includes issuing laws and regulations that foster the development of safe agriculture, along with allocating budgets to responsible agencies in line with development policies to ensure concrete results.

#### 3.4.2 Academic proposals

Supporting agricultural research in GAP is essential, as is the application of technology and innovation derived from research to improve farming systems. However, it is important to acknowledge that implementing a good agricultural operating system can sometimes lead to reduced crop yields, which may impact the welfare of consumers and producers, as well as food security and finance. To mitigate these effects, the government must carefully evaluate which regions are most suitable for safe agricultural practices. Moreover, for products from certain areas, the concept of **geographical indications** can be leveraged to command higher prices, reflecting the unique qualities and origins of the products (Reddy et al., 2022). This approach could help balance the economic impacts of safe agriculture on both producers and consumers.

#### 3.4.3 Provincial level: policy suggestions

At the provincial level, policies should focus on developing a comprehensive system for safe agricultural markets, transportation, and distribution centers. This includes the integration of all sectors to promote the development of GAP in operation. Educational initiatives should be promoted for producers, and efforts should be made to develop a team of inspectors capable of ensuring that safe agricultural standards are consistently met, with sufficient manpower to handle the workload. The aim is to increase the number of manufacturers and producers operating under the GAP system, thereby improving agricultural safety and quality.

#### 3.4.4 Farmer level

At the farmer level, the emphasis should be on applying knowledge of management, innovation, and technology to production within the framework of GAP. This knowledge should be passed on to the next generation of producers, ensuring they are aware of agricultural safety throughout the entire supply chain, while also fostering an environmentally conscious mindset and raising awareness of social responsibility. However, challenges

remain, such as the shortage of skilled labor and the continued reliance on manual tools in the agricultural sector. Addressing these issues is crucial for successful implementation, wider adoption of GAP, and increased returns for farmers (Reddy, 2019).

### 3.5 Hydroponic vegetable business management

The management process of the hydroponic vegetable business involves analyzing and evaluating environmental factors that affect success in order to determine the direction of business operations. A strategic plan has been established, and with its implementation, including control and evaluation processes, the set goals can be achieved. The operational process may be adjusted quickly to accommodate changing environmental factors.

An important factor in strategic management is understanding the nature of the business as it currently operates, as well as the desired business characteristics in the future. Environmental factors that influence business operations must be considered when allocating resources and performing tasks to achieve objectives effectively. The strategic management process consists of the following:

- (1) Defining the strategic vision and mission of the organization,
- (2) setting goals and objectives,
- (3) creating strategies that will help the organization achieve its objectives,
- (4) implementing the strategy,
- and (5) monitoring and evaluating the strategy for improvement.

A SWOT analysis in the operation of the hydroponic vegetable business is essential to guide the development of strategies that promote, strengthen, and achieve the business's objectives. By addressing the challenges in hydroponic vegetable business operations, stakeholders from upstream, midstream, and downstream sectors can collaboratively develop a comprehensive hydroponic vegetable business plan within a holistic good agricultural operating system. The plan, based on this holistic approach, can be outlined as follows:

### 3.6 Strategic plan preparation

#### 3.6.1 Vision

"Holistic Good Agricultural Practices in the Hydroponic Vegetable Business: Creating Standards for Safe Agricultural Products for Sustainable Implementation."

#### 3.6.2 Mission

To develop knowledge and enhance production potential by emphasizing good agricultural practices in the hydroponic vegetable business. The mission also includes building a business network to connect businesses, strengthening marketing efforts, raising production standards, and adding value to hydroponic vegetable products throughout the production chain.

#### 3.6.3 Business objectives

Improve product quality in accordance with GAP standards for food crops and expand the hydroponic vegetable market. Seek new business partners through both online and offline platforms. Production planning should focus on the efficient distribution of goods and services to meet consumer needs. Additionally, modern



innovations should be introduced into the production process, and efforts made to enhance brand recognition for hydroponic vegetable products in the market.

## 3.7 Strategic issues

### 3.7.1 Based on the implementation timeframe and goals, the strategy is divided into three phases

Phase 1 (1st Year): Focus on solving key issues in the agricultural sector and enhancing the capacity of entrepreneurs to manage, establish standards, and improve product quality in accordance with GAP standards for food crops.

Phase 2 (2–5 years): Increase production efficiency while advancing toward international standards. Apply for Standard Certification (GAP) for food crops. Build a network of hydroponic vegetable producers to facilitate knowledge exchange through a holistic GAP approach, integrating economic, social, and environmental dimensions to achieve sustainability.

Phase 3 (Five years or more): Further develop the business by adding value to products, positioning Thailand as a hub for knowledge production and export. Implement advanced agricultural technologies to replace labor and enhance productivity. Expand marketing efforts to cover both online and offline markets, increase consumer access, and create a new generation of entrepreneurs to ensure the long-term sustainability of the business.

## 3.8 Evaluation and control

Evaluate the business by assessing the increase in frequency, volume, and value of products sold through various sales channels according to the strategic plan. Profitability in the hydroponic vegetable business is measured by comparing actual economic value with expected economic value. The growing number of consumers is monitored based on production statistics from producers and entrepreneurs. Performance is evaluated by analyzing any problems or obstacles and devising solutions to overcome them.

## 4 Conclusion

The management of the hydroponic vegetable business in Thailand under a holistic GAP framework highlights both the challenges and conditions for success. Based on a business environment analysis, the hydroponic vegetable sector in a safe agricultural system is poised for growth and expansion, in line with improvements in the economic landscape. The consumption of safe vegetables has gained value, with consumers better informed about safer options through various communication channels. This presents opportunities for entrepreneurs to increase production and drive local economies.

A major challenge lies in the GAP certification process, with limited participation in the standard system. Success depends on farmers and producers complying with standards and demonstrating

serious commitment. The production process must be safe for both producers and consumers, with adjustments made to allow broader access to the standard system. Inspection methods must align with international standards, and maintaining standards post-certification is crucial.

The government must enact laws, provide support, and enhance the efficiency of safe agricultural standard policies at the national level. Implementing a holistic GAP approach to raise production standards will contribute to food security, safety, and the long-term sustainability of communities and the country.

## Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

## Author contributions

PR: Supervision, Methodology, Project administration, Investigation, Validation, Visualization, Software, Formal analysis, Writing – original draft, Conceptualization, Data curation, Resources, Funding acquisition. KK: Validation, Writing – review & editing, Funding acquisition, Supervision, Resources, Formal analysis, Software, Data curation, Investigation, Project administration, Conceptualization, Methodology, Visualization. SP: Writing – review & editing, Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization. AP: Writing – review & editing, Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization.

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## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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## References

- Adams Melanie, S., Adams, R. B., Wessman, C. A., and Demmig-Adams, B. (2016). Nutritional cues tie living organisms to their environment and its sustainability. *Front. Nutr.* 3, 1–15. doi: 10.3389/fnut.2016.00028
- Alenazi, S. A. (2021). Determinants of pre-service failure satisfaction and post-service recovery satisfaction and their impact on repurchase and word-of-mouth intentions. *Qual. Access Success* 22, 87–94.
- Alexey, T., and Zelentsova, L. (2021). Analysis of external and Internal factors of business competitiveness. *Qual. Access Success* 22, 16–19.
- Buscaroli, E., Braschi, I., Cirillo, C., Fargue-Lelievre, A., Modarelli, G. C., Pennisi, G., et al. (2021). Reviewing chemical and biological risks in urban agriculture: a comprehensive framework for a food safety assessment of city region food systems. *Food Control* 126:108085. doi: 10.1016/j.foodcont.2021.108085
- Caputo, A. C., Cucchiella, F., Fratocchi, L., Pelagagge, P. M., and Scacchia, F. (2004). Analysis and evaluation of e-supply chain performances. *Ind. Manag. Data Syst.* 104, 546–557. doi: 10.1108/02635570410550214
- Connell, J. P., and Kubisch, A. C. (1998). “Applying a theory of change approach to the evaluation of comprehensive community initiatives: progress, prospects and problems” in Theory, measurement, and analysis: Vol. 2. *New approaches to evaluating community initiatives*. eds. K. Fulbright-Anderson, A. Kubisch and J. Connell (Washington, DC: Aspen Institute).
- Desku, B. R., and Sadrija, T. L. (2023). The impact of email marketing, online advertising and social media on the consumer decision-making process. *Qual. Access Success* 24, 313–318. doi: 10.47750/QAS/24.194.35
- Duncan, B., Goeb, J., Lambrecht, I., Headey, D., Takeshima, H., Mahrt, K., et al. (2021). Impacts of COVID-19 on agricultural production and food systems in late transforming Southeast Asia: the case of Myanmar. *Agric. Syst.* 188:103026. doi: 10.1016/j.agsy.2020.103026
- Faiza, M., Wei, L., and Chen, J. (2023). Empirical evaluation of ethical practices and digitalization of agricultural system with the mediation of user behavior: a case study of Pakistan. *Front. Environ. Sci.* 11, 1–12. doi: 10.3389/fenvs.2023.1099008
- Gusti Ketut Agung Ulupui, I., Murdayanti, Y., Gurendrawati, E., and Pahala, I. (2023). Integrated reporting using extensible business reporting language (Xbrl) adoption and its effects. *Qual. Access Success* 24, 214–225. doi: 10.47750/QAS/24.192.26
- Hailesslassie, A., Mekuria, W., Uhlenbrook, S., Ludi, E., and Schmitter, P. (2022). Gap analysis and methodological framework to assess and develop water centric sustainable agricultural intensification pathways in sub-Saharan Africa. *Front. Water* 4, 1–19. doi: 10.3389/frwa.2022.747610
- Istriningsih, Y. A. D., AstrinaYulianti, V. W., Hanifah, E. J., Dadang, M. S., Mardiharini, M., SetiadjieAnugrah, I., et al. (2022). Farmers' knowledge and practice regarding good agricultural practices (GAP) on safe pesticide usage in Indonesia. *Heliyon* 8:e08708. doi: 10.1016/j.heliyon.2021.e08708
- Lambertus, A. P., Clemens, C. M., and Marinus, J. M. (2018). How to assure that farmers apply new technology according to good agricultural practice: lessons from Dutch initiatives. *Front. Environ. Sci.* 6, 1–5. doi: 10.3389/fenvs.2018.00089
- Liang, Y., Cossani, C. M., Sadras, V. O., Yang, Q., and Wang, Z. (2022). The interaction between nitrogen supply and light quality modulates plant growth and resource allocation. *Front. Plant Sci.* 13, 1–14. doi: 10.3389/fpls.2022.864090
- Manevska-Tasevska, G., Pettitt, A., Larsson, S., Bimilovski, I., Meuwissen, M. P. M., Feindt, P. H., et al. (2021). Adaptive governance and resilience capacity of farms: the fit between farmers' decisions and agricultural policies. *Front. Environ. Sci.* 9, 1–13. doi: 10.3389/fenvs.2021.668836
- Marine Sasha, C., Martin, D. A., Adalja, A., Mathew, S., and Evertsae, K. L. (2016). Effect of market channel, farm scale, and years in production on mid-Atlantic vegetable producers' knowledge and implementation of good agricultural practices. *Food Control* 59, 128–138. doi: 10.1016/j.foodcont.2015.05.024
- Moh, M. (2023). Supply chain performance as a mediating factor in the effect of supply agility on company performance. *Qual. Access Success* 24, 306–313. doi: 10.47750/QAS/24.193.34
- Muafi, , and Uyun, Q. (2021). Green HRM (GHRM) and business sustainability: the mediation role of environmental management strategy (EMS). *Qual. Access Success* 22, 133–137.
- Osman, K., Boz, İ., and Eryilmaz, G. A. (2020). Comparison of conventional and good agricultural practices farms: a socio-economic and technical perspective. *J. Clean. Prod.* 258:120666. doi: 10.1016/j.jclepro.2020.120666
- Purnamie, T., Susanto, A. B., Prajitiasari, E. D., and Wulandari, G. A. (2022). Business model innovation based management system creative industry strategy in Jember regency. *Qual. Access Success* 23, 119–123. doi: 10.47750/QAS/23.188.17
- Rashiti, M., and Skenderi, N. (2022). Impact of corporate social responsibility as competitive factor on small and medium businesses in Kosovo. *Qual. Access Success* 24, 261–270. doi: 10.47750/QAS/24.192.30
- Reddy, A. A. (2019). The soil health card scheme in India: lessons learned and challenges for replication in other developing countries. *J. Nat. Resour. Policy Res.* 9, 124–156. doi: 10.5325/naturesopolirese.9.2.0124
- Reddy, A. A., Melts, I., Geetha Mohan, C., Rani, R., Pawar, V., Singh, V., et al. (2022). Economic impact of organic agriculture: evidence from a pan-India survey. *Sustainability* 14:15057. doi: 10.3390/su142215057
- Reum, J. A., Lee, G., and Jeong, E. (2020). COVID-19 impact on hygiene practices for food safety in South Korea. *Public Health Pract.* 3:100241. doi: 10.1016/j.puhip.2022.100241
- Robert, L. (2020). “10 – alternative/organic agricultural systems” in *Agriculture's Ethical Horizon (Third Edition)*, Fort Collins, CO, United States: Colorado State University, an imprint of Elsevier, 227–245. doi: 10.1016/C2020-0-00500-1
- Rosegrant Mark, W., Sulser, T. B., and Wiebe, K. (2022). Global investment gap in agricultural research and innovation to meet sustainable development goals for hunger and Paris agreement climate change mitigation. *Front. Sustain. Food Syst.* 6, 1–21. doi: 10.3389/fsufs.2022.965767
- Shahab, M. A., Putra, M. A., and Udin, U. (2022). Strengthening social capital to increasing farmers' entrepreneurial ability. *Qual. Access Success* 23, 200–208. doi: 10.47750/QAS/23.187.25
- Slaba, M. (2021). Influence of sociodemographic characteristics on customers' Price sensitivity. *Qual. Access Success* 22, 84–87.
- Suwanna, P., Vijitsrikamol, K., and Schreinemachers, P. (2022). Ecolabeling to improve product quality and reduce environmental impact: a choice experiment with vegetable farmers in Thailand. *Front. Sustain. Food Syst.* 5, 1–9. doi: 10.3389/fsufs.2021.704233
- Thamrin, S., Mursitama, T. N., and Furint, A. (2022). The moderating effect of environmental turbulence and the influence of critical factors for sustainable MLM business growth: an empirical study. *Qual. Access Success* 24, 136–147. doi: 10.47750/QAS/24.192.16
- Trisha, A., and Martadikusumah, A.Indrawati (2024). Digital marketing implementation by culinary micro small medium enterprises during Covid-19 (an Indonesia case). *Qual. Access Success* 25, 229–235. doi: 10.47750/QAS/25.198.25
- Victor, L., Keesman, K. J., and Joyce, A. (2022). Plants dictate root microbial composition in hydroponics and aquaponics. *Front. Microbiol.* 13, 1–12. doi: 10.3389/fmicb.2022.848057