The Development of Strategic Guidelines to Enhance the Capacity of Young Farmers as Smart Agriculture Entrepreneurs in Chiang Mai Province

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Abstracts

This research article aims to study: 1) the potential and needs of new-generation farmers in Chiang Mai province in transitioning to becoming smart agriculture entrepreneurs, and 2) the development of strategic approaches to enhance their capacity for sustainable smart agriculture operations. The research employed a mixed-methods approach, combining both quantitative and qualitative research methods. In the quantitative research, data were collected from 187 new-generation farmers who were registered with the Department of Agricultural Extension in Chiang Mai province using a questionnaire. The data were analyzed using descriptive statistics such as mean, standard deviation, and multiple regression analysis. In the qualitative research, in-depth interviews were conducted with 10 new-generation farmers who received the provincial outstanding farmer award, and the data were analyzed using content analysis.

The findings revealed that new-generation farmers had a high overall potential, particularly in modern agricultural knowledge and skills, as well as management and marketing skills. Their highest needs for development as smart agriculture entrepreneurs were in the area of building collaborative networks, followed by financial support and assistance. The strategic recommendations for enhancing the sustainable capacity of new-generation farmers include providing training in modern agricultural technologies, establishing specialized support funds, creating collaborative networks with all sectors, and promoting marketing through digital platforms, all aimed at strengthening their position as stable and sustainable smart agriculture entrepreneurs.

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Introduction

Agriculture remains a fundamental pillar of Thailand's economy. Although its contribution to the Gross Domestic Product (GDP) has declined in line with the development of the industrial and service sectors, agriculture continues to play a crucial role in driving the economy, generating income, and ensuring the country's food security. Thailand has earned international recognition as the 'Kitchen of the World' and holds the position as the 11th largest food exporter globally and the 2nd largest in Asia, after China. The country is a major exporter of high-demand agricultural and food products in the global market, including rice, cassava, chicken, shrimp, rubber, sugar, and longan (Tarnittanakorn, 2014). Chiang Mai Province is considered one of the strategic areas for agriculture, with significant potential for producing high-quality agricultural products such as temperate fruits, ornamental flowers, and organic products, which have continuously gained popularity both in domestic and international markets, especially among health-conscious and environmentally-aware consumers (Kawichai et al., 2022). Enhancing the agricultural sector's capacity to add value and sustainability is thus an urgent issue that is prioritized by the government, the private sector, and civil society. However, the agricultural population in Chiang Mai still consists largely of older farmers, accounting for more than 60%, resulting in a clear gap in skills, knowledge, and attitudes toward the adoption of modern technologies (Meedaycha, 2020). Meanwhile, the new generation of farmers, who are crucial in inheriting and developing the agricultural sector, lacks guidance on how to become entrepreneurs who utilize data management and automation systems, also known as 'Smart Agriculture' (Jongpluempiti, et al., 2023). “Smart Agriculture” refers to the application of information technology, sensor systems, the Internet of Things (IoT), and big data analytics to help plan, manage, and monitor agricultural production as well as control production factors (Narusinghsamran & Silpcharu, 2021). International research indicates that smart agriculture can increase productivity by 15–25% and significantly reduce costs related to fertilizers, water, and labor (Saiz-Rubio & Rovira-Más, 2020). In Thailand, the Ministry of Agriculture and Cooperatives has announced a strategy to promote smart agriculture, encouraging farmers nationwide to adopt technology for more efficient farm management, particularly

through the use of soil moisture sensors, smart water management systems, and plant health data analysis platforms (Boonyeam, et al., 2023).

However, most projects and measures focus on general training and technology demonstrations, lacking a strategic framework tailored to the context of new-generation farmers in different areas. In Chiang Mai, although there are several pilot projects on smart agriculture, such as the Mae Rim District Smart Agriculture Demonstration Center and drone and satellite applications for crop monitoring, evaluations have shown problems with the practical adoption of these technologies by new-generation farmers due to a lack of in-depth knowledge, financial support, business networks, and appropriate attitudes and motivation (Chiang Mai Agriculture and Cooperatives Office, 2021). Furthermore, many studies on smart agriculture tend to focus on national-level overviews or case studies of large farms, without delving into the role and potential of new-generation farmers, who often face limitations in cost and business management experience, resulting in a lack of strategic data to promote them as true smart agriculture entrepreneurs.

Given these issues, the researcher aims to develop a strategic framework to enhance the capabilities of new-generation farmers in Chiang Mai to apply smart technologies in farm management, increase productivity, and reduce costs sustainably. This approach will help bridge the skills gap and motivate new-generation farmers to become innovative smart agriculture entrepreneurs by studying their potential and needs to develop appropriate strategies for enhancing their abilities. This will enable them to effectively and sustainably operate smart agriculture businesses.

Research Objectives

1. To study the potential and needs of new-generation farmers in Chiang Mai province in developing them into smart farming entrepreneurs.

2. To develop strategic approaches for enhancing the capabilities of new-generation farmers in Chiang Mai province, enabling them to sustainably operate smart farming businesses.

Research Methodology

This research employs both quantitative and qualitative approaches. The research process is as follows:

1. Population and Sample: The population in this study consists of new-generation farmers who are registered with the Department of Agricultural Extension in Chiang Mai Province between 2014 and 2023, totaling 353 individuals (Department of Agricultural Extension, 2023). The researcher used the Taro Yamane formula (1973) to calculate the sample size, which resulted in an appropriate sample size of 187 individuals. In addition, 10 new-generation farmers with outstanding achievements and who have been awarded as excellent farmers at the provincial level of Chiang Mai were selected for in-depth analysis, in conjunction with descriptive analysis. This approach will provide a more comprehensive and profound perspective on the development strategies and roles of new-generation farmers in the area, in order to identify strategic approaches to enhance the potential of new-generation farmers in Chiang Mai Province.

2. Research Instruments: The quantitative research instrument used was a questionnaire developed to collect data from 187 new-generation farmers in Chiang Mai Province. The questionnaire was divided into five main sections: Section 1: General information about the respondents, such as age, gender, education level, agricultural experience, and occupational patterns. Section 2: The potential of new-generation farmers as smart agriculture entrepreneurs, including skills in technology, planning, management, and innovation. Section 3: The needs for knowledge and skill development, such as training, access to funding, technology, and markets. Section 4: Supportive factors and obstacles in running smart agriculture businesses, including support from government agencies, the private sector, the community, and resource limitations. Section 5: Additional suggestions from the respondents to reflect in-depth opinions and views on development strategies. The questionnaire used a 5-point Likert scale for responses:

1.00 – 1.80: Strongly Disagree
1.81 – 2.61: Disagree
2.62 – 3.42: Neutral
3.43 – 4.23: Agree
4.24 – 5.00: Strongly Agree

Reliability of the instrument was tested through content validation by experts and internal consistency (Cronbach's Alpha), with values above 0.70, which indicates good reliability.

For the qualitative research instrument, in depth interviews were conducted with 10 new-generation farmers who received the Provincial Outstanding Farmer award in Chiang Mai. Transcripts and notes were taken, analyzing factors that promote and the roles of these farmers, which were then subjected to descriptive analysis to summarize strategic development approaches for empowering new-generation farmers towards sustainable smart agriculture entrepreneurship.

3. Data Collection: Data was collected using both quantitative and qualitative methods. For the quantitative research, data was gathered through the questionnaire, distributed in collaboration with agricultural extension officers from the Chiang Mai Provincial Agricultural Office, targeting 187 registered new-generation farmers. For the qualitative data, in-depth interviews were conducted with 10 outstanding new-generation farmers, selected from the Provincial Outstanding Farmer awardees in Chiang Mai. The interviews were scheduled one week in advance and group discussions were held to gain comprehensive and detailed insights. Both methods focused on obtaining data reflecting the potential, needs, and development strategies for promoting new-generation farmers towards stable and sustainable smart agriculture entrepreneurship.

4. Data Analysis: For the quantitative data, descriptive statistics such as frequency, percentage, mean, and standard deviation were used to describe the general characteristics of the sample. For the qualitative data, content analysis was employed to analyze the in-depth interviews, synthesizing key issues reflecting the perspectives, experiences, and strategic approaches to developing new-generation farmers into sustainable smart agriculture entrepreneurs.

Results

The researcher conducted a study on the development of strategic approaches to enhance the capacity of new-generation farmers to become smart agricultural entrepreneurs in Chiang Mai Province. The findings of the study can be summarized in the following steps:

Part 1: General Information of the Respondents. This section presents the personal background of the 187 respondents. The majority of them were female (59.9%), aged between 31–35 years (55.1%), and held a bachelor's degree (63.1%). Most had cultivated land ranging from 1 to 10 rai (47.1%). These findings reflect that this group of new-generation farmers is relatively well-educated, with suitable age

and professional background, indicating strong potential for development into smart agricultural entrepreneurs.

Part 2: Analysis of the Potential and Needs of Young Farmers in Chiang Mai Province for Development into Smart Agricultural Entrepreneurs, The study found that, overall, young farmers in Chiang Mai demonstrate a high level of potential and desire to develop themselves into smart agricultural entrepreneurs ($\bar{X}$=4.07, S.D.=0.713). When analyzed by category, five key areas were identified: 1) Knowledge and skills in modern agriculture 2) Experience in agricultural occupations 3) Access to funding and resources 4) Management and marketing skills 5) Networks and support systems. Each category shows varying means and standard deviations, reflecting the diversity of potential among farmers based on their individual contexts. A summary of each category is presented in the following table.

The potential of new-generation farmers	$\bar{X}$	S.D.	analyze the results
1. Knowledge and skills in modern agriculture	4.10	0.75	very
2. Experience in agricultural occupations	4.18	0.759	very
3. Access to funding sources and resources	4.02	0.781	very
4. Management and marketing skills	4.03	0.721	very
5. Networking and support systems	4.06	0.664	very
total	4.07	0.713	**very**

Table 1 Analysis of New Generation Farmers' Potential

The table indicates that the study found that new-generation farmers have significant potential to develop into smart agricultural entrepreneurs. This reflects their awareness and readiness to adapt to modern farming, particularly in terms of knowledge and technological skills, which have been promoted by both the government and farmer networks. The experience and the transfer of occupation from family members also help strengthen their professional foundation. Meanwhile, the need to access funding sources, management skills, and having a support network remain key factors that farmers prioritize in order to enhance their potential to operate smart agricultural businesses sustainably and securely.

For the analysis of the needs of new-generation farmers in Chiang Mai province in developing into smart farming entrepreneurs, the study results indicate that, overall, the new-generation farmers have high levels of need ($\bar{X}$ =4.41,

S.D.=0.688), reflecting their determination and readiness to adapt to modern agricultural systems. The needs can be classified into five main areas: (1) the need for knowledge and training, (2) the need for capital and support, (3) the need for collaborative networks, (4) the need for marketing and sales channels, and (5) the need for technology and innovation. Each of these areas showed a significant level of need. The details of each area are summarized in the following table.

Development needs	$\overline{X}$	S.D.	analyze the results
1. Knowledge and training needs	4.35	0.752	most
2. Financial and support needs	4.37	0.702	most
3. Collaboration network needs	4.51	0.610	most
4. Market and distribution channel needs	4.35	0.752	most
total	4.41	0.688	**most**

Table 2 Development Needs

The table shows that the study results reveal that new-generation farmers have an urgent desire for development in all aspects. In this era of digital agriculture, farmers are well aware that networking ($\overline{X}$=4.51, S.D.=0.610) is a key element leading to the exchange of knowledge and access to resources. At the same time, investing in innovation ($\overline{X}$=4.37) further emphasizes the need for capital and support, along with skill development through training ($\overline{X}$=4.35), as well as the establishment of modern market strategies ($\overline{X}$=4.35). All of these factors contribute to enabling farmers to transform into smart farmers in a stable and sustainable manner.

Part 3: Strategic Approaches to Enhancing the Potential of New Generation Farmers in Chiang Mai for Sustainable Smart Agriculture, To elevate new generation farmers in Chiang Mai towards sustainable smart agriculture, the following key strategies and approaches are proposed:

1. Capacity Development through Training: Establish training programs, workshops, and hands-on learning projects covering everything from basic IoT and Big Data to the use of drones and sensors, in order to expand knowledge and enhance necessary skills.

2. Financial and Infrastructure Support Systems: Design a specific fund for smart agriculture in collaboration with financial institutions, and establish a center

for renting and exchanging technology equipment, as well as Smart Farm Demo areas for farmers to try out with low investment costs.

3. Collaborative Network with Participation: Build a network of new generation farmers, community enterprises, government agencies, and the private sector to exchange experiences, organize clusters, and foster collaboration in developing innovations together.

4. Expansion of Digital Marketing Channels and Branding: Develop online platforms and community e-commerce systems, train farmers in digital marketing skills, brand communication, and the use of social media, to ensure that products effectively reach consumers.

5. Research and Development of Context-Specific Technology: Collaborate with educational institutions and research centers to develop prototype technologies that are appropriate for Chiang Mai's climate, soil, and agricultural culture, ensuring the best possible outcomes when applied.

6. Promotion of Sustainable Agriculture and Resource Management: Integrate circular farming practices, effective water and soil management, and nutrient recycling systems in the fields, in order to reduce costs and preserve the environment.

7. Proactive Policy and Support Mechanisms: Advocate for tax exemptions, fee waivers, or other benefits for smart agriculture, and establish a new generation farmers' representative committee to ensure that their voices and suggestions are incorporated into policy implementation.

Discussion

The findings from the research on developing strategic approaches to enhance the capabilities of new-generation farmers in Chiang Mai Province to become smart agricultural entrepreneurs present the following key points for discussion:

1. Potential and Needs of New-Generation Farmers in Chiang Mai in Developing Smart Agricultural Entrepreneurs, The research highlights that new-generation farmers are aware and ready to adapt to the era of modern agriculture that integrates advanced technology and sustainable practices. Furthermore, the study demonstrates their commitment in several areas, including enhancing knowledge and skills in modern agriculture, managing resources and funding, developing marketing skills, and building broad support networks. These factors are

crucial in advancing agriculture toward a sustainable smart farming model. For example:

Development of Agricultural Knowledge and Skills: The study shows that new-generation farmers express a strong desire for training and enhancing their knowledge in modern agricultural technologies, reflecting their readiness to adopt technology to improve productivity. Sustainable agricultural knowledge development has received support from the government and farmer networks, enabling farmers to learn new methods to meet ever-changing market demands (Thirada Wongkudlo, 2018; Ngamcharoen & Renliang, 2024). Government promotion of learning and training will help increase new-generation farmers' competitiveness in a rapidly changing market.

Access to Funding and Resources: The research found that new-generation farmers emphasize the importance of access to funding and resources, which is crucial in developing smart farming enterprises. Access to sufficient capital enables investments in new technologies, enhancing farmers' production capabilities (Boonyeam, 2023). Support from the government and relevant agencies to access funding and necessary training is essential in developing new-generation farmers to compete sustainably in agriculture.

Networking: The development of strong networks is a key factor that allows farmers to exchange knowledge, experiences, and resources. Linking networks between farmers, research institutions, and the government is crucial for promoting sustainable development (Ngamcharoen & Renliang, 2024; Trirabaib, et al., 2024). Effective networks improve access to markets, product publicity, and new information on modern agricultural technologies and methods.Marketing and Sales Skills: Marketing is an indispensable factor in agricultural development. Even with quality production, inefficient marketing management makes it difficult to thrive in a competitive market (Taikham, et al., 2024). Developing marketing and sales skills, as well as creating new sales channels, such as using online platforms, will help farmers reach consumers more easily and ensure the sustainability of their agricultural enterprises.

In summary, enhancing the capabilities of new-generation farmers in Chiang Mai requires consideration of various aspects, including knowledge, technical skills, access to funding, network building, and marketing skill development. All of these factors will contribute to ensuring the stability and sustainability of smart agricultural

enterprises in the future. The support from the government and relevant agencies is crucial to driving continuous development in the digital agriculture era.

2. Implications of the Study, The findings clearly demonstrate that the development of new-generation farmers into sustainable smart agricultural entrepreneurs in Chiang Mai requires an integrated strategic approach, which does not focus solely on enhancing specific competencies. Instead, it integrates key elements systematically. Strategies identified as crucial include:

Developing Knowledge and Skills in Modern Technology: This is the foundation of advancing smart farming, especially digital technologies such as IoT, Big Data, and automation systems. These technologies can enhance production efficiency, analysis, and planning, aligning with research by Piyaporn Boonyeam, et al. (2023), who identified modern technology knowledge as a key factor influencing new-generation farmers' decisions to adopt smart farming systems.

Financial Support and Access to Resources: This strategy is equally essential, particularly in the early stages of business when capital is needed to invest in technology. This finding aligns with Kendall, et al. (2022), who highlighted that access to capital and low-interest loans accelerates the adoption of smart agricultural technologies in China.

Networking and Collaboration: Building strong collaboration networks among farmers, government agencies, private enterprises, and academic institutions plays a vital role in knowledge exchange and academic development. This enables new-generation farmers to avoid isolation in innovation and better cope with market changes.

Development of Digital Marketing Capabilities: Digital marketing plays an important role in expanding trade opportunities for agricultural products. Promoting farmers' ability to build brands and directly connect with end consumers is an important focus. This is consistent with the research by Intase, et al. (2024), who found that farmers using digital platforms for sales tended to achieve significantly higher income.

Finally, the integrated strategy of developing appropriate technologies, supporting sustainable agriculture, and continuously implementing supportive policies will lay a solid foundation for long-term growth. This will enable new-generation farmers to adapt, remain resilient, and compete in the digital economy. In conclusion, this research presents new knowledge on designing strategies that can

drive Chiang Mai's agricultural sector into the future, particularly by enhancing the human capital at the center of change. It also underscores that the transition to smart farming requires a balanced integration of skills, technology, and supporting structures to succeed.

New Knowledge

From the study on developing strategic approaches to enhance the capabilities of new-generation farmers as smart agriculture entrepreneurs in Chiang Mai, the following significant new knowledge emerged: 1) Framework of Potential and In-depth Needs, The potential of new-generation farmers was defined and categorized into five dimensions: knowledge and skills in modern technology, professional experience, access to financial resources, management and marketing skills, and support networks. 2) Hands-on Training Approach Addressing Local Context, A curriculum was designed integrating IoT, Big Data, drones, and sensors with the agricultural characteristics of Chiang Mai, tailored to local needs. 3) Specialized Revolving Fund Model and Digital Infrastructure, A Smart Farming Fund model was proposed, offering low-interest loans along with a rental exchange center for agricultural equipment. 4) Integrated Innovation Platform Mechanism, An exchange platform was created for collaboration among the government, private sector, academic institutions, and farmer networks. The Smart Cluster Model was employed to group farmers based on products and geographic areas for joint development. 5) Digital Market and Branding Strategies for Consumer Access, The use of e-marketplaces, social commerce, and blockchain to track product origins was recommended. A strategy for brand communication through social media targeting specific consumer groups was also developed. 6) Integration of Sustainable Agriculture with Smart Farming, The integration of closed-loop agricultural practices and water-soil management systems with smart technologies aimed at reducing costs and preserving resources. 7) Proactive Policy Framework, Measures to promote tax and fee reductions, the establishment of a committee for new-generation farmers, and the development of provincial-level strategic plans were proposed to drive policy initiatives.

Conclusion and Suggestion

The study found that new-generation farmers in Chiang Mai possess strong potential to become smart agricultural entrepreneurs. They demonstrate readiness through their modern agricultural knowledge, experience, management skills, and ability to build networks. However, their key development needs include greater access to funding, technology, training, and collaborative networks essential elements for achieving sustainable and smart farming practices. To support their growth, strategic approaches should focus on enhancing knowledge and technology through training, providing financial support, developing public-private partnerships, expanding digital market access, and promoting sustainable farming methods. These strategies aim to empower young farmers to transition into smart farming, ensuring long-term stability and resilience in the agricultural sector.

Therefore, the researcher has made recommendations based on the study, which are divided into three main areas: policy recommendations, practical applications, and suggestions for future research.

1. Policy Recommendations

1.1 Support access to funding and financial promotion: The government should establish a fund to promote smart farming (Smart Farming Fund) for new-generation farmers, with a focus on offering low-interest loans and repayment terms that align with agricultural production cycles.

1.2 Enhance digital infrastructure in rural areas: Expand high-speed internet and 5G networks in agricultural regions, enabling farmers to access IoT technology and real-time farm management systems.

1.3 Develop policies to promote smart farming at the provincial and regional levels: Create a strategic plan for Chiang Mai province focusing on smart agriculture, integrating government agencies, educational institutions, and the private sector to foster sustainable development.

2. Practical Applications

2.1 Organize training and skill development programs in technology for new-generation farmers: Relevant agencies should provide training courses in agricultural technologies such as drone usage, automated farm management, and production data analysis.

2.2 Establish a cooperative network between new-generation farmers, the private sector, and research institutions: Promote knowledge exchange and real-

world innovation trials in the field through models like "joint experimental plots" or "smart farming community learning centers."

2.3 Promote the use of digital platforms for marketing and management: Encourage farmers to use e-marketplaces, blockchain-based product tracking systems, and platforms for production data analysis to increase product value and market access.

3. Recommendations for Future Research

3.1 Study the development models of smart farming for specific crop groups: Conduct in-depth research targeting specific groups, such as farmers growing medicinal plants, to design tailored and effective promotion strategies.

3.2 Compare regional smart farming promotion models: Compare the development of smart farming in the Northern, Central, and Northeastern regions to identify limitations and promoting factors in each context.

3.3 Study the psychological factors and motivation of new-generation farmers in adapting: Analyze attitudes, beliefs, and motivations for adopting technology to inform the design of suitable policies or promotion activities for the target group.

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