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The Success of Agricultural Small and Medium-sized Enterprises (SMEs) in the Digital Era: A Case Study of Northeastern Thailand

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Abstract

Background and Aim: Agricultural Small and Medium-sized Enterprises (SMEs) in the northeastern region are crucial to the economy but are facing challenges from digital transformation, climate change, and rising household debt. At the same time, new opportunities have emerged through AgriTech and E-commerce. Given this context, this study aims to evaluate the business strategies and technology adoption of agricultural SMEs and examine the factors contributing to their success. The findings will provide recommendations for fostering sustainable growth in digital agriculture businesses.

Materials and Methods: This article is a qualitative research study that employs a case study analysis as its primary research methodology. Data were collected and synthesized from various secondary sources through a systematic literature review. The analysis of the success of agricultural Small and Medium-sized Enterprises (SMEs) is based on the integration of multiple key theoretical frameworks. It begins with the application of business strategy theories to guide organizational direction, along with entrepreneurial characteristics such as innovative thinking and risk acceptance. These elements are further complemented by the adoption of digital technologies and innovations to create competitive advantages, both in production through AgriTech, including IoT, Big Data, and drones, and in marketing through e-commerce. All of these factors are managed systematically using management process principles to achieve organizational goals effectively. The study is based on a systematic literature review and content analysis of case studies involving successful agricultural SMEs in the northeastern region.

Results: The findings reveal that the success of agricultural SMEs stems from the integration of six key interrelated and mutually reinforcing factors: (1) entrepreneurship and leadership, (2) adaptability and the application of innovation and digital technology, (3) the efficiency of internal management processes based on the POLC framework, (4) access to and management of resources, (5) network building and collaboration, and (6) market orientation and responsiveness to consumer needs.

Conclusion: The success of agricultural SMEs in the northeastern region in the digital era depends on the systematic integration of various factors, including entrepreneurial characteristics, the ability to adopt appropriate AgriTech, farm management efficiency, effective development of strong collaborative networks, and a primary focus on meeting market demands. Therefore, a holistic approach is essential for fostering sustainable growth.

Keywords: Small and Medium Enterprises (SMEs), Agricultural Technology (AgriTech), Business Strategy, Northeastern Region

Introduction

Agricultural Small and Medium-sized Enterprises (SMEs) play a significant role in Thailand's economic and social systems, particularly in the northeastern region, which serves as a major agricultural area of the country. These SMEs are vital in generating employment, creating income, and distributing wealth to local communities on a broad scale (Wongchaiya & Phuenpha, 2018).

In the era of digital transformation, agricultural SMEs face increasingly complex conditions that include both challenges and opportunities. The vulnerability of small-scale agricultural businesses in this region to various external factors highlights the urgent need to strengthen their capacities through the application of innovation and effective management systems (Koedsuk, 2022).

Agricultural SMEs in this area are not only dealing with general business challenges, but the digital era has also opened new opportunities for them. The growth of online commerce has expanded marketing channels, enabling farmers to connect directly with consumers across wider areas. Additionally, government policies have supported the adoption of digital technology in the agricultural sector.

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However, the capacity of agricultural SMEs in the region—particularly small-scale entrepreneurs in the northeastern area—to access, understand, and effectively implement these policies and technologies remains a major barrier that must be urgently addressed (Rakbankerd, 2020).

Challenges Faced by Agricultural Small and Medium-sized Enterprises (SMEs): (1) Intense Competition. The business environment is rapidly changing, with increasing levels of competition that pose significant challenges to SMEs. (2) Impact of Climate Change: Changes in climate conditions directly affect both the quantity and quality of agricultural production. (3) Limited Access to Resources Many SMEs face difficulties in accessing investment capital and modern technologies needed to improve operational efficiency. (4) Debt Burden: High levels of household debt lead to liquidity problems and reduce the capacity for further investment. (5) Unexpected Crisis Events, such as the COVID-19 pandemic and outbreaks of cassava mosaic disease, have created serious disruptions. (6) Vulnerability to External Factors Agricultural SMEs in the northeastern region are highly sensitive to both natural conditions and macroeconomic fluctuations. (7) Limitations in Technology Adoption Despite the availability of policies and supporting technologies, many small-scale entrepreneurs cannot access, understand, and effectively utilize these tools (Bank of Thailand, 2024; Office of Agricultural Economics, 2021).

Opportunities for Agricultural Small and Medium-sized Enterprises (SMEs): (1) Digital Technology and Agricultural Innovation (AgriTech). The adoption of technology can enhance production efficiency, reduce costs, and improve product quality. (2) New Marketing Channels The rise of e-commerce has enabled farmers to sell directly to consumers, expanding their market reach and reducing reliance on intermediaries. (3) Government Support Policies There are various government policies and programs aimed at promoting the use of digital technology and big data in agriculture, such as the SME Promotion Plan and initiatives by the Ministry of Agriculture and Cooperatives (Bizidea, 2021; Ministry of Agriculture and Cooperatives, 2019; SDJourney, 2021; Rakbankerd, 2020).

Despite these opportunities, a policy implementation gap still exists. Although the government provides comprehensive support—such as SME promotion plans, big data applications, and the continued emergence of modern agricultural technologies—agricultural SMEs, especially small-scale entrepreneurs in the northeastern region, still struggle to access, understand, and fully utilize these policies and technologies.

This study focuses on addressing challenges such as the lack of digital knowledge and skills, the mismatch between technology design and user needs, and ineffective policy communication. It also aims to explore suitable models of support and promotion that align with the specific context of agricultural SMEs in this region, enabling them to adapt and grow sustainably in the long term.

Objectives

1. To understand the economic, environmental, and digital transformation contexts of agricultural Small and Medium-sized Enterprises (SMEs) in the northeastern region.
2. To explore agricultural SMEs and analyze the role of government and private sector support mechanisms in business development.
3. To study the success factors in the adoption of modern agricultural technologies (AgriTech) and management approaches that lead to business success.
4. To analyze case studies of successful agricultural SMEs in the northeastern region.
5. To synthesize the study's findings and provide practical recommendations for creating a business ecosystem that supports the sustainable growth of agricultural SMEs.

Literature Review

In the digital era, where competition is rapidly evolving, the success of agricultural Small and Medium-sized Enterprises (SMEs) no longer depends on traditional production factors. Survival and sustainable growth now require the integration of modern knowledge, including clear business strategy formulation, the application of agricultural innovations (AgriTech), and the use of digital technology for marketing. These elements are considered essential for creating competitive advantages and driving business forward with stability.

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1. Business Strategies for SMEs

Business strategy defines the direction and guidelines for organizational operations to achieve set objectives, especially in highly competitive and ever-changing business environments (Koedsuk, 2022). For SMEs, having a clear and appropriate strategy helps maximize the efficient use of limited resources and create competitive advantages.

Business-level strategy focuses on gaining a competitive advantage for each business unit or product line. Examples of strategies at this level include cost leadership, which aims to produce goods or services at a lower cost than competitors; differentiation, which emphasizes creating distinctive features or unique value for products or services; and product development, which involves introducing new products or improving existing ones to better meet market demands (Koedsuk, 2022).

Entrepreneurial Characteristics Influencing Success

Beyond strategy, the personal characteristics of entrepreneurs play a crucial role in business success. Studies have found that successful entrepreneurs commonly exhibit seven key traits: (1) need for achievement, (2) risk-taking, (3) self-confidence, (4) knowledge, ability, and eagerness to learn, (5) perseverance, (6) capital, and (7) innovative thinking (Wongchaiya & Phuenpha, 2018).

The innovative thinking characteristic of entrepreneurs is crucial in bridging traditional business strategies with innovation in the digital era. Without this trait, even with excellent business strategies, entrepreneurs may struggle to adapt or effectively apply new technologies. Only entrepreneurs who possess innovative thinking can recognize opportunities to leverage agricultural technology (AgriTech) or e-commerce (Office of Agricultural Research Development, 2020) to strengthen existing business strategies or even transform and create entirely new business models. If entrepreneurs remain attached to conventional methods, even with cost-reduction strategies, they may fail to compete sustainably in the long term against rivals who utilize technology effectively (Koedsuk, 2022).

Strategic Factors Influencing the Success of SMEs

Several studies have attempted to identify strategic factors that contribute to the success of SMEs. For example, research on SMEs in the food and beverage service sector in Bangkok found that four business management strategies—cost leadership, product development, differentiation, and focused market strategy—significantly influence business success. Business success is often measured across multiple dimensions, such as revenue, sales or profit, customer numbers, customer satisfaction, and future planning (Koedsuk, 2022).

Measuring the success of SMEs, especially in the highly volatile agricultural sector, should not be limited to financial indicators such as revenue or profit alone. It should also encompass adaptability and long-term sustainability. Future planning (Koedsuk, 2022) is, therefore, a critically important indicator. In the context of agriculture in the northeastern region, which faces challenges such as drought and plant diseases, emphasizing future planning and building resilience may be more important than short-term profits. Innovations such as Uncle Kam's water management system and organic farming practices by farmer groups in Ubon Ratchathani Province are examples of investments aimed at future sustainability (Bank of Thailand, 2024).

2. Innovation and Application in Agriculture (AgriTech)

2.1 Agricultural Innovation The integration of information technology, biotechnology, and various modern agricultural technologies with traditional farming aims to enhance cultivation efficiency, increase productivity, and improve the quality of agricultural products (Kamchampa & Phosing, 2021). Agricultural innovation is considered a crucial tool for economic and social development, enhancing the competitiveness of the agricultural sector and having a broad impact on both farmers and the general population. The main benefits of agricultural innovation (Office of Agricultural Research Development, 2020) include:

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2.1.1 Adding Value to Agricultural Products Innovation helps increase the value of agricultural products through processes such as processing, packaging development, shelf-life extension, and improvements in transportation and distribution systems (Kamchampa & Phosing, 2021).

2.1.2 Improving Production Efficiency and Resource Use Modern technologies enhance the efficient use of resources such as land, water, fertilizers, and labor, reducing waste and being environmentally friendly (Kamchampa &Phosing, 2021).

2.1.3 Addressing Labor Shortages In the face of labor shortages and an aging farming population, agricultural machinery and automation systems can help substitute labor and reduce farmers' workloads (Akarapitakpong, 2021).

2.1.4 Ensuring Food Security and Sustainable Development Agricultural innovation plays a vital role in increasing production to meet the growing global food demand and promoting sustainable farming practices.

2.2. Application of Smart Farming Technology in Thailand AgriTech, or modern agricultural technology, refers to the application of various digital technologies to increase efficiency and reduce costs in the agricultural sector. These technologies play a crucial role in transforming Thai agriculture into a more modern, sustainable, and globally competitive industry. Key examples of such technologies include (Touch, 2024; SDJourney, 2021):

2.2.1 Internet of Things (IoT) for Agriculture The Internet of Things (IoT) is a network of interconnected devices that communicate and exchange data via the internet. In agriculture, IoT is applied to develop smart farming systems for precise and efficient farm management. Key applications of IoT include: (1) Automated Irrigation and Fertilization Control. Soil moisture and weather sensors send data to a control system, which regulates the amount and timing of water and fertilizer to meet the specific needs of the crops. (2) Monitoring and Controlling Greenhouse Environment Sensors measuring temperature, humidity, light, and other factors help maintain an optimal environment inside greenhouses to support plant growth. (3) Plant Health Monitoring and Pest/Disease Alerts Sensors or cameras can detect early signs of diseases or pest outbreaks and promptly alert farmers to take preventive or corrective actions. (4) Data Collection for Crop Cultivation. Data gathered from sensors and farm activities are analyzed to improve production in subsequent cycles, plan marketing strategies, and control costs. (5) Precision Farming The use of data from IoT combined with GPS and other technologies enables management of cultivation areas at the sub-field level, allowing precise use of inputs and reducing environmental impact. However, when implementing IoT on small farms or by smallholder farmers, factors such as cost, ease of use, accessibility of devices, and the ability to perform self-maintenance should be carefully considered (Rakbankerd, 2019).

2.3. Big Data for Agriculture

Big Data refers to vast amounts of information collected from various sources, such as weather data, soil data, cultivation data, market data, and sensor data. Analyzing Big Data can provide valuable insights to support decision-making in the agricultural sector, including:

2.3.1 Planting Planning Analyzing historical and current data to predict weather trends, select suitable crops for specific areas and seasons, and plan efficient use of fertilizers and water.

2.3.2 Risk Management: Analyzing data to assess risks from natural disasters or price fluctuations, leading to the development of appropriate crop insurance systems (Rakbankerd, 2020).

2.3.3 Traceability and Transparency Storing data for every production step to build consumer confidence regarding the origin and quality of agricultural products (Rakbankerd, 2020).

2.3.4 Development of a Central Farmer Database The government has implemented Big Data action plans to develop systems for analyzing agricultural and water economy data, including creating a central farmer database that connects information among government agencies. This database supports analysis and decision-making in production and marketing (Ministry of Agriculture and Cooperatives, 2019).

2.4. Unmanned Aerial Vehicles (Drones) for Agriculture

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Drones have become an essential tool in modern agriculture, applicable to various activities (Touch, 2024), such as:

2.4.1 Surveying and Mapping Drones equipped with cameras can fly over agricultural areas to create high-resolution maps, analyze crop health, and assess damage from natural disasters.

2.4.2 Seeding, Fertilizing, and Chemical Spraying Drones can perform these tasks quickly, accurately, and over large areas, reducing working time, labor requirements, and farmers' direct exposure to chemicals.

2.4.3 Harvesting In some cases, large drones can assist in harvesting certain types of crops. The main benefits of using drones in agriculture include reducing time and costs for farming operations, improving crop quality and yield, and lowering health risks for farmers. However, considerations include the relatively high cost for small-scale farmers and legal requirements related to registration and operational permits.

3. Digital Technology for Marketing: E-commerce and Online Platforms for Small and Medium-sized Enterprises (SMEs)

Besides applying technology in the production process, digital technology also plays a significant role in opening new marketing channels for agricultural products, especially through e-commerce systems and various online platforms. The trend of e-commerce use in the agricultural sector shows promising directions (Bizidea, 2021), including:

3.1 The Growth of Online Agricultural Product Platforms Currently, there is an increasing number of e-commerce platforms specifically designed for agricultural products. These platforms enable farmers to sell their produce directly to consumers or businesses such as restaurants without intermediaries. This helps farmers receive better returns while consumers can access fresh products at fair prices. Examples of platforms in Thailand include Phenixbox.com, Freshket.com, and the Maknet application.

3.2 The use of technology to improve production efficiency in line with the e-commerce market encourages farmers to adopt smart agricultural technologies. This enables them to better assess market demand and plan production more accurately.

3.3 Online marketing and social media. Many farmers and small agricultural entrepreneurs have started using digital marketing tools and social media platforms such as Facebook, Instagram, and LINE to promote and sell their agricultural products. This helps expand their customer base and raise awareness of their products.

3.4 Access to new customer groups and international markets E-commerce breaks down geographical barriers, allowing agricultural products from remote areas to reach customers in major cities and even international markets more easily through improved transportation and logistics systems.

4. Small and Medium-sized Enterprises (SMEs) in Agriculture and the Digital Economy in the Northeastern Region

The northeastern region is highly significant to Thailand’s agricultural sector. Understanding the specific context of this region-including its agricultural economy and the adoption of digital technologies-helps provide a clearer picture of the challenges and opportunities faced by agricultural SMEs.

The agricultural economy in the northeastern region is closely linked to climatic factors, government policies, and both domestic and international market conditions. In 2022, the agricultural sector in this region was projected to grow between 1.7% and 2.7% compared to the previous year, due to favorable weather conditions and sufficient water availability, along with continued government agricultural policies (Office of Agricultural Economics, 2021). However, in 2024, agricultural output is expected to contract slightly, mainly due to the ongoing impact of cassava mosaic disease that began in 2023 (Bank of Thailand, 2024) and the El Niño phenomenon, causing reduced rainfall in early 2024.

Important cash crops in the northeastern region include rice. In 2021, the yield of off-season rice increased significantly due to expanded cultivation areas and sufficient water availability. However, prices

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declined partly because of the increased supply and reduced purchasing power caused by the COVID-19 situation. Cassava is another important cash crop, but it is currently facing an outbreak of mosaic disease, which has affected production volume (Office of Agricultural Economics, 2021).

Positive factors supporting the agricultural sector in this region include the increased water volume in reservoirs due to higher-than-expected rainfall at the end of 2023, which benefited the off-season rice cultivation in 2024. Additionally, continuous government policies and improved farmer incomes from the prices of certain agricultural products, such as rubber and paddy rice, which remain in demand in the market, have contributed positively. However, negative factors that continue to pose significant challenges include the high level of household debt, which undermines farmers' purchasing power and investment capacity; the impact of the El Niño phenomenon, causing uncertainty in rainfall; and the outbreak of plant diseases (Bank of Thailand, 2024).

The adoption of digital technology and AgriTech in agricultural SMEs in the Northeastern region over recent years has seen increasing awareness and emphasis. The region has been actively integrating digital technology and AgriTech innovations into agriculture to improve efficiency, reduce costs, and enhance product quality. Technologies that have begun to be adopted and promoted include agricultural drones, IoT systems for smart farming, the use of Big Data for analysis and decision-making, and various digital platforms (Ang Thong Provincial Agriculture and Cooperatives Office, 2020).

The government and local educational institutions play a crucial role in driving this initiative. For example, there has been the establishment of Agritech and Innovation Centers (AIC) in the Northeastern region, such as the AIC center in Loei province, which aims to serve as a model and hub for agricultural development in line with the Thailand 4.0 policy (Chotiwannapruke, 2021). Khon Kaen University, a leading higher education institution in the region, has continuously organized the Local Smart Farm training program to transfer knowledge and modern innovations in smart agriculture to local communities. The program focuses on building a foundational understanding of smart farming and precision agriculture, the application of IoT and sensors, drone operation for agriculture, value-added processing techniques, and digital marketing (College of Local Administration, 2025). Additionally, Khon Kaen University is involved in the Smart City development project (Khon Kaen Smart City), which includes the dimension of smart farming (Thaweesangskulthai, 2020).

5. Synthesis of Small and Medium Enterprises (SMEs) from Literature Review

From the study and literature review, two main issues have been identified: market gaps and market opportunities.

5.1. Market Gaps: Digital Commerce and Supply Chain Integration. Improving production efficiency alone is insufficient for success if farmers still cannot access markets that offer fair returns. Digital technology, especially E-commerce, has the potential to revolutionize marketing channels.

5.1.1 Development of Agri E-commerce The growth of numerous E-commerce platforms for agricultural products, ranging from government-supported platforms like Thailandpostmart to specialized platforms such as Farmto, DGTFarm, and Kaspy, has raised expectations for reducing the role of commercial intermediaries. This development enables farmers to sell their products directly to consumers (Direct-to-Consumer: D2C) and businesses (Business-to-Business: B2B), thereby allowing them to capture a higher share of the value added.

However, the practical reality is far more complex than anticipated. Discussions on online forums reflect the concrete challenges faced by farmers. Online distribution channels often do not align with the characteristics of agricultural products, which are highly perishable and produced in large volumes. This misalignment is especially problematic in the absence of an efficient logistics system. Small-scale farmers continue to face difficulties in maintaining consistent product quality and ensuring a steady supply to meet online demand. Additionally, they often struggle to compete with larger enterprises that benefit from well-established distribution networks and cost structures that provide a comparative advantage.

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5.1.2 Infrastructure for Digital Trade and Logistics

A key issue in this area is that the real gap in Agri E-commerce does not lie in the digital dimension but rather in the physical one. Well-designed applications are ineffective if products cannot be delivered to end consumers in optimal condition (Office of Trade Policy and Strategy, 2023). The lack of comprehensive and cost-effective cold chain infrastructure is a major constraint hindering the growth of high-value agricultural markets in the Northeastern region. Without such a system, high-quality fresh vegetables and fruits cannot be transported from agricultural areas in the Northeast to urban or export markets without significant deterioration.

5.1.3 Aggregation Gap

Individual small-scale farmers are often unable to fulfill large orders from businesses or efficiently manage numerous online orders. Therefore, it is essential to establish technology-enabled aggregation hubs, which play several critical roles: (1) collecting produce from various farms in the area, (2) grading the quality and size of produce to a consistent standard, (3) providing cold storage facilities for temporary preservation, and (4) managing packaging and delivery operations for online orders.

The real business opportunity does not lie in simply developing more E-commerce applications, but rather in creating Phygital services—a seamless integration of the physical and digital worlds. Success depends on the ability to integrate the digital front-end, such as online marketplace platforms, with the physical back-end, such as efficient logistics systems. Many E-commerce applications have failed to meet expectations due to fragile logistics systems and unstructured distribution networks. A key lesson is that no matter how well-designed an application may be, it cannot operate effectively without supportive physical infrastructure. For example, while a farmer may be able to list organic melons on an app, if the melons spoil before reaching consumers in Bangkok, the transaction will fail and immediately undermine consumer trust.

Therefore, the businesses that will succeed are those that offer **end-to-end solutions**—organizations that not only provide platforms for farmers to sell their products, but also offer services such as on-farm product collection, quality inspection, cold storage, and last-mile delivery. This value proposition is highly significant, as it addresses all of the farmers' key challenges in one comprehensive package. (Office of Trade Policy and Strategy, 2023)

(Differentiation Strategy) ได้อย่างตรงไปตรงมา (Rakbankerd, 2020)

5.1.4 Integration of E-commerce Platforms The integration of E-commerce platforms with big data analytics can fundamentally transform the demand side of the equation. Platforms like *Cropperz* aim to provide farmers with market demand information, enabling them to plan their production in alignment with the needs of processing factories or exporters. This represents a paradigm shift from the traditional "Grow and Pray" approach—planting first and searching for markets later—to a strategic model of "Plan and Profit," where production is guided by market demand to maximize profitability.

Moreover, technologies such as blockchain, offered by providers like *Farmonaut*, can be applied to establish traceability systems throughout the entire supply chain. For high-value or organic products, this is a highly effective marketing tool that builds consumer trust and justifies a premium price. It aligns directly with a differentiation strategy, providing a rational basis for higher pricing. (Rakbankerd, 2020)

5.2. Practical Business Model Opportunities on the Digital Frontier

The digital agriculture sector in Thailand in 2025 presents immense potential to revolutionize the country's agricultural industry. The adoption of digital technology in agribusiness not only enhances production efficiency but also promotes sustainability and competitiveness in a rapidly changing market.

Opportunity 1: Agricultural Technology Service Providers. The development of B2B businesses that manage fleets of drones and IoT sensor networks aligns with the growing trend of technology adoption in agriculture. The use of drones for field management—such as surveying, spraying fertilizers or pesticides, and collecting yield data—can be integrated with mapping systems to pinpoint crop plots, allowing drones to operate automatically and thus reducing labor costs.

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The concept of subscription-based or pay-per-use services can lower the investment barrier for small-scale farmers, which is a major obstacle to adopting technology in the agricultural sector. A network of IoT sensors that continuously monitor and track farming conditions enables farmers to manage their farms more efficiently. (Digital Economy Promotion Agency, 2019)

Opportunity 2: Integrated Logistics and E-commerce Hubs

The development of *Phygital* businesses that integrate online marketplaces with physical produce aggregation centers effectively meets the demands of the digital era. The emergence of specialized e-commerce platforms and online markets for agricultural products allows farmers to connect directly with consumers.

Khon Kaen Province holds high potential to become a logistics hub for the northeastern region of Thailand. The key factors influencing its potential as a logistics center, ranked in order of importance, are: infrastructure (0.3752), geographical location (0.3571), volume of goods transported via various modes (0.1370), and the presence of logistics-related businesses (0.0879).

Solving the *last-mile* delivery challenges for agricultural products and establishing an efficient cold chain system can significantly increase the value of agricultural goods and reduce post-harvest losses, an ongoing challenge in Thailand's agricultural sector. (Digital Economy Promotion Agency, 2019)

Opportunity 3: Proactive Risk Management Platforms

The use of Big Data, AI, and satellite imagery for risk analysis and forecasting is becoming increasingly vital. The *Dragonfly* platform, developed by GISTDA, is a prime example of proactive risk management. It enables farmers to monitor, track, and forecast risks in order to make informed decisions about planning and managing their crops throughout the entire agricultural cycle—from planting to post-harvest sales.

This platform provides weekly updates on crop health, weather alerts, flood and drought warnings both on and around farmland, real-time market prices of agricultural produce, and recommendations on optimal nitrogen fertilizer application in rice fields to reduce chemical fertilizer costs.

Thailand's launch of the high-resolution satellite *THEOS-2*, capable of capturing images at 50-centimeter resolution, will be a significant data source. It will further enhance planning and development capabilities across various sectors, especially agriculture.

Opportunity 4: Digital Transformation Consulting Businesses

Specialized consulting services for agricultural SMEs are critically important. The Digital Economy Promotion Agency (DEPA) has launched the *DEPA Mini Transformation Voucher* program to support entrepreneurs in their digital transformation journey, offering specific packages for smart farm management. Achieving digital transformation to prepare businesses for the digital age is key to success and sustainability in the industry. Consulting firms must possess expertise in both agriculture and technology to serve as trusted "translators" between farmers and technology providers. (Digital Economy Promotion Agency, 2019)

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Table 1: Detailed Analysis of Identified Business Opportunity Gaps

Business Model (Opportunity Profile)	**Main Problem to Solve Target Group**	**(Specific to Northeast Region)**	**Revenue Channels**	**Risks / Dependencies**	**Supporting Ecosystem**
1. Agri-Tech Service Providers	High initial costs, lack of skills, and labor shortage	Smallholder farmers, cooperatives, and large-scale farms	Service fees per rai, monthly service fees	Price competition, equipment maintenance	AIC Centers, Khon Kaen University (personnel), BAAC (equipment loans)
2. Logistics and E-commerce Hub	Weak logistics, product spoilage lack of bargaining power	High-value vegetable and fruit growers, urban buyers B2B	Commission fees, logistics service fees	Complex supply chain management	Department of Trade Promotion, Thailand Post, and private platforms
3. Risk Management Platforms	Damage from diseases and weather conditions	Large farmer groups, insurance companies	Monthly/yearly service fees	Data sales| Data accuracy, farmer acceptance	NABC, GISTDA, Department of Agriculture
4. Digital Transformation Consultants	Lack of strategic knowledge and digital skills	New generation farmers, SMEs seeking growth	Consulting fees per project/monthly	Need to build high credibility, slow scalability	SME D Bank, Federation of Thai Industries, and local universities

6. Guidelines for Transforming the Agricultural Sector of Northeastern Thailand into the Digital Era

The digital transformation of the agricultural sector in Northeastern Thailand is a complex but achievable mission if all stakeholders collaborate strategically. The overall analysis leads to recommendations targeted at the key stakeholder groups as follows:

6.1. For SME Entrepreneurs

6.1.1 Start with a strategy. Before investing in any technology, entrepreneurs must clearly define their strategic approach—that is, how their business will compete in the market (low cost, differentiation, or niche targeting). The strategy will determine which technology is necessary and most appropriate.

6.1.2 Address the most critical problems. Instead of trying to do everything, focus on solving specific problems that pose the greatest challenges for farmers, such as disease management or logistics issues. Targeted solutions create clear value and encourage customers to pay for the service.

6.1.3 Leverage the As-a-Service model. For those who want to adopt technology, it is advisable to seek providers offering services in an as-a-service model to reduce initial investment risks. For those aiming to start a new business, this model is key to penetrating the smallholder farmer market with limited capital.

6.1.4 Connect with the ecosystem. Do not operate in isolation. Utilize resources such as the AIC centers, university training programs, and local government agencies to gain knowledge, networks, and

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collaboration opportunities.

6.2. For Investors

6.2.1 Integrated Model Investments with potential for expansion and effective competitor defense are not in applications or hardware alone, but in business models offering integrated services, such as Phygital Hubs that connect online markets with physical logistics, or data platforms that can generate added value.

6.2.2 As-a-Service: The Key to Scaling. The agricultural SME market is very large but constrained by limited capital. The As-a-Service (AaaS) model is a mechanism to unlock this market, allowing investors to access a vast customer base without waiting for each farmer to have substantial upfront capital.

6.2.3 Data as the New Asset Businesses that can effectively collect and analyze agricultural data (e.g., risk management platforms) are creating highly valuable assets, which can be leveraged into other sectors such as finance, insurance, or commodity forecasting in the future.

6.3. For Policymakers

6.3.1 Promote Technology Adoption through Service Models
The government should consider providing support or subsidies for initial costs to farmers who choose to adopt technology in an as-a-service model, to accelerate acceptance and create a market for new service providers.

6.3.2 Invest in Infrastructure through Public-Private Partnerships (PPP). Building critical infrastructure, such as cold chains or aggregation centers, requires large investments that may exceed the capacity of a single private sector entity. The government should initiate public-private partnership projects to develop these infrastructures, which will benefit farmers and businesses broadly.

6.3.3 Open Data to Foster Innovation The government should establish clear policies that allow the private sector and researchers to access data from public projects, such as data from NABC or GISTDA, in usable formats. This will enable developers to build value-added services based on these foundational datasets.

Conceptual Framework

This article is based on an integrated conceptual framework that connects theories to analyze the success factors of agricultural SMEs in the digital era. The Organizational Management theory, using the POLC framework (Planning, Organizing, Leading, Controlling), serves as a tool to analyze the efficiency of internal management processes. This framework will be applied to analyze data from case studies in the Northeastern region to synthesize success factors covering dimensions of entrepreneurs, strategies, innovation, and management.

The POLC Framework is one of the widely accepted and still commonly used management frameworks, originally developed by Louis A. Allen in 1958. It consists of four main management functions: (HREX.asia, 2019; Kunavechkij, 2021).

1. P – Planning

Planning is the first and most crucial step in determining the direction of an organization's operations. It involves defining the organization's vision and mission, setting clear and measurable goals and objectives, devising distinctive and context-appropriate strategies, and creating action plans to achieve the set goals. Good planning should specify the activities and tasks to be performed within each timeframe clearly.

2. O – Organizing

After planning, the next step is organizing, which involves establishing an appropriate organizational structure, clearly defining job positions, roles, duties, and responsibilities of personnel in each department, allocating resources (including staff) suitably for the tasks, and arranging workflows to be agile, smooth, and non-overlapping. This ensures operations proceed with maximum efficiency and effectiveness. (Kunavechkij, 2021)

3. L – Leading

Leadership is a crucial factor in driving an organization toward success. It involves the ability of

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managers or leaders to guide, motivate, communicate, and inspire their teams to work together to their fullest potential to achieve the organization's goals. Sharp and timely decision-making, as well as creating a positive work environment and good relationships within the organization, are also important aspects of leadership.

4. C – Controlling

Controlling is the process of monitoring, inspecting, and evaluating performance to ensure it aligns with the established plans and objectives. It also involves identifying defects or problems and taking corrective actions to ensure operations meet standards and achieve desired outcomes. Effective control helps organizations adapt and respond quickly to changes.

In the digital era, control within the POLC Framework is no longer limited to overseeing internal operations according to pre-established plans. Its meaning has expanded to include data-driven control, utilizing information obtained from agricultural technologies (AgriTech) such as IoT and Big Data (Rakbankerd, 2019). This approach enables precise management of production factors like water, fertilizers, and pests, and allows for timely responses to rapidly changing market conditions. Farmers can accurately control irrigation and fertilization based on sensor data, monitor product quality using stored data, and align production with market demand information, making the control process more efficient and agile.

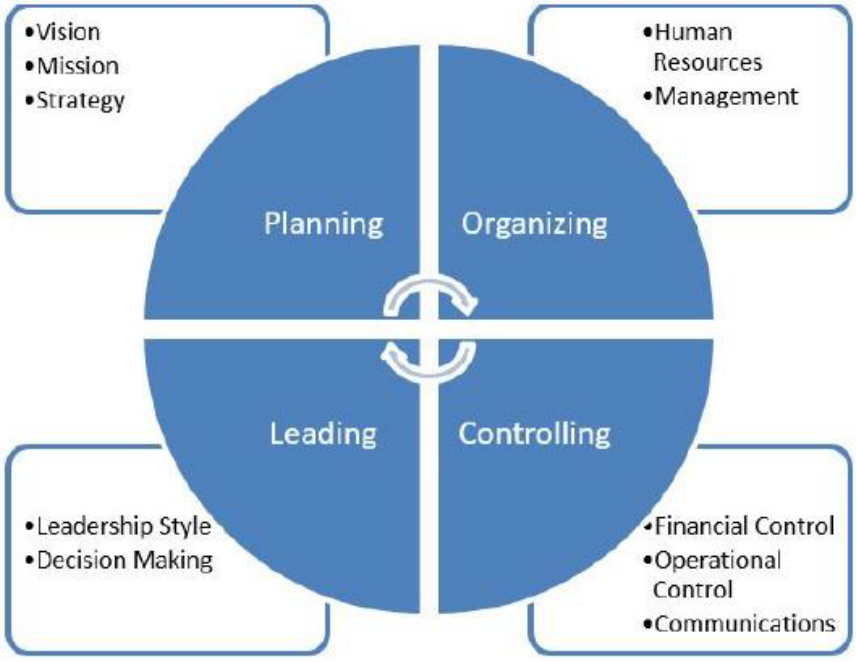

Figure 1: Conceptual Framework
(Source: Allen L. A. (1958). Management and Organization)

Application of POLC in Agricultural SMEs

The POLC framework can be effectively applied to the management of agricultural SMEs, such as:

1. Planning: Planning crop production to align with the seasons, market demand (which may be informed by Big Data analysis or data from e-commerce platforms), and the potential of the land. Planning investments in technology and financial planning is also included.

2. Organizing: Organizing the farm structure, assigning tasks to family members or employees, and procuring and managing agricultural machinery and various technologies.

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3. Leading: The entrepreneur's role as a leader in adopting and experimenting with new technologies, solving arising problems, and motivating the team.

4. Controlling: Controlling product quality to meet standards, managing production costs, monitoring operational performance, and evaluating the return on investment in different technologies.

Methodology

This research employs a qualitative approach through a multiple case study analysis using secondary data to investigate the success factors of agricultural SMEs in the Northeastern region. The research process is divided into two main phases.

The first phase involves a systematic literature review to develop an initial conceptual framework and to understand the relevant context. Data was collected from international databases such as Scopus and Web of Science, domestic databases such as ThaiJo, as well as research reports from key agencies, including the Office of Small and Medium Enterprises Promotion and the Bank for Agriculture and Agricultural Cooperatives. The review focuses on synthesizing three main themes: the definition and characteristics of modern agricultural SMEs, the application of digital technology in agricultural marketing, and theoretical frameworks explaining business success.

The second phase involved selecting and analyzing case studies based on clear criteria for choosing 5–8 cases. These cases had to be agro-processing businesses or smart farms that have been operating for at least five years with continuous growth or national recognition. They must have documented success stories published through reliable sources and clear evidence of using digital technology in marketing.

For example, the industry sector must consist of entrepreneurs primarily engaged in agro-processing or smart farming, reflecting value addition and the use of technology. The case studies should be well-documented with detailed success stories available through credible public sources such as articles, documentaries, television programs, or in-depth organizational reports, to ensure sufficient secondary data can be extracted.

Next, a qualitative content analysis was conducted by building upon the literature review from the first phase to identify key concepts and group codes into main themes reflecting success factors. Peer debriefing and expert consultations were used to verify credibility. Finally, a cross-case synthesis was performed to identify common success factors as well as context-specific factors, as illustrated in the accompanying figure.

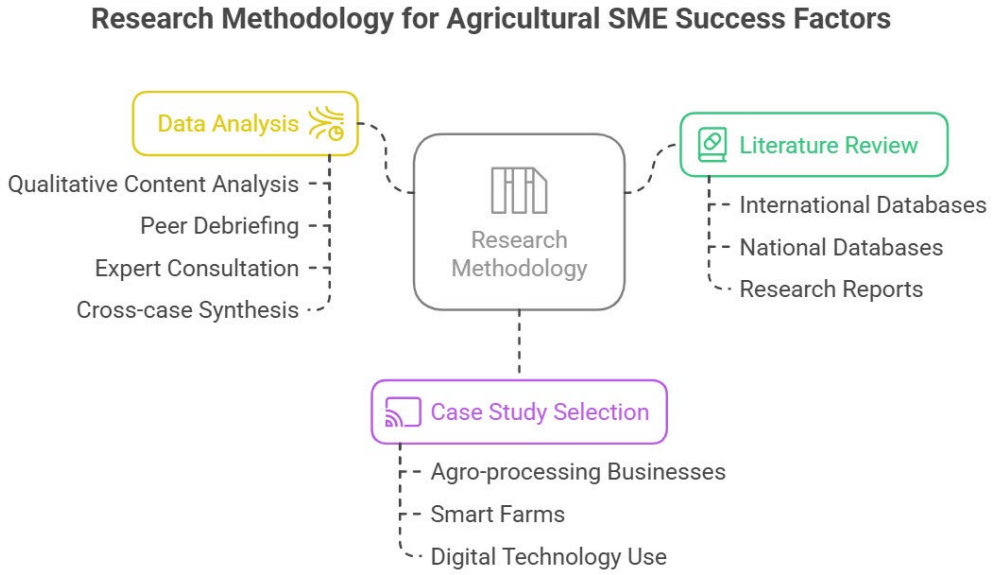

Figure 2: Research Methodology Process

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Results

From the analysis of success factors for agricultural SMEs in the Northeast region, it was found that the success of entrepreneurs depends on factors arising from the integration of multiple dimensions. The key factors identified are as follows:

1 Entrepreneurship and Leadership Characteristics of entrepreneurs, such as the desire for success, willingness to take risks, and especially an innovative mindset, serve as the fundamental drivers for change and adaptation (Wongsachaya and Puenpha, 2018).

2 Adaptability and Application of Innovation & Digital Technology The ability to embrace and appropriately apply innovation and digital technology is a crucial factor for success in the current era. This includes selecting suitable technologies, integrating local wisdom, and using data for decision-making (Rakbankerd, 2019).

3 Effective Internal Management Processes Efficient internal management based on the POLC principles (Planning, Organizing, Leading, Controlling) is another key factor that ensures operations are well-directed and goals are achieved (Kunavejkit, 2021).

4 Access to and Management of Resources Access to funding sources (Department of Agricultural Extension, Ministry of Agriculture and Cooperatives, 2016), sustainable management of natural resources, and knowledge development are fundamental factors necessary for growth.

5 Networking and Collaboration Building cooperation with other farmers, the private sector, government agencies, and academic institutions helps strengthen capabilities and opens new opportunities (Community Enterprises, 2017).

6 Market and Consumer Orientation Producing quality and safe products, building a brand, and utilizing digital marketing channels to reach consumers are key to business success (Department of Agricultural Extension, Ministry of Agriculture and Cooperatives, 2016).

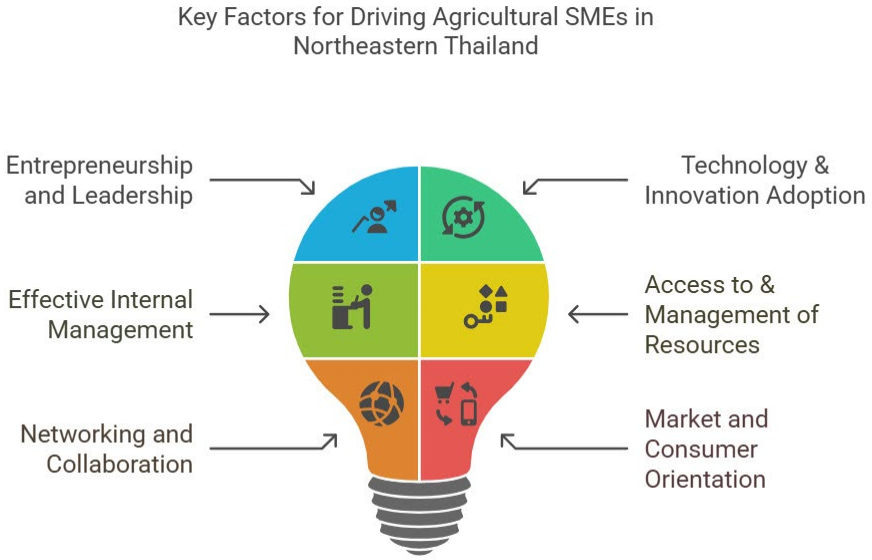

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Table 2: Research Findings Related to the Factors of Integrated Business Success

Research Title / Source	Related Factors	Sample Group / Study Area	Key Findings
The Influence of Business Strategies and Entrepreneurial Characteristics on the Success of Small and Medium Enterprises (SMEs) (Wongchaiya, 2018)	1. Entrepreneurship and Leadership	SME entrepreneurs in Ubon Ratchathani Province	Confirms that business strategy factors and personal characteristics of entrepreneurs have a direct impact on business success.
Use of Agricultural Technology and Innovation for Sustainable Agricultural Management (Tatthiam, 2024)	2. Adaptation of Technology and Innovation	Nationwide, Thailand	Agricultural innovation is a key tool for solving farmers' problems, enhancing competitiveness, and promoting Thailand as an important global agricultural production base.
Management of Fish Processing Community Enterprises in Nong Bua Lamphu Province (Yanapiboon and Krisanaput, 2020)	3. Efficiency of Internal Management	General SMEs	The groups received support and certification from multiple agencies, but lacked structured production planning and did not prepare business plans.
Access to Capital and Problems in Accessing Capital for Community Enterprise Entrepreneurs in Phra Nakhon Si Ayutthaya Province (Sartsara and Mekdee, 2021)	4. Access to and Management of Resources	Small entrepreneurs in Ayutthaya Province	Found that the main problem in accessing capital is the lack of knowledge and understanding of loan conditions from financial institutions.
Participation of Partners and Networks in Agricultural Extension Work (Department of Agricultural Extension, 2022)	5. Networking and Collaboration	Farmer groups and community enterprises	Networks are an important channel for creating learning processes, exchanging experiences, building bargaining power, and linking production to marketing.
Online Marketing Promotion Strategies for Organic Farmer Community Enterprises in the Northeastern Region (Buasri and Rittmas, 2021)	6. Market and Consumer Orientation	Organic farmer community enterprises in the Northeastern provinces	Found that the organic agriculture industry still has growth opportunities through online channels, but relevant agencies must emphasize promoting knowledge of online marketing and technology management skills.

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Discussion

It highlights that the six success factors do not operate independently but are systematically interconnected and mutually reinforcing (synergy). Entrepreneurial vision, Factor 1, naturally leads to the openness and pursuit of innovation, Factor 2. Building networks and collaborations, Factor 3. Accessing necessary resources, Factor 4. All these factors converge toward the common goal of meeting market demands, Factor 5. Enabling the development of effective internal management processes, and Factor 6. Implementing these processes efficiently. The analysis of these factors can be summarized in the following table.

Table 3: Comparative Analysis of Success Factors in the Agricultural SME Sector — Similarities and Differences

Success Factors	**Brief Description**	**Supporting Examples from Case Studies in Northeastern Thailand**	**Connection to Theoretical Concepts**
1 Entrepreneurship and Leadership	Traits of risk-taking, creativity, and team leadership	Uncle Kammee dared to change agricultural methods, a community leader Khun Chumphon pioneered organic cassava	Entrepreneurial traits, Leadership (Leading) in POLC
2 Adaptability and Application of Innovation	Ability to select and apply technology to improve production and marketing	Pak Mai Farm uses IoT, solar cells, and machinery. Na Na Farm demonstrates technology, and Uncle Kham has an innovation for water management.	- Innovative thinking - AgriTech
3 Efficiency of Management Processes	Systematic planning, organizing, leading, and controlling operations	- Pak Mai Farm divides production zones The organic cassava group controls quality	- POLC Framework
4 Access to and Management of Resources	Ability to acquire and utilize capital, water, soil, and knowledge	Uncle Kammee manages water/soil, Young Smart Farmer	- Investment factors - Resource management
5 Networking and Collaboration	Collaboration with other farmers, the government, the private sector, and academic institutions	The organic cassava group cooperates with the public and private sectors Na Na Farm provides knowledge Young Smart Farmer project Na Na Farm, driven by the private sector, Training project at Khon Kaen University	Modern organizational theory
6 Market and Consumer Orientation	Producing market-driven products, building brands, and using appropriate channels	Organic cassava group targets health-conscious market Pak Mai Farm adds value through processing	Business-level strategy E-commerce

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The study results identified six key success factors for agricultural SMEs in the Northeast region, which align with the framework of international business theories. However, the core value lies in the integration and contextual synthesis by viewing these factors as an interconnected ecosystem. This approach adapts global theories to the specific context of the Northeast region, which faces unique challenges. Consequently, technology becomes a tool for survival, and risk management is significantly reduced.

Synthesis of Obstacles and Implementation in Small and Medium Enterprises (SMEs)

Obstacles to Applying Success Factors in Practice

1. Entrepreneurship: High debt burden leads to a forced risk-avoidance mindset.
2. Technology Use: High initial costs, lack of digital skills, and distrust of technology.
3. Internal Management: Household businesses lack management systems and long-term planning.
4. Access to Resources: Loan rejections, lack of working capital, and water supply uncertainty.
5. Networking: Dispersed production leads to weak bargaining power and difficulty in forming groups.
6. Market Orientation: Lack of cold chain systems, digital marketing skills, and brand building.

Regional Characteristics That May Limit Application in Other Areas

1. Agricultural and Climate Context: Drought issues and specific crops (cassava, jasmine rice) differ from other regions.
2. Economic and Social Structure: A high proportion of farmers with severe debt burdens requires low-cost and accessible models.
3. Institutional System: Reliance on local educational institutions (Khon Kaen University) and the AIC center.
4. Geography and Logistics: Landlocked with no sea access, far from major markets, requiring a focus on value-added processing.

This research creates new value by synthesizing factors into a holistic system and adapting universal theories to the specific context of the Northeast region. This makes technology a tool for survival rather than just efficiency improvement. However, key obstacles remain, including debt burdens leading to risk avoidance, high technology costs, household-style management, lack of access to capital, dispersed production, and logistical challenges. These unique characteristics may limit the applicability of the findings to other regions with different agricultural-climate contexts, economic-social structures, institutional systems, and geography.

Conclusion

The success of agricultural small and medium-sized enterprises (SMEs) in Northeast Thailand, amid the challenges of the digital era, depends on the systematic integration of several key factors. These factors include visionary entrepreneurial characteristics, the ability to appropriately apply agricultural technology (AgriTech), the efficiency of farm management processes, the establishment of strong collaborative networks, and a market-oriented focus on meeting consumer demands. All these factors are interconnected and mutually reinforcing. Therefore, the development of agricultural SMEs requires a holistic approach in which all sectors collaboratively play their roles to create an enabling ecosystem that supports sustainable growth.

Recommendation

Based on the research findings, the following practical recommendations are proposed for various sectors:

1.For Agricultural SME Entrepreneurs: They should continuously embrace learning and develop digital skills, starting with selecting technologies suitable for their scale and context. Emphasis should also be placed on building networks with other entrepreneurs to exchange knowledge and increase bargaining power.

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2. For Government Agencies: They should take a proactive role in supporting accessible digital infrastructure in rural areas, implement promotion programs, and provide funding to support tangible AgriTech investments for smallholders. Importantly, structural issues must be urgently addressed, especially farmers' debt problems and irrigation security.

3. For Educational Institutions and the Private Sector: They should develop practical training curricula that are easy to understand and transfer technology effectively, create central platforms to connect farmers with markets and technology providers, and promote research and development that genuinely meets the needs of local farmers.

The summary of recommendations grouped by stakeholders can be categorized into three main groups:

1. Agricultural SME entrepreneurs should develop digital skills, appropriately apply technology, and proactively build networks.

2. Government agencies responsible for supporting digital infrastructure, financial and policy support, and addressing structural problems such as farmer debt and irrigation systems.

3. Educational institutions and the private sector should develop practical training courses, create platforms linking farmers to markets, and conduct technology R&D tailored to the Northeast regional context.

Training Recommendations:

1. Short-term (1-2 years): Focus on hands-on activities with immediate visible results, such as digital skills training for farmers, funding support for small-scale technology, and free short-term training courses.

2. Long-term (3-5 years): Emphasize structural reforms for sustainability, such as building strong community enterprise networks, investing in large-scale irrigation systems, reforming policies to solve farmers' debt issues, expanding high-speed internet coverage in rural areas, and fostering cross-sector collaboration to develop advanced agricultural technologies and pilot new digital agriculture business models.

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