A STUDY OF THE USE OF ARTIFICIAL INTELLIGENCE (AI) AND DIGITAL TECHNOLOGIES IN RICE PRODUCTION

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ABSTRACT

The purpose of this research is to examine the use of agricultural technologies and Artificial Intelligence (AI) in rice production. The study focuses on how these tools affect productivity and value added contributions, aiming to explore implications for advancing rice production. This research investigates how farmers face issues in rice production, as well as the effects, challenges, and solutions of using AI technologies. Additionally, the study examines the effectiveness of agricultural technologies in addressing these issues. A mixed-methods approach was employed, including interviews and surveys, supported by a review of relevant literature, recent analyses, publications, websites, textbooks, and records of AI applications in agriculture. The findings indicate that most farmers use the internet to access social media platforms, such as Facebook and WhatsApp, to communicate, share knowledge, learn online, and watch videos on YouTube. This access to knowledge helps farmers improve and increase rice production in Thailand. Overall, more than half of the farmers adopted at least five technologies tools. The top three agricultural practices they largely embraced were leguminous crop cultivation to preserve soil fertility. The findings highlight the importance of effective communication and knowledge-sharing for farmers.

Keywords: rice production, agriculture technology, artificial intelligence

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Name : MI MI

Date: 27 December 2023

DECLARATION

I, MI MI, hereby certify that the work embodied in this independent study entitled "A Study of the use of Artificial Intelligence (AI) and Digital Technologies in Rice Production" is result of original research and has not been submitted for a higher degree to any other university or institution.

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CHAPTER 1

Introduction

1.1 Background of the Study

The majority of people in Asia eat rice as their main source of sustenance. Humans take almost 50% of their calories from grains like wheat, rice, and corn. In Thailand, rice is the most significant crop. Since the Ayutthaya era, it has been a significant source of national money, and it continues to be an agricultural crop that generates significant income for the nation now. The Thai economy heavily depends on the production of rice, which employs a large number of people. Thailand is the world's largest exporter of rice and has the fifth-largest area dedicated to rice farming. Research on rice is essential for creating technologies that boost yields and raise the income of farmers whose main business is growing rice (Guo, Xiang, et al., 2021).

Since ancient times, agriculture has been the mainstay of the Thai economy. In the past, Thailand's agriculture solely relied on labor. New technology has been incorporated into Thai society as the population begins to age. The agricultural industry in Thailand today uses a variety of agricultural machinery as well as cutting-edge technologies and artificial intelligence (AI). A new government strategy called "Thailand 4.0" has been established in Thailand; it is a new model of the country's economic engine that reorganizes the economic structure into agricultural technology as value economy from traditional agriculture to new-age agriculture (Bhandhubanyong, 2019). Thus, this study investigates the use of artificial intelligence (AI) in agricultural technology created in Thailand. The purpose of this study is to chart the gradual advancement of agricultural technology utilized by Artificial Intelligence in Thailand.

Thailand has created its own line of agricultural machinery and technology that is fit for its requirements and resources, primarily the country's agricultural population. Thailand's top consumer is the country's rice industry. Thailand's present agricultural output greatly benefits from artificial intelligence. It is now clear that there are labor shortages and that manufacturing costs must be brought down. It goes without saying that over the upcoming ten years, demand for agricultural machinery will increase dramatically. The cultivation of rice uses the most agricultural technology mechanization when compared to other crops. The Central Plains region has the highest level of mechanization, and other areas of the country have begun to experience nearly complete mechanization (Thepent, 2018).

This study attempts to track the gradual advancement of agricultural technology using artificial intelligence on rice production in Thailand over time. It also focuses on how tools affect productivity and contribute value-added aspects, aiming to provide insights for further improvements in rice production.

The demand of agriculture sector especially rice production is high in every country due to its good environment and soil. Even in the urbanized countries such as, Cambodia, Laos, and Myanmar. The rate of rice production is rapidly rising combined with growth of rice, this has profound impact on the regions of labor. Then their use of AI technology in traditional way of agriculture so that this can increase the rate of cultivation of crop and time consuming (Talaviya & Shah, 2022).

Thai farmers have historically relied on basic implements, animal power, and water wheels. When the government imported steam tractors and rotary cultivators in 1891, it found that they were not fit for the circumstances in rice fields and were also rather expensive. This was the beginning of the mechanization of energy technology (Yahya, 2019). The Lanshi Rice Station in the Central Plains introduced agricultural equipment for test use at the beginning of the 1920s. The absence of highly skilled local talent during this time limited the progress of research and development in the area of agricultural mechanization. Also, the start of World War II halted all scientific operations across the nation. A 4.4 KW single-axle tractor was imported in 1947, however due to its low chassis, it was unsuitable for swampy terrain. The State Rice Experiment Station introduced contract services at the beginning of the 1950s to encourage the usage of four-wheel tractors. The endeavor was a failure. In 1955, 262 tractors were imported from several nations, but Japanese motor cultivators or two-wheel tractors were the most common on rice production (Mairghany, 2019). When the number of imported tractors significantly increased between 1956 and 1957, local workshops were forced to simplify the designs of imported tractors in order to cut costs and adapt them to local conditions. The "Debaridhi Water Pump" axial pump design was published in 1957 by the Agricultural Engineering Division (AED) of the Ministry of Agricultural Cooperatives for use locally. The pump was subsequently developed commercially and utilized extensively (Kaur, 2021).

In rice production, the majority of agricultural machinery used in Thailand today is domestically made, including tractors, rotary tillers, disc plows, disc harrows, water pumps, sprayers, threshers, and harvesters, harvesting equipment, dryers, rice milling machines, and processing machinery. However, the quality, effectiveness, and durability of local machines made by small manufacturers are not standardized (Vashist, 2021). Thai agricultural rice production enterprises import some agricultural equipment from other countries. the industry for four-wheel tractors with rotary tillers under 40 horsepower. In the Central Plains and northern regions, it is currently being developed and will eventually replace two-wheel tractors for planting rice. Most farm owners or farmers are looking forward to an appropriate and effective harvester due to the labor shortage during the harvest season, especially for rice and sugar cane (Brar, 2021). It is acknowledged that Thailand's agricultural technological mechanization has reached a tipping point from labor-intensive to intensive management, including advanced, high-quality rice milling machines, irrigation system equipment, mechanical sprayers, combine harvesters, dryers using biomass fuel, silos and storage processing, etc. After all, farmers swiftly adopt these devices in rice production. Therefore, local factors must be taken into account when making adaptations and adjustments in rice production (Zhang, 2017). One of the largest energy providers and consumers, the agricultural industry depends on a variety of direct and indirect energy sources for its operations, including labor, fossil fuels, electricity, fertilizers, and herbicides, among others in rice production. Energy has emerged as a crucial resource for activities in the era of subsistence farming because to the advancements in agriculture. The need for energy in the plantation business has significantly expanded as a result of the need for high-yielding varieties and the use of mechanical rice production techniques (Elsoragaby, 2019).

1.2 Problems of the Study

More than half of the farmers in Thailand face the challenges related to the agricultural technologies that utilize artificial intelligence in rice production, which also provide crucial services that support farmers' livelihoods. Traditional rice production, however, are dealing with a number of issues, such as pests or difficult-to-reach markets. This study investigated how farmers face issues in the rice production, as well as using artificial intelligence, effects, and solutions. The study also looked at how effective of agricultural technologies these issues in rice production. The aim of this study is to encourage the adoption and utilizing of modern technology in rice production in Thailand. Thai farmers have historically been receptive to new ideas and technologies. Thailand had progressed from subsistence farming to agribusiness and finally to an industrialized economy by the turn of the 20th century. Industrial agriculture used new crop varieties, synthetic fertilizers, and machinery to boost agricultural productivity and yields because there was an excess of labor and land in rural areas (Igel, 2021).

Thai creativity is one of the important factors that has contributed to past success. The quality of rice types is actively improved by fruit growers in response to consumer demand. Local businesses can modify imported farm equipment to fit local farming needs and export the modified equipment to other low-income nations. Farmers are able to split costs thanks to the emergence of hire services and rental marketplaces, particularly for combines (Yahya, 2019). Thailand's agricultural mechanization has reached a saturation point, making future productivity gains challenging. While expenditure on agricultural research dropped dramatically from 0.9 percent of agricultural GDP in 1994 to just 0.2 percent now, introducing technical change is similarly challenging (Igel, 2021). Governments all across the world have abandoned technological advancement in favor of populist agendas over the past ten years. Agriculture 4.0 must fundamentally reorient toward the development and commercialization of technology, particularly precision agriculture in rice production, agricultural robotics, and biotechnology (Elbasi, 2023). Yet, small farmers in

Thailand, where agriculture and aquaculture are essential to economic development, live in a state of permanent poverty because they lack the managerial and Computer skills required to innovate in rice production. One of the main barriers to this agricultural sector's sustainable development is a lack of expertise (Mairghany, 2019). The Ministry of Industry's Thai Industrial Standards Institute (TISI) is in charge of standardizing agricultural equipment in rice production sector. After careful consideration, the agricultural technological equipment standards were modified to fit Thailand's agricultural technology machinery and associated with rice production in Thailand how to properly apply agriculture technologies using by artificial intelligence (Verdouw, 2018).

1.3 Objective of the study

The objective of this research is to examine the use of Artificial Intelligence (AI) in Thai agriculture, especially rice production. The first step is to explore Thai farmers' knowledge of agriculture technology in rice production. The second step is to examine how AI technology is utilized in rice production and development of Thai agriculture.

1.4 Scope of the Study

The knowledge of agricultural techniques and how to develop farming utilizing AI technology in Thailand was the focus in this research. The use of AI technology in agriculture to increase production was examined. This study aimed to explore how employing AI technology increased agriculture crop industry. This study adopted a document analysis covering numerous research projects, publications, websites, textbooks, and records of AI applications in agriculture, and a questionnaire survey was conducted for data analysis.

1.5 Significance of the Study

This study offers significant insights into how Artificial Intelligence (AI) and digital technologies are being integrated into rice production in Thailand. With global food security and sustainability becoming ever more vital, AI-driven technologies present promising ways to boost productivity and tackle major challenges in agriculture. It showcases how these innovations can optimize farming methods and greatly improve efficiency. Furthermore, it helps to close the gap in our understanding of how readily small and medium-scale farmers in Thailand are adopting AI. In practical terms, the findings of this study are beneficial for farmers, agribusinesses, and policymakers alike. It sets the stage for a future where rice production in Thailand is smarter, more efficient and more resilient.

CHAPTER 2

Literature Review

This literature review synthesizes key findings from various studies on agricultural technology, adoption challenges, methodological approaches, and societal impacts. Each reference contributes to a broader understanding of how technology can transform agriculture while addressing the barriers and ethical considerations associated with these advancements.

2.1 Agriculture of Thailand

Thailand's agriculture industry is extremely important. Not only is rice a key food crop in the nation, but it is also a significant agricultural export. Thailand has long been one of the biggest exporters of rice in the world. Rice yields were significantly lower than in East Asia despite the advent of high-yielding rice cultivars in the 1960s, primarily because of ineffective labor inputs. The Chao Phraya River Basin and the Nakhon Ratchasima Plateau are where most of Thailand's commercial rice is grown. To satisfy the demands of both domestic and international markets, agricultural output has undergone tremendous diversification. Corn (maize), longan, mango, pineapple, durian, cashew nuts, vegetables, and flowers. Kenaf is a material that resembles jute. Agribusiness, which started to emerge in the latter decades of the 20th century, principally owns the vast swaths of land where cash commodities like rubber, coffee, sugar cane, and numerous fruits are grown. Once a significant cash crop, tobacco production has drastically decreased as a result of declining demand (Sirirangsi, 2019).

Buffalo and cattle have long been prized in northeastern Thailand. The requirement for buffalo, historically employed for ploughing and harrowing, greatly declined as agriculture became more technologically industrialized. But because of a sharp rise in demand for beef in the region's cities, cattle output has surged in the Northeast. To accommodate the rising demand for pork, the Northeast also produces hogs. Since the middle of the 20th century, chicken production in central Thailand has increased significantly, but increasingly by corporations rather than local farmers. Early in the twenty-first century, a bird flu outbreak in Southeast Asia prompted the government to repeatedly order the killing of a large number of chickens, leading to a general decline in poultry production and a significant loss of income for producers (Aonngernthayakorn, 2017). Although few comparable studies have been conducted in tropical forests and tropical agricultural production areas, human land use alters soil microbial composition and function in a variety of systems. The two main causes of tropical deforestation are the expansion of logging and oil palm agriculture, with the latter being most common in Thailand (Krista, 2018). Millions of people rely on the variety of ecosystem services that Thailand's mangroves offer, which are highly biodiverse. The mangrove environment has among the highest carbon storage densities of any ecosystem on earth and improves fisheries and coastal protection. Mangrove forests have become increasingly in demand worldwide (Daniel, 2019).

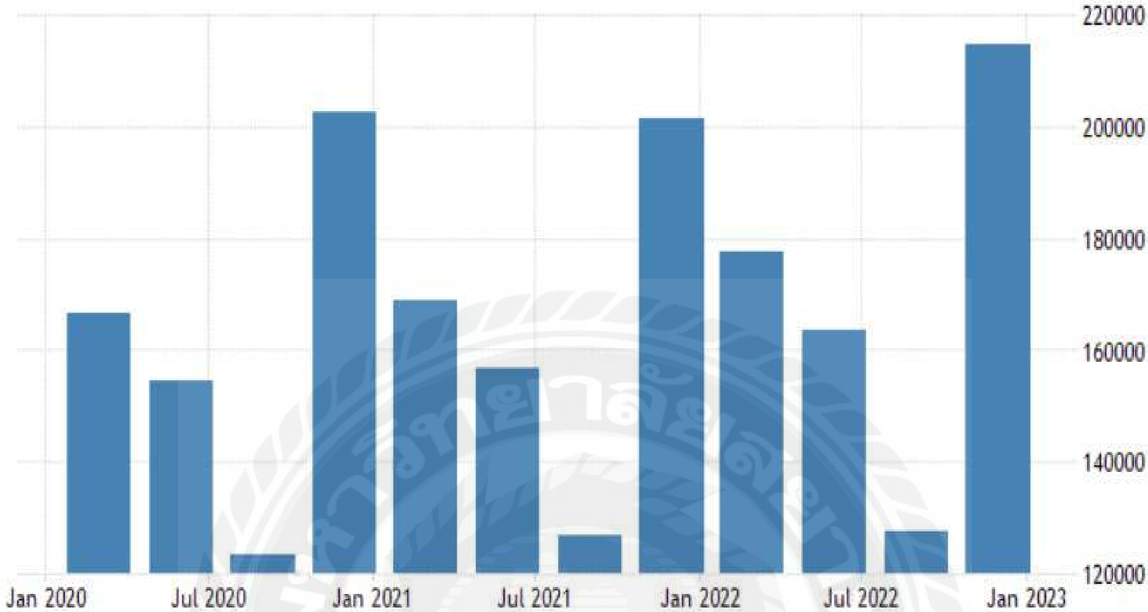

Figure 1: Thailand's Agricultural Production from 2020 to 2023

2.2 Rice Production in Thailand

Rice history can be traced back to the prewar period, at the time farmer produced rice for themselves and surplus was sold in the market through traveling (Efferson, 1952). Since the end of World War 2, and in the 1950s Thai rice market has expanded and in modern is a top market for exporting rice. The Thai farmer's manager to export. One of its major exports of Thailand is rice and for years it has been in the top six nations of rice exporters. The nation has provided 100s million tons of rice. The nations are expected to continue the increase in production (USDA, 2021). Thai government has built up a policy to support extensive rice production and network marketing (Forssel, 2009). The government and local players keep on pushing and increasing the production of rice. The awareness is created to use the AI system to increase and improve the production and marketing of rice.

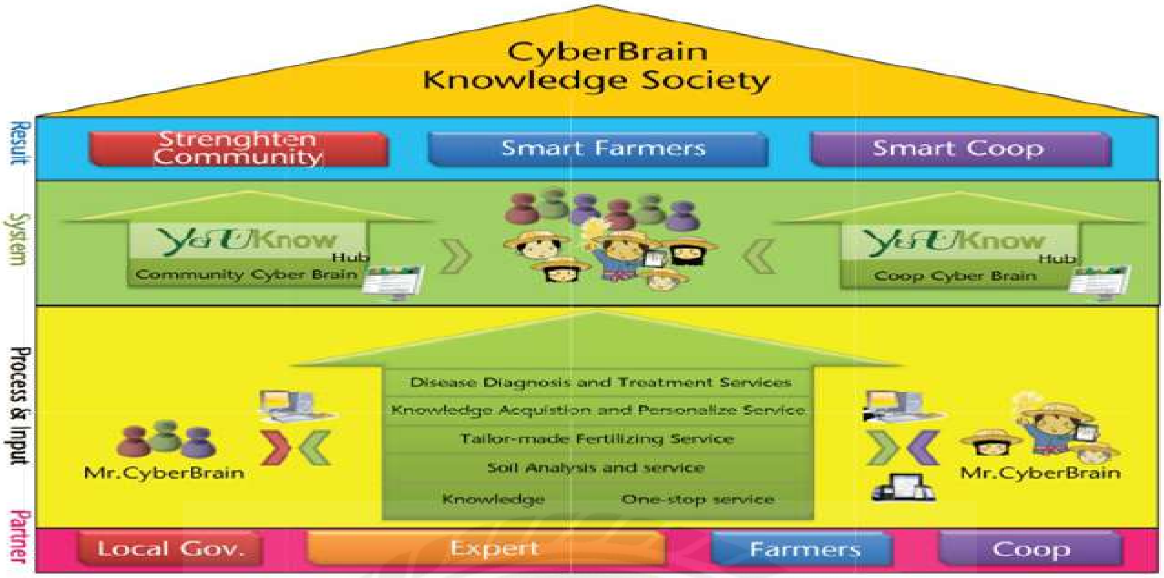

Figure 2: Outline of CyberBrian Knowledge Society Source: worldwide AI (2014)

2.3 Agricultural Knowledge

The main obstacle to farmers adopting new technologies is that many of them are intimidated by the amount of information they need to learn and feel uncomfortable learning how to use new digital technologies. Sometimes people's age makes them hesitant to pick up new skills. For instance, in response to this barrier, DTAC limited participation in its Smart Farmer campaign to farmers between the ages of 18 and 45. SKC, however, disregards this restriction. Both farmer groups and non-farmer groups may participate in the KAS project. Other requirements are set forth by the business in its SKCE learning pathways, such as a cap of just 30 farmers per group (Nadee, 2020). Several farmers were initially unable to realize the true benefits of the new technology due to their attitudes and fear of technology. The inability to alter one's perspective was a common barrier in both case studies. Farmers over the age of 45 are less likely to adopt new farming practices, according to Sayruamyat & Nadee's (2019) research, because they do not want to invest in smart technology, such as purchasing smartphones or tablets or even paying for agricultural information apps (Sayruamyat, 2019). Farmers work with businesses to establish the trust necessary to motivate farmers to embrace innovation. Access to credit and loans for farmers is another significant barrier to these initiatives. In order to provide loans to support farm management methods, such as the acquisition of sensor-equipped equipment, DTAC intends to collaborate with the Bank of Agriculture and Cooperatives. Future DTAC projects will include this attempt to make the tool more accessible to farmers (Nadee, 2020).

2.4 Digital Technology Knowledge

Digital agriculture refers to the use of advanced technologies that have transformed the agricultural sector by making farm operations more insightful and efficient. This can be achieved with the use of automated methods such as AI, Internet of Things (IoT), and collection and processing of farm data. Substantial amounts of data are collected and used by AI-based solutions in data-driven services and decision support systems (DSS) in farming applications (Zhongming et al., 2021). Farm data are combined with other data sources, such as weather data, to improve resource management and production (Sykuta, 2016).

The application of AI in agriculture and food has been on the rise. According to Statista's report, the use of AI-based technologies in the agriculture market has had significant growth. The Market is forecasted to grow from $1.1 billion in 2019 to more than $3.8 billion by 2024 (von See,2022). AI solutions in agriculture refer to AI algorithms, software, and hardware (e.g., robots) used in farming applications (Ryan, 2022). AI software applications often analyze data to provide forecasts, recommendations, and assistance in decision-making to improve farm operations. Advanced hardware technologies used in farm robotics and automation such as robotic greenhouses, robotic harvesting, and milking robots in dairy farms have helped in increasing production yield.

Predictions can help farmers decide when to seed and harvest to approach the best productivity. In precision livestock farming, farmers can be informed about the possibility of disease or distress among animals on the farm. For instance, using image recognition tools plant disease can be detected or livestock animal behavior patterns can be monitored to help them with potential health issues (Ryan, 2022). Market demand and forecasting can help farmers adjust the type and amount of production and reach the best profitability.

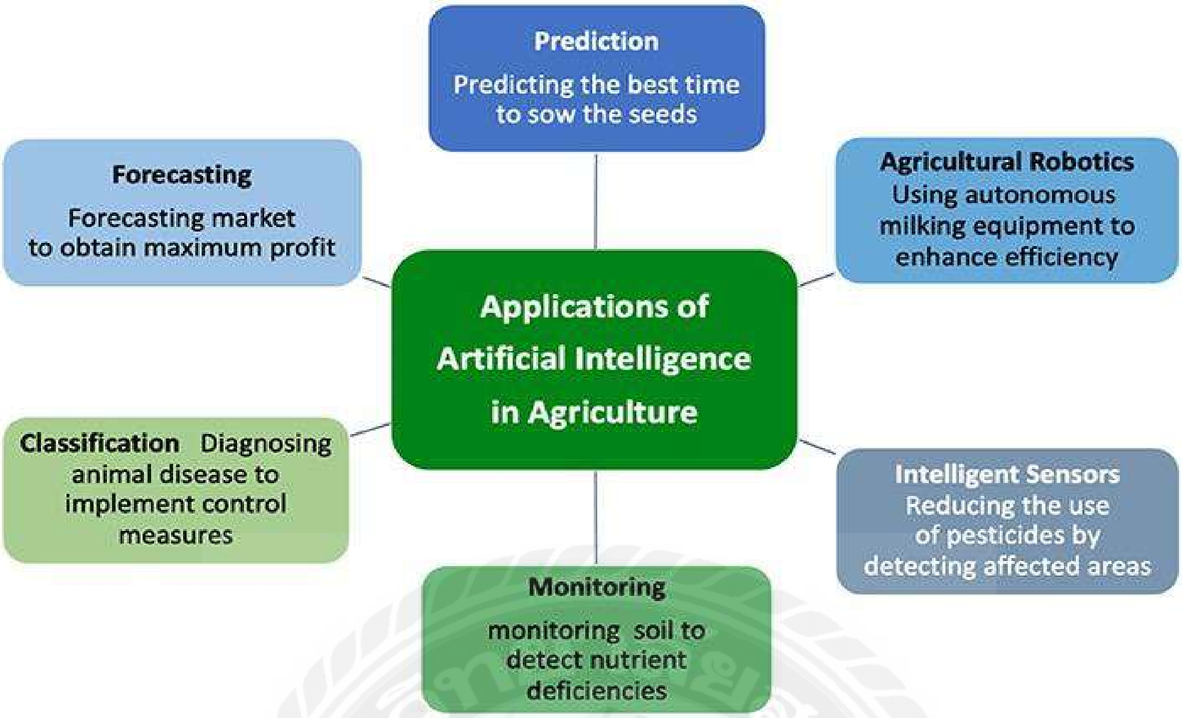

Figure 3: Artificial Intelligence Applications in Digital Agriculture

Source: modern agriculture drones (Unpaprom et al., 2018)

No	Application	Technologies/algorithms used	Results
1.	Pesticide Spraying	Wireless Sensor Networks, Gyroscope and Accelerometer sensors	N/A
2.	Crop Monitoring, Mapping, and Spraying	DJI Phantom 3 Advanced UAV and other softwares	UAVs could be used in order to detect abnormalities and identify potential problems.
3.	Crop Monitoring	Multispectral sensor	Linear regressions between NDVI and plant nitrogen, aerial biomass, etc. were significant. This has the potential to provide insight to good management practices and techniques.
4.	Pesticide Spraying	Spray motor	Worked satisfactorily when tested on groundnuts and paddy crops

5.	Remote Sensing	Multispectral camera	The UAV remote sensing system was tested on a turf grass field and was capable of monitoring the temporal changes in the field.
6.	Remote Sensing	Spectral Spatial classification, Bayesian information criterion (BIC)	Manual Tomato detection is difficult so using this technology, the areas could be classified into tomato and non-tomato regions. Detection was carried out successfully on two representative images.
7.	Crop Monitoring	Hyperspectral Frame Camera	Camera flight campaign successfully delivered the hyperspectral data. This enables the monitoring of the leaf nitrogen concentration in rice.
8.	Crop Monitoring	Camera and Software's	Accurate way to monitor various aspects of the farm like creating digital map of field, detecting problems with crop health, etc.
9.	Precision Agriculture Monitoring	–	Provides an approach for the segregation of sparse and dense areas within a sugarcane field. It makes use of satellite data. Accuracy was 87% for testing.
10.	Spraying Fertilizers and Pesticides	Accelerometer and Gyroscope Sensors, Arduino	It has the ability to reduce time and human effort.

Table 1: Summary of Various Applications of Drones in Agriculture

2.4.1 Impact of AI on Agriculture

The application of Artificial Intelligence (AI) in agriculture is widely recognized as a transformative approach to enhancing productivity and addressing food insufficiency. Zhao (2020) emphasized that AI can significantly impact areas like soil management and weed control, offering a glimpse into its potential benefits. The ability of AI to adapt to the needs of a growing global population makes it a crucial technology in modern agriculture. Several AI models and techniques are used to advance agricultural practices.

Examples include:

- Crop Yield Estimation: Utilizing synthetic aperture radar and models to estimate crop yields.
- Crop Mapping: Employing very high-resolution data for accurate crop mapping.
- Inversion Modeling: Retrieving crop biophysical parameters through inversion modeling.
- Drought Impact Mapping: Assessing the impact of droughts on rice cultivation areas.
- Salinity Stress Detection: Using time series coarse resolution data to detect salinity stress.
- Mapping Oil Palm Plantations: Applying visual and automated methods for mapping oil palm plantations.
- Land Surface Fluxes: Evaluating the influence of aerosols on land surface fluxes.

These methods contribute to a more precise and efficient approach to managing and optimizing agricultural practices (Justice & Gutman, 2019).

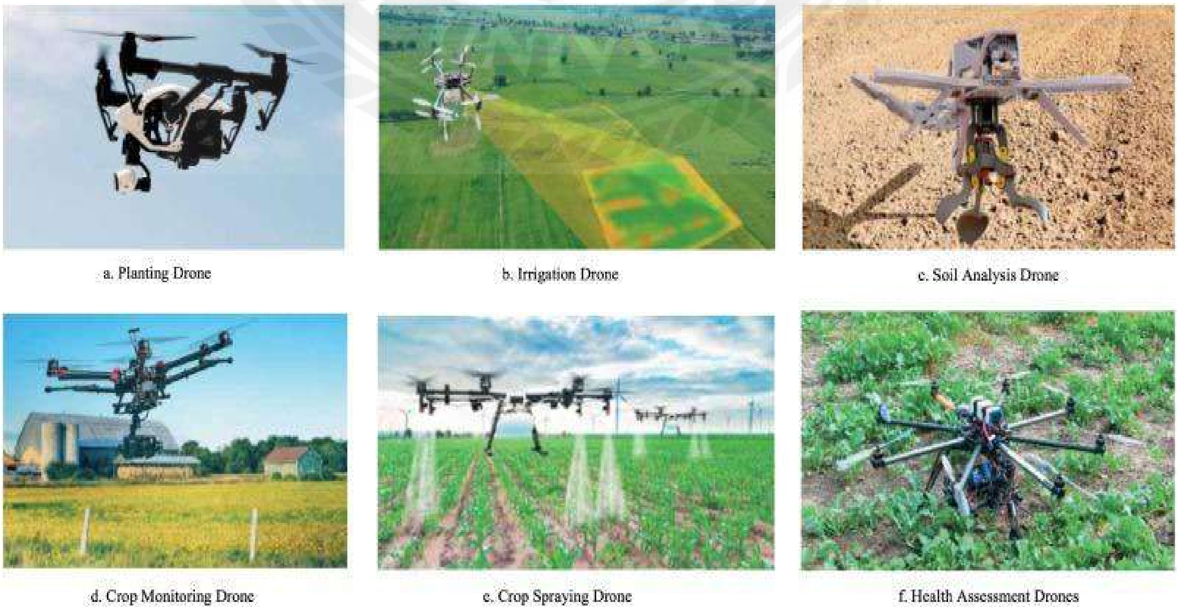

Figure 4: Types of Agricultural Drones

UAV	ROTARY WINGS	FIXED WINGS
Flight duration	Fly up to 20 min	Fly up to an hour
Wind pressure	Can be flown from in winds gusting from 20 to 50 mph	Fly in and out of the wind for satisfactory images
Flexibility in changing direction	Allow new direction during flight for re-direction	Allow new direction upload during flight for re-direction
Price range	$500 to $100,000	$500 to $100,000
Deployable option	Highly deployable	Highly deployable

Table 2: Classification of Drones for Agricultural Application

2.4.2 AI and the Internet of Things (IoT) in Agriculture

The Internet of Things (IoT) represents a significant advancement in agricultural technology. Wolfert (2018) explains that IoT offers a platform for integrating time-series data from various sources through sensors, GPS systems, radio frequency identification tags, and smartphone applications. This integration enables comprehensive data analysis and decision-making. The applications facilitate machine-to-machine learning, where applications communicate with each other to identify patterns in data. Gremmen (2018) highlighted that this process allows for more efficient data management and utilization. For instance, IoT data processing helps farmers track livestock movement and monitor soil pH levels, aiding in better planning, management, and control of their crops (Baumüller, 2017).

Technologies offer practical benefits in various agricultural practices. By tracking and analyzing data, farmers can make informed decisions about crop management and optimize their farming practices. The integration of IoT enhances the ability to monitor environmental conditions and manage resources effectively.

2.5 AI Technology in Agriculture

Ducatel (2019) posited that technology serves as a powerful instrument for achieving social and environmental harmony. Brey (2018) further expanded on this by suggesting that technology has the potential to promote social justice across various income levels and demographics. This notion is particularly pertinent in agriculture, which is a crucial income source for many small-scale producers in developing nations.

2.5.1 Smart Farming: The Evolution of Agricultural Technology

The concept of "smart farming" has emerged as a way to describe advanced agricultural practices that utilize technology to improve farm management and production efficiency. Blok & Gremmen (2018) defined "smart agriculture" as the use of equipment, systems, and wireless sensors to enhance agricultural productivity. This approach is gaining traction among academics and industry professionals as a method to transform traditional farming practices. Digital technologies play a critical role in modern agriculture by generating valuable data on various factors such as weather, soil conditions, crop growth, disease detection, and machinery control. According to Muangprathuba and Regan (2019), these technologies help farmers manage their crops more effectively. For instance, the use of sensors and data analytics allows monitoring and management of activities.

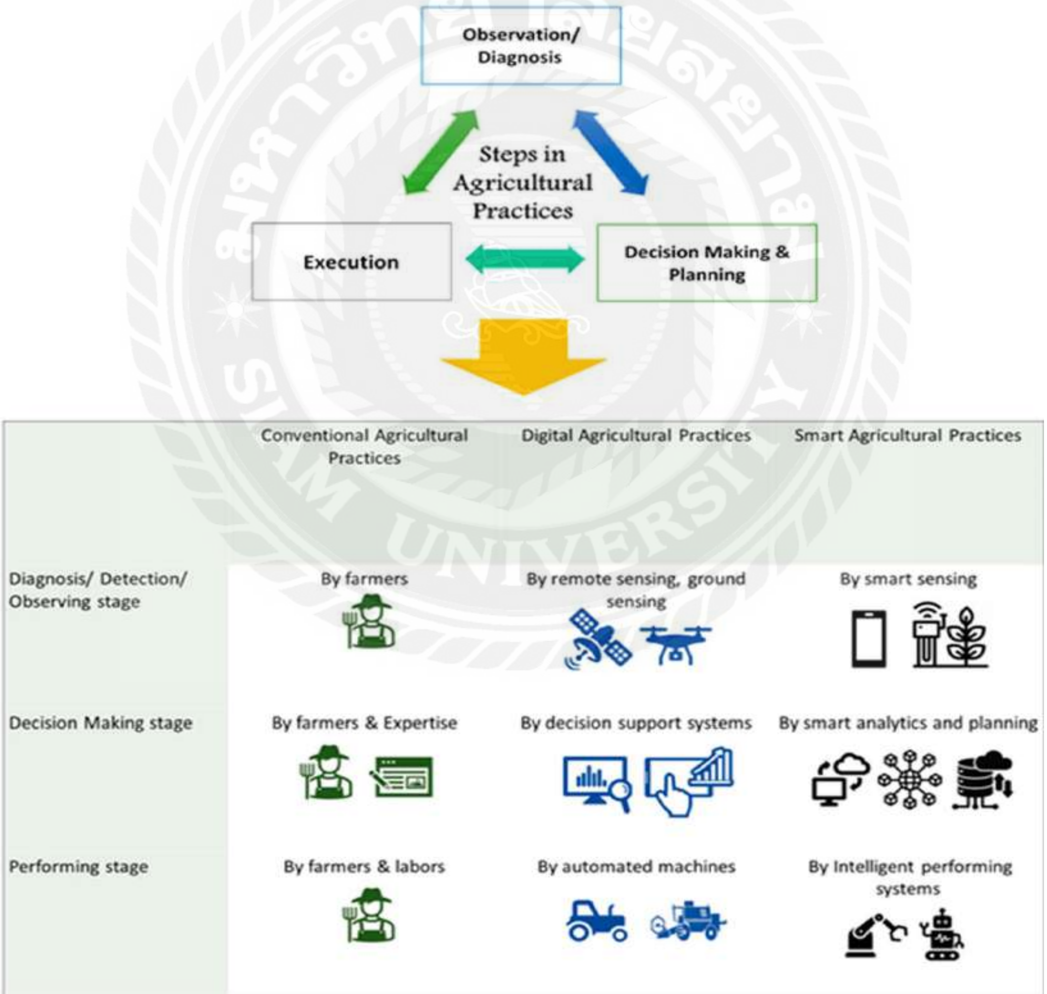

Figure 5: Path to Smart Farming

2.5.2 AI's Role in Agricultural Forecasting and Management

Artificial Intelligence (AI) has emerged as a transformative technology in agriculture, performing tasks that require human-like capabilities. Bahroun (2017) identified several AI technologies, including drones for image-based insights, robotics for various tasks, and chatbots for virtual engagement. These AI tools are employed in agriculture for:

- Forecasting: Predicting events such as droughts and calculating soil moisture levels.
- Cognitive Tasks: Identifying optimal crop varieties that grow quickly and resist pests, such as high yielding soybean crops and non-destructive maize types.

AI techniques are being utilized in diverse agricultural processes across the globe. For example, farmers in India, France, and Mexico have successfully employed AI technologies to cultivate crops like tea, wheat, rice, mango, and cassava. These applications illustrate AI's potential to enhance crop yield and farm efficiency.

2.5.3 Complementary Technologies in Agriculture

Big data, AI, and the Internet of Things (IoT) are crucial technologies driving innovation in agriculture. Nayyar and Puri (2016) predicted that the adoption of these technologies could increase food output by 70% by 2050. The IoT, for instance, enables farmers to track their produce along the supply chain reliably, while big data analytics provides insighted that can optimize farming practices. The IoT integrates data from various sources such as sensors, GPS systems, and smartphone applications. Wolfert (2018) highlights that IoT technologies help farmers by offering platforms for data integration and pattern recognition. Gremmen (2018) described this process as machine-to-machine learning, which facilitates efficient data management. For example, IoT data processing helps track livestock movement and soil pH levels, assisting in crop planning and management (Baumüller, 2017).

2.5.4 Challenges and Opportunities in Implementing Technology

Brey (2018) noted that while technology can significantly benefit developing countries by providing weather forecasts and boosting crop yields, it also presents challenges. Small farmers, particularly in regions like Thailand, face obstacles such as lack of managerial and computer skills, which hampers their ability to innovate and sustain agricultural practices. Bogaardt (2018) identifies this skills gap as a major barrier to the sustainable development of agriculture. Despite these challenges, there are successful examples of technology adoption in agriculture. For instance, farmers in the Chao Phraya Basin and Korat Plateau in Thailand have utilized advanced technologies to improve the productivity of their organic crops

(Brey, 2018). This highlights the potential for technology to drive agricultural growth, even in the face of economic and skill-related barriers.

2.6 Use of Artificial Intelligence in Agriculture

Artificial Intelligence (AI) is revolutionizing agriculture by enhancing efficiency, productivity, and sustainability. AI-driven tools, such as machine learning algorithms, drones, precision irrigation, and IoT sensors, are assisting farmers in making data-driven decisions. These technologies optimize water usage, boost soil health, detect plant diseases early, and improve overall crop yields. AI is applied in various aspects of agriculture, including precision farming, where systems use satellite imagery and sensors combined with deep learning to monitor soil health and optimize fertilizer use (Guo et al., 2021). Additionally, AI models are used for crop disease detection, analyzing images from drones or mobile devices to identify diseases in plants early on (Justice & Gutman, 2019). AI-based predictive analytics also forecast crop yields based on climatic conditions and soil quality (Han et al., 2017). Automated weed control, powered by machine learning, uses robots to differentiate between crops and weeds, reducing herbicide use (Nayyar & Puri, 2016). Moreover, IoT-based smart irrigation systems monitor soil moisture levels in real time, helping to optimize irrigation schedules and minimize water consumption (Gremmen, 2018).

AI technologies have particularly impacted rice farming in Thailand, improving efficiency and minimizing waste. Digital tools such as drones for aerial mapping, IoT sensors for water management, and robotic harvesters have significantly boosted productivity in rice farming (Nadee, 2020). Research indicates that AI-driven precision farming reduces labor costs by 20% and enhances rice yields by up to 15% (Manyuen et al., 2019). However, the adoption of AI in agriculture is not without challenges. High initial costs of AI tools make it difficult for many small-scale farmers to afford them (Joblaew et al., 2019). Additionally, a lack of technical skills among farmers hampers the adoption of these technologies (Bhandhubanyong & Sirirangsi, 2019), and limited internet connectivity in rural areas further complicates the implementation of AI solutions (Sayruamyat, 2019). To address these challenges, governments and private organizations are supporting AI adoption by providing subsidies for AI tools, offering training programs to enhance farmers' digital literacy, and investing in initiatives like Thailand's DTAC Smart Farmer Program, which integrates AI and IoT in farming (Kwanmuang, 2020; Richardson et al., 2019). These efforts aim to make AI more accessible and empower farmers to adopt smart farming technologies.

2.6.1 Collaborative Approaches to Sustainability

Rattichot (2018) argued that achieving sustainable agricultural development requires collaboration between various stakeholders, including government agencies, for-profit businesses, and non-profit organizations. Such multi-stakeholder partnerships are vital for pooling resources, sharing information, and fostering innovation. These collaborations help to drive social and environmental impact, as they enable the effective implementation of agricultural projects that might otherwise struggle to achieve scale and impact on their own. According to Knierim (2019), awareness of the benefits of technology motivates farmers to adopt new practices. A study of 27 German farmers successfully utilizing smart farming technologies indicates that understanding these advantages drives enthusiasm and willingness to learn. This suggests that when farmers see the tangible benefits of technological innovations, they are more likely to engage with and implement these technologies.

2.6.2 Challenges in Technology Utilization

Despite the advantages of technology, the implementation of new systems poses significant challenges for farmers. Kwanmuang (2020) noted that farmers often struggle with mastering new skills and technologies, which can delay the adoption of advanced practices. For example, New Zealand dairy farmers have been slow to adopt robotic milking systems, even though these systems are more cost effective compared to traditional methods. Farmers may experience information overload when introduced to new agricultural techniques and applications. Kwanmuang (2020) observes that this can be particularly problematic when farmers are faced with a multitude of new technologies and methods simultaneously. The complexity of these innovations can create additional barriers to their adoption, making it crucial to provide adequate training and support to help farmers integrate these technologies into their practices.

2.6.3 Impact of Startups and Ag-Tech Innovations

In Thailand, the rise of Ag-Tech startups has significantly disrupted traditional agricultural practices. Rattichot (2018) highlighted the urgent need to reform Thailand's inefficient agricultural sector, which is characterized by high investment costs and low prices despite abundant natural resources. The impact of climate change, such as droughts and floods, exacerbates production risks and further underscores the need for innovative solutions. Eastwood (2019) and Annosi (2020) discussed how Ag-Tech startups are transforming Thai agriculture by integrating digital technologies into farm management. These startups are instrumental in enhancing soil quality, increasing productivity, and advancing the use of modern agricultural machinery and equipment. Over the past decade, Ag-Tech innovations have played a crucial role in improving farm productivity and sustainability, providing new business opportunities, and addressing long-standing challenges in agriculture.

2.6.4 Conclusion

The development of agriculture through artificial intelligence and technology presents both opportunities and challenges. While technological advancements, including AI and digital tools, offer significant benefits for improving agricultural productivity and sustainability, they also introduce obstacles such as information overload, the need for new skills, and financial constraints. Collaborative efforts and inclusive approaches are essential for overcoming these challenges and ensuring that technological innovations can be effectively integrated into agricultural practices.

2.7 Conceptual Framework

This study is based on the literature on agricultural technologies, focusing on success factors, obstacles for businesses and farmers, and effects of artificial intelligence (AI) performance. Existing literature shows a lack of comprehensive studies discussing success factors and barriers from two perspectives: digital technology knowledge and agricultural knowledge and technology as factors for technology adoption, and the impact of agricultural technologies on the adoption, and the impact agricultural technologies on the adoption of farming practices by firms (Annosi, 2020).

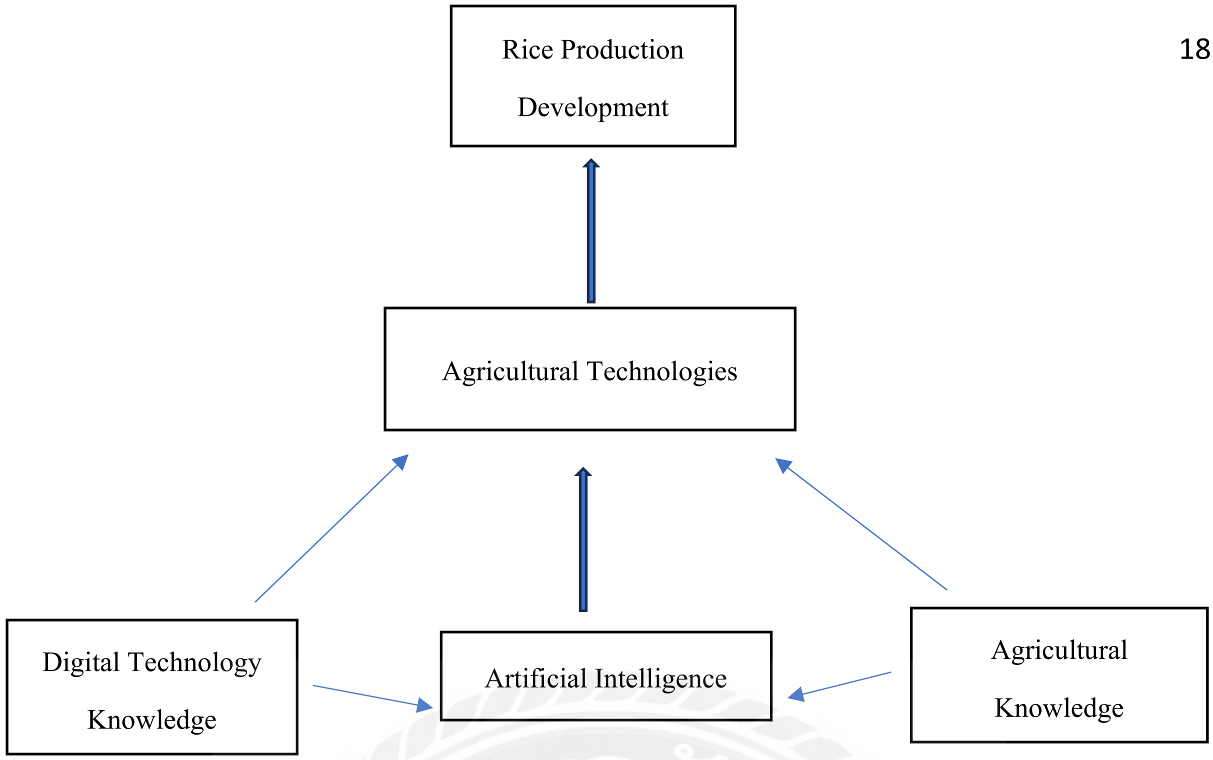

Figure 6: Conceptual Framework

Source: Annosi, (2020). Digitization in the agri-food industry.

CHAPTER 3

Research Methodology

3.1 Introduction

This chapter outlines the approach and procedures used to investigate the impact of artificial intelligence (AI) on agriculture. The focus is on examining how artificial intelligence influences agricultural practices, their adoption challenges, and their potential for enhancing farm productivity and sustainability.

3.2 Research Design

The research employed a mixed-methods approach, combining both qualitative and quantitative methodologies. This design allows for a comprehensive analysis of the impact of AI in agriculture, incorporating both numerical data and in-depth insights. Case studies of specific agricultural projects and surveys of farmers and industry professionals were used to gather data. Case studies provided detailed examples of technology implementation and its effects, while a questionnaire survey offered broader insights into the attitudes and experiences of a larger sample.

3.3 Questionnaire Design

A questionnaire for this study was designed to gather insights from farmers regarding their experiences with artificial intelligence (AI) and digital technologies in rice production. The design follows a structured format, ensuring that all relevant aspects of AI adoption, economic factors, and digital literacy are covered. The questionnaire consists of multiple sections that focus on demographic information, economic status, technology use, access to training, and perceived benefits and challenges of AI in agriculture.

Demographic Information

This section collects basic information about the respondents, including their gender, age, farming experience, and farm size. Understanding these demographics helps contextualize the responses and identify trends in AI adoption among different groups of farmers.

Economic Status

This section assesses the financial background of farmers, including their annual income from farming, access to credit, and sources of financing. These questions help evaluate how economic factors influence the ability to adopt and implement AI and digital technologies in rice production.

Technology Use and Familiarity

This section aims to determine the extent to which farmers use agricultural technologies, including AI-driven tools. Respondents are asked about their familiarity with various AI applications, such as precision irrigation, drones, mobile applications, and soil sensors. The goal is to assess farmers' readiness to adopt new technologies.

Access to Information and Training

This section investigates whether farmers have received training related to AI and digital technology. Questions focus on the effectiveness of training programs and the sources from which farmers acquire knowledge about technological advancements.

Perceived Benefits and Barriers

This section explores farmers' expectations regarding AI technology, including benefits such as increased yield, cost savings, and time efficiency. Additionally, it identifies barriers to adoption, such as high costs, lack of knowledge, limited access, and poor internet connectivity.

Interest in Future AI Adoption

To understand the potential for wider adoption, this section asks about farmers' willingness to learn more about AI technologies and the types of support they require, such as financial subsidies, training programs, and peer support.

3.4 Data Collection

Primary data was collected through direct methods, including interviews, focus groups, and surveys. Key stakeholders, such as farmers, technology providers, and agricultural experts, were interviewed to understand their experiences with AI and digital technologies. Surveys questionnaire were distributed to farmers to gather quantitative data on technology adoption rates, challenges, and benefits. Secondary data was obtained from existing literature, industry reports, and academic publications. This includes studies on smart farming, AI applications in agriculture, and the impact of digital technologies on farm management. A total of 200 questionnaires were distributed to farmers across various regions involved in rice production. Out of these, 178 completed questionnaires were returned, resulting in a response rate of 89%. The high response rate indicated a strong willingness among farmers to share their perspectives on AI and digital technologies in agriculture. The returned questionnaires were carefully reviewed, and incomplete responses were excluded from the final analysis to ensure data accuracy and reliability.

3.5 Ethical Considerations

Participants were provided with clear information about the research objectives, procedures, and potential impacts. Informed consent was obtained from all participants, ensuring they understood their right and the voluntary nature of their involvement. Confidentiality and anonymity were maintained throughout the research process. Personal identifiers were removed from data, and information was stored securely to protect participants' privacy.

3.6 Limitations

Potential limitations included the availability of participants, variability in technology adoption rates, and the influence of external factors such as economic conditions and climate change. These limitations were addressed through careful sampling and data collection strategies. The study focused on specific regions and types of agricultural practices where AI and digital technologies are being implemented.

CHAPTER 4
Findings

In recent years, the integration of digital technologies and artificial intelligence (AI) into agriculture has brought significant changes to farming practices. This section delves into how digital technologies and AI are transforming agricultural practices, with a focus on rice farming in Thailand. The adoption of these technologies aims to improve efficiency, increase production, and address challenges faced by farmers. The following sections provide an overview of findings related to digital technology knowledge, its application in agricultural technologies, and its impact on rice production development.

4.1 Survey Findings

The quantitative survey conducted from 178 farmers revealed significant insights into the adoption of agricultural technology. The demographic breakdown showed a diverse representation, with 60% of respondents identifying as male and 40% as female. Respondents ranged in age from 18 to 65 years, with an average age of 42. The majority had substantial farming experience, averaging 15 years, indicating that the respondents possessed a strong foundational knowledge of agricultural practices. Regarding technology adoption, the survey found that 65% of farmers had integrated at least one form of agricultural technology into their practices. Among the technologies utilized, precision irrigation was the most common, reported by 40% of respondents, followed by mobile applications for market access at 30%, and drones for crop monitoring at 15%. This indicates a growing trend towards adopting technologies that enhance efficiency and productivity in farming operations.

The analysis also explored factors influencing technology adoption. Economic status emerged as a critical factor, with higher-income farmers being 30% more likely to adopt new technologies. Educational background was similarly influential; farmers with a college degree exhibited a 25% increased likelihood of using agricultural technology. Furthermore, access to training programs significantly impacted adoption rates, with those receiving adequate training experiencing a 40% increase in technology use, highlighting the importance of education and skill development in facilitating technology integration. Farmers who had adopted technology reported notable benefits, reinforcing the value of these innovations. A substantial 70% indicated that their crop yields had improved due to technology use, while 55% noted a reduction in operational costs. Additionally, 65% of participants emphasized the time-saving advantages that technology brought to their farming activities, suggesting that these tools not only enhance productivity but also allow for more efficient resource management.

Despite the positive impacts, barriers to adoption were also identified. High initial costs were a significant concern for 50% of respondents, making financial investment a critical hurdle. Additionally, 45% expressed that a lack of knowledge and training limited their ability to effectively implement technology. Infrastructure issues, particularly poor internet connectivity, were mentioned by 30% of farmers as a challenge to fully utilizing digital tools. These barriers indicate the need for targeted interventions to support farmers in overcoming financial and educational obstacles. Looking to the future, the survey revealed a strong interest among non-adopters in exploring agricultural technology. An impressive 75% expressed a desire to learn more, and 60% indicated they would consider investing in technology if financial support or subsidies were made available. This openness to adopting new technologies suggests potential for increased adoption rates, provided that appropriate resources and support systems are implemented.

4.2 Focus Group Findings on Agricultural Technology Adoption

Demographic Overview

The focus group consisted of 12 farmers from various regions, primarily engaged in rice and maize cultivation. Participants represented a mix of small-scale and medium-scale farmers, with varying levels of education and technological expertise. This diversity allowed for a comprehensive understanding of different perspectives on agricultural technology adoption.

Perceived Benefits of Agricultural Technology

Farmers unanimously acknowledged the benefits of adopting agricultural technology. Many noted that it significantly enhanced their efficiency, enabling them to manage larger fields with reduced labor. Participants reported increased crop yields, attributing this improvement to precision farming techniques and advanced irrigation systems. Furthermore, they expressed that digital marketing platforms facilitated better access to markets, resulting in higher prices for their products.

Barriers to Technology Adoption

Despite recognizing the advantages, several barriers to adoption emerged during discussions. A predominant concern was the high initial costs associated with purchasing technology and equipment, which many farmers felt were prohibitive. Additionally, a lack of training and support in using these new technologies was highlighted as a significant hurdle. Farmers also mentioned infrastructure limitations, such as poor internet connectivity in rural areas, which hindered the effective use of digital tools.

Support and Resources Needed

Participants emphasized the need for greater support to overcome these barriers. They advocated for more government initiatives, including subsidies and financial assistance programs aimed at helping farmers invest in technology. Furthermore, they suggested the establishment of regular training programs conducted by local agricultural extension services to enhance their skills in using new tools. Creating community networks among tech-savvy farmers was also proposed as a way to facilitate knowledge sharing.

Future Outlook and Recommendations

Looking ahead, farmers expressed optimism about the potential of agricultural technology to transform their practices. There was a noticeable interest in emerging technologies, such as drones and IoT devices, for monitoring crops and optimizing resource use. Participants highlighted the opportunity for collaboration with technology companies to develop solutions tailored to their specific agricultural challenges, thereby fostering a more sustainable farming environment.

4.3 Digital Technology Knowledge and Agricultural Technologies

Recent research highlights the pivotal role of digital platforms in enhancing agricultural knowledge among Thai farmers. According to Manyuen et al. (2019), Thai farmers primarily use social media platforms like Line, Facebook, WhatsApp, and YouTube to access agricultural information. These platforms facilitate knowledge exchange and help farmers improve their practices and increase rice production.

Platform	**Usage Frequency**	**Purpose**	**Impact on Farming Practices**
Line	High	Knowledge exchange, communication	Enhanced access to farming advice and community support
Facebook	Medium	Sharing experiences, learning	Improved knowledge sharing and community engagement
WhatsApp	Medium	Communication, group discussions	Facilitated quick information exchange and support
YouTube	High	Learning through videos, tutorials	Increased understanding of farming techniques and practices

Table 3: Digital Technology Knowledge and Usage by Thai Farmers

Richardson, et al. (2019) further reinforced by significance of digital technology in expanding farmers' understanding of farming processes. Gremmen (2018) also emphasized the importance of effective communication and knowledge sharing through digital tools. Collectively, these findings suggest that Thai rice farmers are increasingly leveraging digital technologies to educate themselves and enhance their farming practices.

4.4 Integration of Digital Technologies and AI in Agriculture

The integration of digital technologies and AI has addressed various agricultural challenges, including weather fluctuations, temperature changes, humidity, and pest management. Both DTAC and Siam Kubota have made strides in utilizing these technologies to support farmers.

Company	**Technology**	**Description**	**Key Features**	**Impact on Farmers**
DTAC	IoT and Precision Farming	Real-time monitoring of weather, temperature, soil, and pests	Sensor equipment, "Farmer Info" application	Improved decision-making, enhanced resource management
Siam Kubota	Telematic GPS Devices	On-demand control of agricultural machinery	GPS for precision control of machinery	Increased efficiency and accuracy in machinery operation

Table 4: Integration of Digital Technologies and AI by DTAC and Siam Kubota

Source: Nadee (2020), Gremmen (2018)

Nadee (2020) highlighted DTAC's efforts to educate Thai farmers about smart farming through their projects. However, challenges such as budget constraints and varying levels of willingness to adopt smart technologies remain. Despite these hurdles, younger Thai farmers are increasingly embracing AI, weather information, and soil data to improve production (Gremmen, 2018).

4.5 Agricultural Technologies and Rice Production Development

Thai farmers have incorporated various agricultural technologies to enhance rice production. The CF (Collaborative Farming) project has been instrumental in introducing and supporting these technologies.

Technology Adoption:

Top Technologies: Farmers have adopted technologies such as leguminous crop cultivation, breeding rice seeds (e.g., Rice 906), and applied chemical fertilizers based on soil analysis.

Farmer Feedback: Overall, farmers have positively received these technologies, though some challenges, such as the insufficient availability of production inputs, have been noted.

Training and Support: Farmers received information and training primarily through the CF project, community leaders, and agricultural extension officers, which helped them understand and implement the new technologies effectively.

Information Sources: Farmers accessed project information through CF project training, community leaders, and agricultural extension officers.

External Assistance: Government departments, such as weather forecasting services, have provided essential support for optimizing harvest timings and water management.

Joblaew et al. (2019) noted that while farmers generally embraced the technologies, challenges related to technology adoption, such as budget constraints and external support needs, persist. Bhandhubanyong and Sirirangsi (2019) emphasized the role of government support in addressing these challenges.

4.6 Challenges in Technology Adoption

Despite the benefits of technological advancements, Thai farmers face several challenges in adopting new technologies:

Challenge	**Description**	**Impact on Adoption**	**Potential Solutions**
Budget Constraints	High costs of advanced technologies	Limited adoption among low-budget farmers	Subsidies, financial support programs
Limited Access	Restricted availability in rural areas	Hinders technology reach and utilization	Expansion of technology distribution
Resistance to Change	Reluctance to adopt new technologies	Slows down technology uptake	Educational programs, hands on training

Table 5: Challenges in Technology Adoption

Source: Sayruamyat (2019), Bhandhubanyong and Sirirangsi (2019)

Additionally, the effectiveness of technology adoption varies based on farmers' digital literacy and willingness to learn. Overcoming these barriers requires targeted educational programs and support from government and private sectors.

4.7 Summary of Findings

The integration of digital technologies and AI into Thai agriculture has led to significant advancements in farming practices, particularly in rice production. The use of digital tools has empowered farmers with valuable knowledge and improved communication, contributing to more effective farming techniques and enhanced productivity. Technologies such as IoT, precision farming, and telematic GPS devices have addressed various agricultural challenges and enabled farmers to make better-informed decisions. The CF project has successfully introduced and supported several agricultural technologies, leading to positive outcomes in rice production. However, challenges such as budget constraints, limited access, and resistance to change continue to impede the full adoption of these technologies.

Overall, while digital technologies and AI offer substantial benefits, addressing the challenges associated with their adoption is essential for maximizing their impact. Continued support, both in terms of financial assistance and educational initiatives, will be critical in ensuring that Thai farmers can fully leverage these technologies to improve agricultural practices and achieve sustainable growth. The findings underscore the need for ongoing efforts to enhance technology accessibility, provide adequate support, and foster a culture of innovation and learning among farmers.

CHAPTER 5

Conclusion and Recommendation

This chapter summarizes the findings from the research on digital technology and AI's impact on agriculture in Thailand, particularly focusing on rice farming. It also provides recommendations for improving the integration of these technologies into agricultural practices and suggests areas for future research.

5.1 Conclusion

The research reveals that digital technologies, including social media platforms and AI, play a significant role in enhancing agricultural practices among Thai rice farmers. Platforms like Line, Facebook, WhatsApp, and YouTube are extensively used for knowledge exchange and communication. Technologies such as IoT, precision farming, and big data analytics have been adopted to address agricultural challenges and improve productivity. Despite these advancements, there are barriers such as budget constraints and varying levels of digital literacy among farmers.

5.2 Recommendation

The findings of this research pose the government to create a policy or platform. First, the government, for instance, may use the study's findings to encourage private companies that wish to undertake smart farming initiatives for regional farmers and enhance the country's digital development strategy. Second, Thailand is complicated and needs a national strategy to quickly improve the situation. Some of the recommendations made included gathering information on land management and soil quality. Next, the government needs to provide the Thai framer grant who uses AI framer, the individual who keeps on sharing information with others through the social platform. The framers are advised to invest time and money to learn new away of the frame by sharing the knowledge, learning for the international market, learn to use AI in the rice product, and the local and small-scale farmers are advised to adopt the moderate way of farming to competitive with domestic and international competition. Lastly, more research of this nature needed to be done and promote SMART farming.

5.2.1 Recommendations for Policy and Platform Development

The findings suggest that the Thai government should develop and implement policies to support the adoption of smart farming technologies. Specifically:

Encourage Private Sector Initiatives: The government should incentivize private companies to invest in smart farming projects. By collaborating with these companies, regional farmers can gain access to advanced technologies and training, which will contribute to the country's overall digital development strategy (Nadee, 2020).

National Strategy for Technology Integration: A comprehensive national strategy is needed to address the complexities of Thailand's agricultural sector. This strategy should include efforts to gather and analyze data on land management and soil quality, which will inform better agricultural practices (Bhandhubanyong & Sirirangsi, 2019).

Grants and Financial Support: Providing grants or financial assistance to farmers who adopt AI technologies will encourage more widespread use. Support should also be extended to those who actively share knowledge and information through digital platforms (Manyuen et al., 2019).

5.2.2 Recommendations for Farmers

Invest in Learning and Technology: Farmers should dedicate time and resources to learning new farming techniques, utilizing AI tools, and understanding international market trends. This will help in adapting to changes and improving competitiveness (Richardson, Kelley, & James, 2019).

Adopt Moderate Farming Practices: Local and small-scale farmers should consider adopting moderate and innovative farming practices to remain competitive in both domestic and international markets (Joblaew et al., 2019).

5.2.3 Importance of Knowledge Sharing

Farmers should be encouraged to continue sharing their knowledge and experiences with peers through digital platforms. This collaborative approach helps in spreading best practices and enhancing the overall knowledge base within the farming community (Gremmen, 2018).

5.2.4 Need for Further Research

Further research is essential to explore the long-term impacts of digital technologies and AI on agricultural productivity and sustainability. Studies should focus on assessing the effectiveness of different technology adoption models, understanding regional variations, and evaluating the economic impacts on small-scale and large-scale farms (Sayruamyat, 2019).

5.2.5 Promotion of SMART Farming

Promoting SMART (Sustainable, Measurable, Adaptable, Responsive, and Technology-driven) farming practices is crucial for the future of agriculture in Thailand. Efforts should be made to educate farmers about SMART farming benefits, provide access to relevant technologies, and develop support networks to facilitate technology adoption (Srivetbodee & Igel, 2021).

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APPENDIX

Dear Student: Hello!

Thank you very much for taking your valuable time to fill out this questionnaire. This questionnaire is anonymous, and the data collected is for academic research only, and will never bring any negative impact to you personally. There is no right or wrong answer, the real answer is the best answer. We kindly ask you to fill in the answers according to the actual situation, and your real answers are very important to my research. Thank you again for your sincere cooperation!

Part I: Survey on the situation of questionnaire recipients (absolute confidentiality) Please fill in (tick the items that match your situation):

1. Your gender is.

A. male   B. female

2. Your grade.

A. first year university student

B. Second year of university

C. Third year of university

D. Fourth year of university

Part 2: Please read the following items carefully and answer.

Question	**Response Options**
Section 1: Demographic Information	
1. Which digital platforms do you use for agricultural information? (Select all that apply)	☐ Line ☐ Facebook ☐ WhatsApp ☐ YouTube

	☐ Other: _________
2. How often do you use these platforms for obtaining agricultural information?	☐ Daily ☐ Weekly ☐ Monthly ☐ Rarely
3. Farming Experience (in years)	_____ (Years)
4. Farm Size (in acres)	_____ (Acres)
Section 2: Economic Status	
1. Average annual income from farming	☐ Less than $5,000 ☐ $5,000 - $10,000 ☐ $10,000 - $20,000 ☐ More than $20,000
2. Do you have access to credit or financial support?	☐ Yes ☐ No
3. How do you typically finance your farming operations?	☐ Personal savings ☐ Loans ☐ Grants ☐ Other: ___________
Section 3: Technology Use and Familiarity	
1. Have you adopted any agricultural technologies?	☐ Yes ☐ No
2. If yes, which technologies do you currently use? (Check all that apply)	☐ Precision irrigation ☐ Drones ☐ Mobile apps ☐ Soil sensors

	☐ Other: ___________
3. How familiar are you with agricultural technologies?	☐ Not familiar ☐ Somewhat familiar ☐ Very familiar
4. What motivates you to adopt agricultural technology?	☐ Increased efficiency ☐ Cost reduction ☐ Better yields ☐ Other: ___________
Section 4: Access to Information and Training	
1. Have you received any training related to agricultural technology?	☐ Yes ☐ No
2. If yes, how effective was the training?	☐ Not effective ☐ Somewhat effective ☐ Very effective
3.What sources of information do you use to learn about new technologies? (Check all that apply)	☐ Extension services ☐ Online resources ☐ Workshops ☐ Social media ☐ Other: __________
Section 5: Perceived Benefits and Barriers	
1. What benefits do you expect from using agricultural technology? (Check all that apply)	☐ Increased yields ☐ Cost savings ☐ Time savings ☐ Improved quality ☐ Other: __________

2. What barriers do you face in adopting agricultural technology? (Check all that apply)	☐ High costs ☐ Lack of knowledge ☐ Limited access ☐ Poor internet ☐ Other: __________
3. How important is technology in your farming practice?	☐ Not important ☐ Somewhat important ☐ Very important
Section 6: Perceived Benefits and Barriers	
1. Are you interested in learning more about agricultural technologies?	☐ Yes ☐ No
2. If yes, what support would encourage you to adopt new technologies? (Check all that apply)	☐ Financial subsidies ☐ Training ☐ Information access ☐ Peer support ☐ Other: _________
3. How likely are you to adopt new agricultural technologies in the next 2 years?	☐ Very unlikely ☐ Unlikely ☐ Neutral ☐ Likely ☐ Very likely
Section 7: Additional Insights	
1. What type of technology would you like to see more available to farmers?	
2. Have you participated in any farmer cooperatives or groups focused on technology?	☐ Yes ☐ No

3. What challenges do you face in accessing technology?	