# การบริหารจัดการโดยใช้กระบวนการวิเคราะห์ข้อมูลมหัตเพื่อสร้างโอกาสให้กับเกษตรกรไทยในช่วงวิกฤตการขาดแคลนอาหารโลก

# Management Using the Big Data Analytical Process to Create the Opportunity for Thai Agriculturists during Global Food Crisis

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## บทคัดย่อ

บทความวิชาการนี้มีวัตถุประสงค์เพื่อนำเสนอแนวทางในการช่วยเกษตรกรไทยแก้ปัญหาและพัฒนาการเกษตรโดยใช้ข้อมูลมหัต (Big Data) ในการวางแผนเพื่อประกอบการตัดสินใจในกระบวนการเกษตรตั้งแต่ต้นน้ำ กลางน้ำ และปลายน้ำ ทำให้ผลผลิตทางการเกษตรมีประสิทธิผลเหมาะสมต่อการจำหน่ายเพื่อสร้างรายได้ให้กับเกษตรกรไทยอย่างมีประสิทธิภาพ นำไปสู่โอกาสการขยายอุปทานและส่งออกผลิตภัณฑ์ของอุตสาหกรรมเกษตรไทยเพื่อตอบสนองความต้องการของอุปสงค์ในต่างประเทศจากวิกฤตการขาดแคลนอาหารโลก ดังนั้นการจัดการระบบข้อมูลสารสนเทศโดยใช้ “ข้อมูลมหัต” จึงมีความจำเป็นอย่างยิ่ง โดยดำเนินการตามกระบวนการวิเคราะห์ข้อมูลมหัต 4 ขั้นตอน ดังนี้ 1) การเก็บรวบรวมข้อมูล 2) การบูรณาการข้อมูล 3) การวิเคราะห์ข้อมูล และ 4) การประยุกต์ใช้จริง ซึ่งการนำกระบวนการวิเคราะห์ข้อมูลมหัตมาประยุกต์ใช้ในการทำการเกษตร จะสามารถยกระดับเกษตรกรไทยในด้านคุณภาพของผลผลิต ตลอดจนการสร้างรายได้อย่างมั่นคงและยั่งยืน

**คำสำคัญ:** การบริหารจัดการ ข้อมูลมหัต เกษตรกรไทย วิกฤตการขาดแคลนอาหารโลก

## Abstract

The aim of this academic article is to propose the guidelines to Thai farmers that they can solve their agricultural problems and development by using Big Data. It can be used for planning and decision–making throughout the agricultural process, from upstream to downstream. This process can make agricultural products to be more effective and suitable for distribution, allowing the farmers to generate income efficiently. Furthermore, it could create an opportunity to expand the supply and export of Thai agricultural products to meet foreign demand caused by the global food crisis. Therefore, the use of Big Data analytics is urgently needed in the management of

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the agricultural industry. The Big Data analytics process can be implemented in four steps: 1) data collection, 2) data integration, 3) data analysis, and 4) real–world application. This process can help Thai farmers improve the quality of their agricultural production and ensure sustainable income.

**Keywords:** Management, Big Data, Thai farmers, Global food crisis

## Introduction

The food crisis is expanding around the world due to the Russia–Ukraine war. In fact, since the war started, food costs and food insecurity have risen throughout the world. Adding to the crisis are the COVID-19 pandemic, an energy crisis, delivery limitations, and climate-induced extreme events. The goals of food sustainability and security will undoubtedly be disrupted by this.

Thailand's agricultural sector produces the most important food crops in the world, but in recent years, Thai agriculturists have been unable to make decisions about the type of seed and fertilizer to use based on historical calendars and traditional knowledge due to climate change, soil erosion, and water scarcity. These issues have forced Thai farmers to adapt to an ever-changing environment (Wanakitpaiboon, 2022) and require greater assistance and responsive information. Agriculture digitization is anticipated with high hopes. Big Data is a collection of enormous amounts of data sets that apply the process for managing data and have capacities that go beyond those of traditional processes from the past. For instance, farmer cooperatives can use information to find the most effective product from farmer profiles in real-time (Manyuen et al., 2019, p. 1795). Additionally, Big Data can provide Thai farmers with practical methods to increase productivity and reduce expenses. As a result of the global food crisis, there is an opportunity to generate income for Thai farmers efficiently while decreasing costs and transforming how food is produced to sustainably match the forthcoming global population growth.

The purpose of this article is to demonstrate the Big Data analytical process that can support Thai farmers' decision–making in the agricultural process from upstream, midstream, and downstream. In order to demonstrate how Big Data can help in an agriculture sustainable decision–making process, this article revisits the main steps of the Big Data analytical process and focuses on information system management by reviewing recent applications related to each crucial step to lead to effective

agricultural products suitable for distribution to generate income while reducing costs to traditional agriculture as occupational immunity among small agriculturists in Thailand.

## Global Food Crisis

Global food crisis is a growing problem worldwide, with many households in underdeveloped and developing countries still suffering from food insecurity. The present availability of food to people reflects very unequal economic and political power relationships within and between countries. Food security is about having access to a sufficient quantity and high quality of food, and it is influenced by factors such as political conflict, economic instability, pandemic diseases, and climate change.

Firstly, the ongoing conflict between Russia and Ukraine has reinforced fundamental flaws in global food security and led to the emergence of food shortages. Russia and Ukraine produce nearly 30% of the world's traded wheat and 12% of its calories, while Russia and Belarus produce a large portion of the world's fertilizer supply. As a result, the cost of food and fertilizer has increased, which could have an impact on all farmers worldwide for the foreseeable future (Behnassi & Haiba, 2022).

Secondly, a majority of people's access to food has been disrupted by economic instability. A major concern is inflation driven by increasing costs for food, energy, and other consumer products. Due to the pandemic, a large number of people have lost their jobs and income, which has reduced families' ability to purchase food. The resulting insufficient calorie supply has led to a 10% decrease in the number of grains available on international export markets and export restrictions of maize in the US, wheat in Russia, and rice in Thailand (Bren d'Amour et al., 2016).

Thirdly, the COVID-19 pandemic has caused some governments to adjust their food trade policies in the direction of restricting exports and facilitating imports. The main reason that countries impose export restrictions is to ensure the maintenance of the number of products in the domestic market. Export limitations reduce domestic pricing, which hurts farmers financially and reduces crop production in industry incentives. Export limitations impair exporters' reputations and encourage importers to have less faith in the global market, which undermines international trade and eliminates possibilities for exporters to grow their businesses. (S. Aday & M. S. Aday, 2020).

Finally, the agricultural sector has already been significantly impacted by climate change, and the situation will get worse in the future. Increasing temperatures have had a negative impact on crop production and yield from a national to a global scale. Additionally, crop failures will rise because of intense heat and unpredictable rainfall.

Even heavy rainfall can hinder harvesting and lower crop quality. Higher sea levels have decreased the amount of land that can be used for agriculture in many countries, while rising rainfall rates have caused floodplains to extend across more countries. In general, these long–term effects of climate change on agricultural industries will continue and significantly threaten food security (Nguyen, Sahin et al., 2021).

Food insecurity and the food supply dilemma are global issues due to lower crop yields resulting from a shortage of fertilizer and animal feed caused by the ongoing Russia–Ukraine war. As stockpiling of food appears to be unavoidable, it is essential for farmers to be involved in all aspects of the global endeavor to achieve sustainable and secure food security. The more motivated the farmers are in the process, the higher the chances of attaining lasting food security.

## The obstacles of Thai agriculturists during global food crisis

The key development principle of Thailand's 20–Year National Strategy (2018–2037) is "stability, prosperity, and sustainability" through the development philosophy of sufficiency economy (National Strategy Secretariat Office, 2018). However, the Thai agriculture sector employs around 30% of the total domestic workforce, covering 6.4 million households. The proportion of planted lands was reported at 40% across the country. Nevertheless, the agriculture sector only generated 10% of Thailand's gross domestic product (GDP). The revenue growth of the Thai agricultural sector is rapidly slowing (Udomkerdmongkol, 2020).

Thai agriculture investment, which provides "high risk, low return," has four primary factors. The first factor is the weather, which affects all farmers due to climate change and global warming. There are regular floods and droughts. Thai agriculturists rely primarily on weather and water, making crops tend to collapse if the weather is unpredictable. The second factor is market prices, which Thai farmers cannot control. It changes based on supply and demand. The third factor is the crop yield per plot. Thai agriculturists still practice traditional agriculture because they lack technology and knowledge of production, which contributes to their inability to produce enough quality products to meet manufacturers' demands. Additionally, agricultural manufacturers and exporters could not access the agriculturists' information, making it difficult to predict their outputs. The fourth factor is that agricultural manufacturers have an obstacle in planning forward contracts. These issues are impeding the development of Thailand's agricultural industry (Wanakitpaiboon, 2022).

The most concerning issue for Thai agriculturists in the supply chain is crop yields because it affects their incomes. It serves as the security of Thailand's agricultural supply chain. However, the problems that Thai agriculturists encounter include difficulty locating the required data, unreliable data, a lack of sources and references, and inappropriate data sharing. There are no recommendations for locating data sources, retrieving data, analyzing data, or comparing data before implementation (Purichpisittakorn & Siriprasertsin, 2019). To support Thai agriculturists and increase crop yield and secure the agricultural supply chain, it is necessary to find solutions for six issues of Thai agriculturists as follows: 1) types of seed 2) time of planting 3) time of fertilizing 4) plot monitoring 5) time of harvesting 6) channel of market (Wanakitpaiboon, 2022).

## The opportunity of Thai agriculturists during global food crisis

Thailand considered as one of the world's top food producers, there is a sufficiency of food for domestic consumption. It can be the great opportunity to grow agricultural and food exports. As an important food producer, this can be noticed from agricultural exports of the first quarter of 2022 (January - April 2022) that have grown significantly compared to 2021 during the same period. Thai agricultural products exports to the world increased from 418,883 million baht to 516,127 million baht. It is an increase of 97,244 million baht or 23.22 percent. The top ten of agricultural products exported were durian, rice, natural rubber, flavored chicken, food of dog and cat, Tuna, cassava, natural latex, nonalcoholic beverages, and tofu (Office of Agricultural Economics, 2022).

Enhancing food security is the most challenging of Thai agriculture industry and a crucial part of economic development in the effort to eliminate global food crisis. Consequently, the agricultural supply chain is currently concentrated on production and distribution to increase efficiency from the initial stage to the final stage, decreasing time and costs to satisfy the increased demand (Wattanutchariya, Tansuchat et al., 2016). Thai farmers are benefiting from the insecurity of the global agricultural supply chain. Many agricultural sectors can improve operational effectiveness and provide value to the agricultural supply chain. One of the processes for agriculture industry management is “Big Data analytics”, it is utilized in the manufacturing process to increase productivity as well as to decrease costs, resources, and management (Rao, 2018). For example, the preparation of a provincial crop calendar monthly which support the planning for the distribution of agricultural products.

The Ministry of Agricultural Economics has a plan to enhance food security operations by implementing a large, comprehensive, and interconnected database

system for Big Data, as well as conducting research and development (R&D) to strengthen incentives for Thai farmers and achieve sustainable productivity growth. This plan can help the Thai government create local food security and build immunity for Thai farmers to deal with crises sustainably by increasing productivity and adding value to agricultural products (Office of Agricultural Economics, 2022).

## The Big Data analytical process for management

Agriculture has been economically driven for more than a century, but data was not digitally stored. To improve production efficiency, agriculture meticulously accounted for yields across farms and weather trends. However, the scale and analytical capacity of digital technology's Big Data differs from this earlier form of information collection. Developers of Big Data technology promise a degree of accuracy, data storage, processing, and analysis that was previously impractical owing to technological constraints (Bronson and Knezevic, 2016). The term "Big Data" was first coined in 1998 by John Mashey at Silicon Graphics (SGI). Big Data development requires expanding capacity limits and processing power. Big Data is a collective phrase used to describe data that is enormous and complex, such that it cannot be processed using standard software and data management methods. One of the key drivers for Big Data analysis tools is the requirement to analyze and utilize trend data gathered by businesses (Geethanjali et al., 2019). Big Data is characterized by three main features or dimensions: volume, velocity, and variety. The volume dimension of Big Data is too large for ordinary database systems to handle, and it is subjectively defined. The idea of Big Data also differs among industries, ranging in size from several terabytes to many petabytes. The velocity dimension refers to the ability to gather, analyze, comprehend, and interpret data in real time, in other words, the speed of data processing. The variety dimension is unique and engaging, and simply relates to the diversity of data types (Himesh et al., 2018).

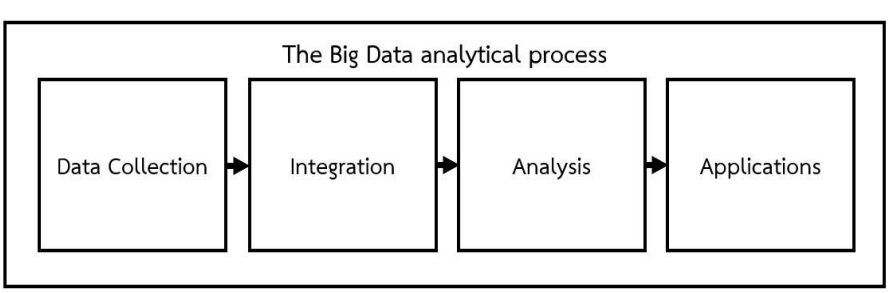


**Figure 1** The Big Data analytical process
Source: Apply based on Alguliyev et al., 2017

As shown in Figure 1, the Big Data analytical process and extracting essential information can be divided into four stages. The first stage is data collection. Data is gathered from a variety of sources, including batch–oriented applications, near–real–time systems, and real–time systems. The step of data discovery is used to process Big Data and prepare it for integration into structured analytical platforms or a data warehouse. The second stage is integration. The most crucial stage in building the integration of Big Data into a data warehouse is the capacity to use metadata, semantic libraries, and master data as the integration linkages. This procedure is the critical phase in transforming and incorporating unstructured and raw data into a structured manner. The third stage is analysis. The data is tagged, classified, and categorized during the analysis step, which is similar to the data model design stage of topic area construction in the data warehouse. The fourth stage is real application. Big Data is processed within analytical applications and reporting systems before being transmitted to downstream systems. Another method of distribution is to use flat files to export the data for usage in other programs such as online reporting and content management systems. The main goal of this section was to inform readers on how to build a solid, scalable, and adaptable data processing architecture for processing and integrating Big Data by adopting a data–driven approach and adding master data and metadata (Alguliyev et al., 2017).

Big Data is developing and contributing to increased productivity. Technology or equipment utilized in agriculture, such as lands, operations, and production, is referred to as agricultural technology. It can assist with the planning and application of the agricultural process at every stage (Kamilaris et al., 2017). Big Data applications can support farmers in Thailand to improve crop yields using artificial intelligence and machine learning. It has signed up almost 400,000 farmers in Thailand (Tan, 2021). Furthermore, Thai agriculturists should access Big Data from applications that give farmers access to data to support them in making better decisions throughout the farming cycle. Big Data can be the solution to six problems for Thai agriculturists: 1) types of seed, 2) time of planting, 3) time of fertilizing, 4) plot of monitoring, 5) time of harvesting, and 6) channel of market.

**Table 1** The Big Data analytical process for agricultural management

| Problems (Data collection) | Tools (Integration) | Solutions (Analysis) | Implementations (Application) |
|---|---|---|---|
| 1. Types of seed | Weather forecast | Big Data system analyzes climatic factors, soil conditions, and market prices. | Farmers can plan and decide whether they should plant to optimize their productivity and profitability. |
| 2. Time of planting | Satellite weather maps | Big Data provides weather prediction technology that can forecast weather up to nine months in advance. | Farmers can plan for the weather conditions that may occur in their plots. Therefore, farmers will be able to decide when to plant. |
| 3. Time of fertilizing | Soil conditions | Big Data provides a plan to fertilize crops and avoid rainfall, which can help farmers save costs. | Farmers could minimize their costs for fertilizers and seeds by choosing a plan that is suitable for their time and location. |
| 4. Plot of monitoring | Satellite images | Satellite–based Big Data technology can support farmers in managing their plots. | Satellite–based Big Data serves as a monitoring tool to identify problem areas. This allows farmers to focus only on the plots that require attention. |
| 5. Time of harvesting | Plant information | Big Data shows the right time to harvest, which can lead to the best prices and yields. | Farmers will not incur the opportunity cost of incomplete growth. |
| 6. Channel of market | Market price | The Big Data system provides market price options for plots or provinces. | Farmers have the opportunity to choose the best price at markets located near their land. |

## Conclusion and Suggestion

This article presents the use of big data analytics to create opportunities for Thai agriculturists during global food crises. The application of big data analytics can transform the management of Thailand's agriculture, enabling better planning and decision–making to solve fundamental problems. Management information systems and tools capable of measuring and monitoring crop and soil health are contributing to the growth of digital agriculture and precision farming.

The agriculture sector in Thailand is undergoing a new revolution driven by Big Data during global food crises. This presents an opportunity for Thailand's agriculture industry to transform from traditional, skill–based agriculture into knowledge–based and technology–driven digital agriculture. Therefore, the Ministry of Agriculture and Cooperatives should encourage the use of Big Data analytics. The Thai government should support local agriculturists in each area, covering the entire cycle of the farm sector from farm to food. Furthermore, the collection of multiple large databases to form big datasets should be open–sourced and available to the public, with contributions required from each part of Thailand's agriculture supply chain.

Big Data applications in agriculture should be used in ground-breaking ways throughout the food supply chain. These applications should be accessible to the public, government agencies, universities, and NGOs. Open-sourced Big Data databases should support parallel research and development in innovative solutions that benefit a variety of farmers and diverse agricultural models. As a result, Big Data can provide innovative and sustainable solutions for Thailand's agriculture and help address global food crises.

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