

# The Information Analysis of Vegetable Traceability to Support the Agricultural Safety

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## Abstract

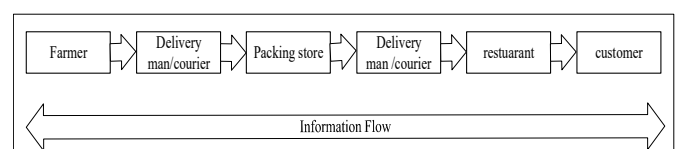
The objective of this research is to analyze data flow in vegetable traceability systems which support the Agricultural safety by reviewing two main standards. These two main standards consist of the standard of traceability system and Safety Agricultural Standards. The standard of the traceability system complies with 6 standards; namely, Standards of the Federation of Thai Industries, Food and Drug Administration, ISO 9001: 2015, Thai Agricultural Standard (TAS 9028-2557), EU standard, and Codex Alimentarius Commission. The Safety Agricultural Standards comply with 10 standards as follows: Thai Good Agricultural Practice; ThaiGAP, Organic Thailand, Organic Agriculture Certification Thailand; A.C.T., ISO 9001: 2015, ISO 22000: 2018, Good Hygiene Practice; GHP, Japanese Agricultural Standard; JAS, Global Good Agricultural Practice; Global GAP, BRC (British Retail Consortium) Food Issue 8, and The National Organic Program; NOP. The data can be analyzed for 14 data of vegetable traceability systems supporting safe agriculture in order to meet vegetable safety standards.

**Keywords:** Vegetable Traceability, Agricultural Safety, Agricultural Safety, Information Analysis

## 1. Introduction

Thailand is recognized as an agricultural country with mostly serving as farmer and has produced various kinds of agricultural products. Vegetable planting is considered a main value of Thailand's agriculture which can be seen from Thailand's export value in 2019 at 89.18 million US dollars and such number had increased by 15.01% from the previous year. The domestic selling value in 2017 was 2,100 million baht per year, with an increase of approximately 2.7% from the previous year. Thailand has consistently emphasized on the importance of chemical residues in vegetables by establishing clear policies. These policies include the ban on using chemicals in the Paraquat, Chlorpyrifos, and Glyphosate etc. Thai Government has encouraged the organic farming in Thailand in order to have more planting areas. The main factor that supports safety agriculture to be sustainable and create more value is an "Information flow" in the vegetable logistics system. It allows the consumers to see information on relevant vegetable logistics, thus ensuring the production process in the safe vegetable supply chain. Nowadays, the flow pattern of vegetable logistics system focuses only on the product that does not give priority to information flow, making it unable to link to information of the source of problem. Most of the problems regarding chemicals in the products may result in the problems of exporting to the EU, China and many other countries. The information flow in the logistics of vegetables is an important issue. Vegetable production in Thailand is in the process of developing from traditional production.

with high use of chemicals to become a safer agricultural planting. However, upon changing into a much safer agriculture in Thailand, we are often faced with the information flow of vegetable logistics that cause consumers, both domestic and international, to lack confidence in an agricultural system. If the traceability system can be established, it will reduce the problem of finding the source of a problem relating to the agricultural products and also increasing the value of agricultural products. The flow diagram in the vegetable logistics system can be seen in Figure 1.



**Figure 1:** Thailand's Vegetable Logistic Diagram

Figure 1 illustrates that vegetable logistics in Thailand consisting of 6 stakeholders in the logistics flow; that is, farmer, the delivery person delivering product from farmer to the packing store, the packing store, a delivery person from the packing store to the restaurant and the customer. All information must be linked together. Nowadays, there is a lack of data analysis in the logistics flow system and the standards related to safe agriculture has caused the creation of traceability information

to become ineffective. Then, the researcher uses the data in the vegetable logistics system and safety agricultural standards to analyze and create appropriate data for the development of the traceability system.

## **2. Traceability Standard**

The standard of the traceability system reviews must comply with 6 standards which can be seen below:

### **2.1. Federation of Thai Industries**

Federation of Thai Industries has defined traceability as a mechanism to track the origin of products throughout the supply chain, from the manufacturing process to the consumer. Each step has been collected information on the production to facilitate the retrieval of information and tracking the origin of the product quickly from raw materials, production, processing, transportation and distribution of products to consumers. The traceability system consists of two important processes: 1) Following which is a system that can be used to track where the interesting thing goes; for example, a manufacturer has found out the problem of one slot of raw material, but the product has already been sold; therefore, the manufacturer must follow the route of production and distribution so as to acknowledge the place where such product was sold and to be able to retrieve it accurately and quickly. 2) Tracking which is the ability to trace the origin of a product such as when the product was produced, which production line was employed and where did the raw material come from as well as where was the production source etc. This is to search for the origin of the product as a result of finding the product's destination [1]. In 2019, Samo Kumperscak et al. reviewed research related to tracking technology to analyze the traceability data and technology in the food chain. The results of the study showed the pros and cons of the analysis in which most of them have used barcode technology and RFID technology while some technologies are still under the development stage which enables a rapid progress in the area of safety food technology [2].

### **2.2. Food and Drug Administration**

Food and Drug Administration has defined traceability as the examination of records and evidence of verification in the past, labeling of those relevant (Manufacturer/importer) according to the notification of the Ministry of Public Health No. 386, 2018 regarding the production method, equipment and fresh fruits and vegetables storage, showing a label for the benefit of traceability which must consist of 1). Name and address of the manufacturer or importer or head office (depending on the case), as for importing fresh vegetables or fruits, the country of the manufacturer must be shown as well. 2) Text and number of the production/importing place that mentioned in the square frame with not less than 2 mm. in size and the color of the numbers contrasting with the frame background color. 3) Any code, symbol, or pattern that indicates the production model, such as QR CODE / Barcode/code number assigned by the manufacturer (The major defect is to identify a production model or production date) [3]. In 2016, D. Calvo Dopico et al conducted a survey of 2075 online consumer samples. The goal is to study the relationship between traceability and food quality.

Market research was conducted in Spain, Portugal, France, the UK and Germany. The study has found that the expected benefits for consumers relating to traceability have been focused mainly on food safety and quality. Applying technology (such as QR) can promote awareness of attributes related to quality, food safety, sustainability, and willingness to pay (WTP) [4]. In 2017, Mazia Ingrassia et al surveyed 267 consumers. The goal is to acknowledge the consumers' preferences regarding.

the information contained in food labels. By focusing on groups with the same preferences, the results of the study had discovered that consumers' need of information differed from the characteristics presented on the label of the product. It showed that the consumers became more aware of the relationship between food production and quality [5].

### **2.3. The ISO 9001: 2015 standard**

The ISO 9001: 2015 standard, 8.5.2 Identification and traceability has determined that the organization must use as deemed appropriate to identify outcomes when necessary. To ensure the consistency of products and services, the organization shall identify the status of the results related to the requirements of monitoring, measurement, production, and service delivery. The organization shall control the unique identification. (When traceability is a requirement and must maintain the document to enable traceability). The definition of this specification is the relationship between identification and traceability which are 1). Identification for product traceability by referring to the quality record showing consistency, inspection, testing, measurement. For example, assigning the Lot no. / Batch no. to refer to the inspection history, testing, product identification such as Lot no. of installation to trace production history. 2). The status indication of the product test results such as "Pass", "Accept", "Approved", "Release", "Failed", "Reject", "Hold" etc. Identification of inspection results/test in batches or according to Lot no./Batch no., Etc. to prevent delivery of products that do not pass to customers 3). Unique identification set by the customer or by law [6]. In 2020, Anna Walaszczyk et al. present the research result of 500 food consumers is the characteristics of food consumers in Poland. In factors of gender, age, education, financial status and factors related to food traceability such as the importance of the characteristics of the food products. The results of the study found out that the consumers pay most attention to food origin, while manufacturer's information is required for food packaging [7].

### **2.4. Thai Agricultural Standard (TAS 9028-2014)**

Thai Agricultural Standard (TAS 9028-2014) has defined the traceability/product tracing as the source tracking and the next destination of agricultural /food products according to the production, management, processing, and distribution that defines one or more successive steps, by design and implementation guidelines for food chain organizations, 1) the organization must clearly identify where it belongs in the food chain and indicate the origin or delivery of the goods one step back and indicates one step forward of destination. 2). the manufacturing process and/or management 3). Necessary information shall be recorded which consist of the following: 1. Source of goods such as name

and address of the consignee, volume or quantity of goods. 2. Information about production processes and/or management information about important control points including the model of the goods. 3. Product destination information such as name and address of the customer or consignee, type, quantity, or volume, including the model of the delivered goods [8]. In 2018, Cheng et al. conducted a survey of Chinese consumers in the agricultural market and supermarkets, 108 consumers were interviewed by the Best-Worst Scaling method to study consumer preferences for traceability data. The study found out that Chinese consumers focus on the information on the use of pesticides, stock-picking processes and use of fertilizer [9].

## 2.5. E. EU

EU has defined a traceability system as a system to track the journey of an entire food cycle from raw materials, production, processing, transportation and distribution to the consumer. Each step must collect information on the production to facilitate the retrieval of information and faster tracking of the product origin. In Regulation (EC) No 178/2002, this law provides traceability by assigning the operator of food business or animal feeds. Animal feeds and any relevant substances that are incorporated into food and animal feed throughout every step of the process from production, processing, and distribution, including import, gross production, harvesting, storage, transportation and sales are responsible for establishing a traceability system which must be able to specify the information related to their products and partners in the form of "One Step Back - One Step Forward" [10]. In 2020, Sara Tessitore et al. conducted an online survey of 511 Bocconi consumers, students, and employees in Milan. The results illustrated that the consumers are interested in food traceability components and look for labels that provide information on the product's supply chain. Besides, it has shown that traceability is an important factor in the food market. (in terms of product and origin sustainability) [11].

## 2.6. The Codex Alimentarius Commission

The Codex Alimentarius Commission defined Traceability or Product tracing as a system that consisting of product identification, product information, and linkage between product identification and product information. Codex has established the Principle for Traceability / Product Tracing as a tool within a Food Inspection and Certification System (CAC / GL 60-2006) to enable member countries to apply this principle to the policy of each country. In its scope, traceability is a tool for the inspection and certification of food to support the prevention of harm to consumers. In the definition section, various definitions related to Inspection, Certification, Equivalence, and Traceability / Product Tracing. A traceability system is a tool in food inspection and certification that may apply in all processes in the food chain from production to distribution. However, the traceability must be able tracing by using the One Step Back - One Step Forward principle. As well as being able to display information quickly and transparently by the country of export [12]. In 2019, HUY DUC DANG et al conducted a sample survey of 150 Chinese morning glory consumers in Ho Chi Minh City, Vietnam. The goal is to improve food safety in the country by using Lancasterian consumer theory and Random

Utility Theory to stimulate consumer demand for traceable food safety and food safety awareness. In addition, traceability should be identified through food labels to increase the effectiveness of traceability, Plus, consumers are willing to pay for traceable products [13]. In 2017, Alim Setiawan et al interviewed 878 consumers in the Greater Jakarta area, (Jabodetabek) Indonesia performed descriptive analysis, factor analysis, and target binary logistic regression model to characterize traceable fresh fruit and vegetable (FFV) consumers in Indonesia and analyze the influencing factors that help explain why consumers are buying traceable FFV. The results of the study showed that purchasing traceable products was lower than the respondents who preferred to buy conventional products. The study also indicates that well-educated and up-to-date consumers are more likely to purchase traceable FFV [14].

## 3. Agricultural Safety Standard

The Safety Agricultural Standards complies with 10 standards as indicated below.

### 3.1. Thai Good Agricultural Practice (ThaiGAP)

Thai Good Agricultural Practice (ThaiGAP) is the agricultural safety production system standard of the private sector, under the operation of the ThaiGAP Institute with the cooperation of 3 partnership organizations, consisting of the Chamber of Commerce of Thailand, the Food Institute and Kasetsart University which has developed and adapted from the requirements of international standards of the private sector known as GLOBAL GAP which belongs to the European retail group to ensure that agricultural products produced in Thailand are free from chemicals and pathogens that are harmful to producers, consumers, animals, nature and the environment. There are various records in the record system and internal audits such as the list of inputs purchased for seeds, planting material, fertilizers and plant protection. It consists of trade names, type of product, quantity, name of the supplier, (including waybill and information on the package) as well as operational records etc. In terms of traceability and product segregation, they have been used for product management purposes. During production management, products derived from certified plots and non-certified plots will classified for all movements. In addition, there are procedures for classification and recording; for example, describing incoming and outgoing products, which includes product identification, product name or other specifications such as ThaiGAP certification status, incoming quantities and details of the certified and non-certified products by ThaiGAP, especially information about the quantity sold. Besides, the documents must also show the balance between the incoming and outgoing of certified and non-certified products [15].

### 3.2. Organic Thailand

Organic Thailand is a certification mark of production factor, production sources or organic products that have been certified by the Department of Agriculture which is a certification body (CB) as a certification mark "Only for the agency". National Bureau of Agricultural Commodity and Food Standards (ACH), Ministry of Agriculture and Cooperatives Organic Agriculture have defined the term "organic agriculture" as a holistic

agricultural production management system that supports ecosystems and biodiversity. Biological cycle has emphasized on employing natural materials, avoiding the use of any synthetic raw materials, plants and animals or microorganisms derived from techniques of genetic modification or genetic engineering. This processed must be proceeded with caution in order to maintain the condition of organic agriculture and quality. The operator must also keep records and documents, accounting system, inputs, production and/or products that can be traceable to their source, nature, including the quantity of all raw materials [16].

### **3.3. Organic Agriculture Certification Thailand (ACT-IFOM)**

Organic Agriculture Certification Thailand (ACT-IFOM) is a Thai brand used to certify Thai organic products called Certified Organic, a member of IFOAM (International Federation of Organic Agriculture Movements) or the International Federation of Agriculture. Products having this logo are also certified internationally as A.C.T. (Organic Agriculture Certification Thailand). As for the processing and postharvest standards, the entrepreneurs must prepare a document system, documents for purchasing raw materials which specify the date of purchase, the vendor's name and address, the production documents with mentioned date and time of production, type and quantity of raw materials, and the number of products. Production period code (lot no.) must be traceable and sales document must illustrate the number of products that have been sold. Income from the sales of products must indicate the word "Organic" on the sales document, raw material stock and finished product stock. In addition, the entrepreneurs must define lot number on the product to enable traceability to the product documentation, including the source of raw materials [17].

### **3.4. ISO 9001: 2015 Standard**

ISO 9001: 2015 Standard of Quality Management System (QMS) has been recognized at an international level. It is a system used to manage the process in obtaining quality products or services that meet customers' demands on a regular basis. Such standard was prepared and announced by International Organization for Standardization (in Geneva, Switzerland). For identification and traceability, the organizations must take various appropriate measures to indicate results when necessary to ensure the consistency of products and services. The organization shall identify the status of the results related to the monitoring and measurement requirements throughout the entire production and service delivery. [18].

### **3.5. ISO 22000: 2018**

ISO 22000: 2018 Food Safety Management System, analysis of dangers and the critical point that needs to be controlled in the food production process called HACCP (Hazard Analysis and Critical Point System) which is a management system that ensures food safety for consumers by taking control of the Critical Control Point (CCP) in this system. Food operators must implement all processes involved in the food chain, starting from the primary producer to the consumer. As for the traceability system, it must be able to identify the incoming raw material

from the vendor and the preliminary distribution path of the end product. When establishing and reusing the inspection system, at least the following factors must be taken for consideration: a) Relationship of the incoming raw material model, components and related intermediate of end products, b) Duplication of raw materials and c) Distribution path of the end product [19].

### **3.6. Good Hygiene Practice (GHP)**

Good Hygiene Practice (GHP) is a food safety standard that has been applied from Good Manufacturing Practice (GMP) It is a basic guideline for controlling the production of food products. Its primary purpose is to protect against food hazards, including physical, chemical and biological hazards. The GHP guidelines are similar to those of the GMP (Good Manufacturing Practices) standard which covers manufacturing site hygiene, raw materials and packaging, hygiene in every production process, production facilities and transportation up until the product reaches the consumer. In terms of identification and traceability indicating the model or other indication strategies, GHP guidelines are very important for product recalls and they also facilitate effective inventory turnover. Each packaging should be permanently marked to indicate the manufacturer and model by following general standards for the labeling of food packaging. [20].

### **3.7. Japanese Agricultural Standard (JAS)**

Japanese Agricultural Standard (JAS), the Japanese agency that issued the Organic Farming Regulation / Standard under the JAS (Japanese Agricultural Standard) Law, MAFF, Ministry of Agriculture, Forestry and Fisheries). By setting the standard for Organic crops, processed organic products with respect to the production process, raw material/seed, substances for disease control, storage and labeling etc. This JAS standard is based primarily on Codex as follows: 1) As for the soils used for organic crop production, the use of agrochemicals and chemical fertilizers is prohibited during sowing, planting and harvesting for at least two years. For perennial crops, they must be left at least three years before planting. 2) Genetically modified seeds are prohibited for the cultivation of organic crops whereby the product must be controlled in a manner that it will not mix with any other plants in accordance with the "area" regulation. "Plantation area ", " collection area ", " seed"," Planting Management in the Plantation " labeling as "Organic JAS Mark " which is in accordance with the Cabinet Office Ordinance. NO.20 in 2015) [21].

### **3.8. GlobalGAP**

GlobalGAP, the private sector standard for agricultural production of European retailers, is derived from GAP (Good Agricultural Practice) and the United Nations Food and Agriculture Organization (FAO). GlobalGAP is a concept of sustainable agriculture which cares for the environment and society. It has an efficient system to separate the output from certified plots and non-certified plots while the certified numbers can be identified and GLOBAL GAP status references are available [22].

### **3.9. BRC (British Retail Consortium) Issue 8**

BRC Issue 8, International Food Safety Standards created



by the UK Retailers Association states that safety and quality requirements must be followed in accordance with the law with an emphasis on the promotion of the development of a product safety culture. The scope of the BRC Food Safety Standard also sets the standards for the production, processing, and packaging of processed foods for both owners/manufacturers and customer products. Ingredients must be controlled by food service companies, food companies and/or food manufacturers. For the standards of key products such as fruits and vegetables in term of traceability, the organization shall document traceability procedures designed to maintain traceability throughout the establishment process regarding how the traceability works, label details, requirement records, raw material identification (including first-class packaging), products during the process, material part and finished products. The facility is required to test the product portfolio of traceability systems to ensure that the suppliers of raw materials (including primary packaging) will take into consideration the traceability to go through the finished product, including, quantity and mass balance checks. The test should be performed at the prescribed frequency at least once a year [23].

### 3.10. The National Organic Program (NOP)

The National Organic Program (NOP) regulated by the United States Department of Agriculture (USDA), has been accredited for use as a regulatory standard on organic agriculture in the US since 2002. The agreement made between the United States and Canada Convention on Equality Certification was signed in 2009. The United States Standard (USDA-NOP) and the Canadian Standard (COR) are deemed equivalent to such agreement and this agreement has allowed for the smooth exchange of organic products between these two countries without additional certification. In terms of recording, information must be able to be tracked, including the origin, nature and quantity of organic products that delivered to the production unit, quantity and consignee of the product leaving the unit, any other information for verification purposes [24].

## 4. Methodology

As from the analysis of six agricultural traceability system standards and ten safety agricultural standards, they were brought together to create a table for analyzing necessary data for vegetable traceability as shown in Table1.

Traceability data analysis	Thaigap	Globalgap	Organic Thailand	ACT-IFOM	NOP	JAS	ISO 9001:2015	ISO 22000:2018	GHP (GMP)	BRC Issue 8
1. There are records of management for pre-planting and plot planning.	√	√	√	√	√	√				
2. There is a record of the plant code and data on planting plots	√	√	√	√	√	√				
3. There are records of soil management.	√	√	√	√	√	√				
4. There are records of water management.	√	√	√	√	√	√				
5. There is a record of storage / evidence of acquisition and a list of pesticides.	√	√								
6. There is a record of the using of pesticides every time and the names of workers.	√	√								
7. Detailed records on acquisition, using of fertilizers, pesticides and worker name	√	√								
8. There is a record of the processing time before and after harvest.	√	√	√	√	√	√				
9. There is a record of the using of transportation vehicles.	√	√	√	√	√	√	√	√	√	√
10. There is a record of personal hygiene information.	√	√	√	√	√	√	√	√	√	√
11. Prepare documents or records for in-season production and sign the worker name every time the information is recorded	√	√	√	√	√	√	√	√	√	√
Traceability data analysis	Thaigap	Globalgap	Organic Thailand	ACT-IFOM	NOP	JAS	ISO 9001:2015	ISO 22000:2018	GHP (GMP)	BRC Issue 8
12. Specify Lot model or add code or mark of production or date of harvest / production	√	√	√	√	√	√	√	√	√	√
13. Record buyer information or the source of the sold product, including the sold quantity	√	√	√	√	√	√	√	√	√	√
14. Complaints are resolved and kept in record	√	√	√	√	√	√	√	√	√	√

**Table.1 Traceability data analysis of Safety standard**

## 5. Result

The data can be analyzed for 14 data of vegetable traceability systems supporting safe agriculture to meet the vegetable safety standards which consist of: 1) records of management for pre-planting and plot planning 2) records of the plant code and data on planting plots 3) records of soil management. 4) records of water management. 5) records of storage / evidence of acquisition and a list of pesticides. 6) records of the use of pesticides every time and the workers' name. 7) Detailed records on acquisition, using of fertilizers, pesticides and workers' name. 8) records of the processing time before and after harvest. 9) records of the use of transportation vehicles. 10) records of personal hygiene information. 11) prepare documents or records for in-season production and the worker must sign every time the information is recorded. 12) specify lot model or add a code or mark of production or date of harvest / production 13) record buyer information or the source of the products that have been sold, including sales quantity and 14) complaints must be resolved and recorded.

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