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Title

Pressure-State-Response of traceability implementation in seafood-exporting-countries: Evidence from Vietnamese shrimp products

Authors

Khuu Thi Phuong Dong[1, 2], Yoko SAITO[3], Nguyen Thi Ngoc Hoa[2], Tong Yen Dan[2] and Takashi MATSUISHI[4]

Affiliation

Author's name: Takashi MATSUISHI

Full address: Faculty of Fisheries Sciences, Hokkaido University, 3-1-1 Minato-cho, Hakodate, Hokkaido, 041 – 8611 JAPAN.

Telephone: +81- 138 – 40 – 8857

Fax: +81 – 20 – 4623 - 0037

E-mail: catm@fish.hokudai.ac.jp

[1] Graduate School of Fisheries Sciences, Faculty of Fisheries Sciences, Hokkaido University, Japan

[2] College of Economics, Can Tho University, Vietnam

[3] Faculty of Agriculture, Hokkaido University, Japan

[4] Global Institution for Collaborative Research and Education, Faculty of Fisheries Sciences, Hokkaido University, Japan

Abstract

Shrimp products play a vital role in the international trade of fisheries products. The main suppliers for shrimp products are developing nations such as Vietnam, Thailand, Bangladesh and other countries in Southeast Asia. Among them, Vietnam is one of the largest exporters of shrimp products, and developed countries, especially the United States, Europe and Japan, are key importers of shrimp in the global market. An increase in the demand for shrimp products has led to the development of traceability regulations in developed countries. In this study, Pressure–State–Response (PSR) concepts are applied to evaluate the implementation responses of traceability regulations by exporting countries to meet the mandatory requirements of global markets. The evaluation was based on the prepared questions that were developed to allow comparison of specified indicators in the traceability regulations of importing countries and those of Vietnam. The examination showed that importing countries have introduced stringent traceability regulations via legislation and quality assurance practices. Regarding measures taken by exporting countries, Vietnam has introduced traceability regulations for both shrimp and other seafood products. Thus, Vietnamese regulations were found to satisfy the regulations of importing countries. However, the implementation of these regulations has faced a number of challenges, largely because of complicated of distribution channels, small-scale production, price discrimination and a lack capital to apply for international certificates.

Keywords

Pressure–State–Response (PSR), Quality assurance practices, Regulations, Shrimp, Traceability

Introduction

Traceability is important to ensure both food safety and consumer confidence (Bernard et al. 2002; National Academy of Sciences 2010; Pouliot and Sumner 2013). The basic principles required in a food traceability system are the recording and providing information about the flows of distribution along supply chain to trace and track product origins provide information on product ingredients, understand and communicate the effects of production practices and distribution on product quality and safety (Thompson et al. 2005; Hobbs 2004; Golan et al. 2004). Traceability is not a quality practice or assurance. However, the recording and providing information about suppliers is recorded and provided through the traceability system can help to identify from whom and to whom a food product has been supplied with the approaches of traceability rule "one step backward"–"one step forward" and then, to enhance the food safety, quality and product labeling (Pouliot and Sumner 2013; Marucheck et al. 2011).

The amount of information recorded in and the ability to trace and track of traceability systems are reflected by the objectives of implemented systems (Alexander 2016; Golan et al. 2004). The priority for food producers and manufactures is to improve operating efficiency and quality control. Traceability systems with the essential function to support information management and movement within supply chain actors have been considered sufficient (Palacios 2001). In contrast, consumers, government and civil actors seek to ensure consumer health and to reduce food incidents with regard to sustainability development. Traceability systems in this case have been developed to ensure traceable information from production to distribution to consumption (Golan et al. 2004; Bailey et al. 2018).

63 The initial implementation of a traceability system requires mandatory regulations to
64 clarify the liability of food supply chain agents (Thompson et al. 2005). However, producers
65 and manufactures along the supply chain generally deny any responsibility after food incidents
66 (Golan et al. 2003). For instance, in the United States (US), the first case of bovine spongiform
67 encephalopathy (BSE) was discovered in 2003. To provide appropriate answers to consumers,
68 authorities and marketing firms made significant efforts to trace the origins of the infected cows
69 to specific US farms. However, US farming organizations were against any traceability
70 activities so as to deny any liability for the adverse effects of BSE (Pouliot and Sumner 2013).
71
72 On the other hand, within international food markets, importing countries have
73 implemented specific policies and regulations for both imported and domestic food traceability
74 in order to ensure food safety and protect consumer health (Hobbs et al. 2005; Dickinson and
75 Bailey 2002; Thompson et al. 2005). Compared with local producers within importing
76 countries, it may be difficult for exporters to understand, access and keep up-to-date with the
77 regulations of those countries without any government support (National Academy of Sciences,
78 2010). The key difficulties are language differences and the lack of food control systems in
79 exporting countries (Ziggers and Trienekens 1999; Van de Vorst 2000; Trienekens and
80 Zuurbier 2008; National Academy of Sciences, 2010). The policymakers in exporting countries
81 have made efforts to develop national food traceability regulations to meet the mandatory
82 requirements of importing countries. Those regulations aim to provide general guidance for
83 food producers in the implementation of traceability procedures (Trienekens and Zuurbier
84 2008; Karipidis et al. 2009; Chen and Huang 2013).
85

As with other food products, traceability requirements for seafood products are becoming increasingly focused on enhancing food safety and quality. For instance, the European Union (EU) introduced traceability regulation EU178/2002 (Hall, 2010), and the United States introduced mandatory Country of Origin Labeling (COOL) (Caswell 1988). Similarly, Japan issued Japan Agricultural Standards (JAS) Law as well as food safety regulations based on those of other countries (Loureiro and Umberger 2007).

At the international level, various approaches have been applied to introduce traceability in a number of major seafood exporting countries (e.g., Thailand, Vietnam and Malaysia), in the hope that they become eligible to export to global markets. For example, Thailand has established traceability systems for farmed seafood products to provide information about the movement of products from hatcheries, farms and processing plants through to the delivery of fry to buyers (Uddin 2009). In Malaysia, traceability was developed in 2011 for fish and fisheries products exported to the US and EU markets (SEAFDEC 2016). Furthermore, the Vietnamese Directorate of Fisheries introduced Circular No. 03/2011/BNN-PTNT as a national regulation governing traceability requirements for fish farmers and business operators in the fisheries industry (Lap et al. 2015).

Despite such regulations, the implementation of traceability systems for seafood products in exporting countries remains challenging because most producers lack awareness about traceability and are not willing to provide information regarding production procedures or product qualities (Trienekens and Zuurbier 2008; Hall 2010). Moreover, small-scale production also limits the implementation of traceability in exporting countries because the products from small-scale farms are distributed to many intermediary actors before being

processed. Thus, it is difficult to record and keep information regarding movement and processing, which are essential aspects of traceability systems (Golan et al. 2004; Bailey et al. 2018; SEAFDEC 2016).

On the other hand, the requirements of traceability in importing countries are currently incorporated to quality assurance certificates such as GLOBAL Good Agriculture Practices (GLOBAL GAP), the Hazard Analysis and Critical Control Points (HACCP), Aquaculture steward council (ASC) or ISO (Chan, 2016) besides the requirements in food safety, environmental and social welfare (Lap et al. 2015). The exporters, thus, prefer to obtain those certifications from the target markets rather than investing in separate traceability systems. However, a minimum set of standards as the guidelines for seafood products to be accepted by various importing countries has not agreed upon yet. The diversity of food safety certificates across importing regulators, therefore, has created further difficulties for exporters to cover all requirements (Lap et al. 2015; Suzuki and Nam 2013; Bailey et al. 2018).

Shrimp is one of the most important seafood products for global consumers, especially in the US, EU and Japan (Suzuki and Nam 2018; Loc 2006; Uddin 2009). According the Food and Agriculture Organization (FAO) in 2018), the imported value of shrimp products in the US, EU and Japan, where the rules in terms of food quality assurance, product quality and traceability requirements are stringent, equals 10% of the total imported value of all seafood products. Thus, the level of quality, safety and traceability of these export products has needed to improve to meet the importing requirements. This has helped to extend the market shares to other countries (Tran et al. 2013). Suzuki and Nam (2013) reported that where shrimp products are unable to satisfy entry requirements and are rejected by US, EU and Japan markets,

processors and exporters could shift these products to Asia and Middle East markets where the standards are less stringent.

Vietnam is one of the largest shrimp suppliers, supplying 9% of the global shrimp markets (FAO, 2018). The US, EU and Japan are three of the largest shrimp importers, receiving more than 50% of the total export volume (Loc 2006; Suzuki and Nam 2018). Vietnam's shrimp industry plays an important role via its economic contributions, poverty reduction and social equity (Duc 2009; Phuong and Oanh 2010). In recent years, the growing demand for traceability by importing markets and competition from other exporters such as Thailand, Indonesia, India, Malaysia and Ecuador (Tran et al. 2013) have resulted in the implementation of traceability systems by shrimp producers and stakeholders along supply chain to maintain the international market shares and increase the competitive advantages.

To better understand the requirements of traceability related to seafood products, Pressure–State–Response (PSR) concepts, which have been previously applied to environmental policies as suggested by OECD in 1994 (Naimi and Zadeh, 2012), have been used in the present study with the collected information from the prepared questions. Concerning food safety and traceability, some scholars have relied upon PSR frameworks, with "Pressure" referring to food safety risk management or food traceability practices. Furthermore, the "State" indicator refers to the evaluation of the current situation of the food chain safety, food safety practices, food traceability systems and food safety policies while "Response" is used to evaluate any responses to the pressures (Charlebois et al. 2014; Baert et al. 2012; Vasileiou 2002; Poll et al. 2005; Waheed et al. 2009).

The overall purpose of the present study is to inform the development and adoption of traceability systems in seafood exporting countries with the evidences of Vietnamese shrimp products. This paper seeks to achieve this overall purpose with the following goals:

1. To review traceability regulations and requirements concerning shrimp products in the US, EU and Japan where are the main importing markets of Vietnamese shrimp products;

2. To explore the responses and evaluate the level of compliance of Vietnamese shrimp industry with traceability requirements of those importing countries; and

3. To discuss the state of traceability implementation for Vietnamese shrimp industry, and put forward a research agenda.

The results of this study are expected to reveal useful preferences for exporting countries, whereby they will contribute to the adaptability of traceability to meet the demands of global markets. Additionally, to the best of our knowledge, the PSR concepts have not been scientifically applied to explore the development and adoption of traceability requirements regarding shrimp products in global markets. Therefore, the framework of the PSR model for the assessment of the implementation of regulations can be applied to other food products and food safety issues in future studies.

Analytical Framework

Pressure–State–Response (PSR) concepts

The concepts of PSR framework are considered an important tool to aggregate policy responses related to food safety risks and traceability, and can be used to develop frameworks

to assess the sustainability of food supply chains. The “Pressure” refers to the food safety risk management or food traceability practices required from the consumers or importing countries in case of the international market based on the growing concerns of consumers to the food safety. The “State” indicator refers to the description or evaluation of the current food-related situation such as food chain safety, production practices, traceability systems, and food safety policies, these are important to understand the current regulatory situation of both importing and exporting countries. The “Response” is used to evaluate any responses, reaction, and decision made by stakeholders based on the “Pressures” indicator. “Response” part, can be the description of the current regulatory situation, but also derived the reaction of the government of importing countries to the growing number of the safety conscious consumers in the global market (Baert et al. 2012, Charlebois et al. 2014, Vasileiou 2002; Poll et al. 2005).

The PSR framework used in food safety and traceability is dynamic, that is related each other, since the “Status” of those issues are influenced by the other two aspects of PSR concepts (Baert et al. 2012). The “Pressure” and “Response” indicators, then, may lead to change the “Status” of food safety and traceability (Waheed et al. 2009). In this study, the detail explanation and definition of the Pressure, State and Response indicators are described as follows:

- ✓ Pressure refers the application of the mandatory regulations and requirements of the US, EU and Japan markets (importing countries) relating to shrimp products;
- ✓ Response denotes the implementation of the current regulations and requirements by the Vietnamese government. The information of responses indicators is expected to utilize to

evaluate whether the Vietnamese regulations meet the mandatory regulations in the US, EU and Japan markets.

✓ State refers the current situation and challenges of traceability implementation for shrimp industry in Vietnam.

Data collection and analysis

The data used in this study was collected based on the framework of the PSR model and the discussed information of previous studies related to traceability implementation for shrimp industry in Vietnam and other exporting countries.

The Pressure and Response indicators were conducted to answer the questions as designed in Figure 1. This question list was adapted based on a previous study in this research field (Charlebois et al. 2014). The information regarding the Pressure indicators was obtained from the specific traceability requirements for shrimp products in national policies and regulations of the US, EU and Japan markets, while the Response indicators were achieved from the Vietnamese national policies and regulations about traceability regarding shrimp products.

[INSERT FIGURE 1 HERE]

The level of compliance of the Vietnamese regulations and requirements regarding traceability, was evaluated by comparison of the requirements of the importing countries and the implemented regulations and requirements in Vietnam. The assessment scale used included three responses: “Satisfied”, “Partially Satisfied” and “Not Satisfied.” The assessment scale

"Satisfied" was selected when the traceability requirements included in the Vietnamese regulations/practices exactly matched those included in the regulations of the importing countries. "Partially Satisfied" was used when the traceability requirements specified in Vietnamese regulations/practices did not exactly match those of the importing countries but partly represented the regulations of the importing countries. "Not Satisfied" was selected when the traceability requirements demanded by importing countries' regulations were not included in Vietnamese regulations/practices. Only those requirements stipulated in importing countries' regulations were evaluated.

The "State" of traceability implementation for Vietnamese shrimp products were identified, and discussed based on the collected information from the previous scholars regarding shrimp industry in Vietnam and other exporting countries to be able to put forward the research agenda regarding traceability implementation for shrimp products.

Results and Discussions

The Pressure and the Response of the implemented traceability regulations and practices for Vietnamese shrimp products were produced based on the findings of the related questions shown in Figure 1. The details are described as follows.

The Pressure of the traceability requirements of importing countries on Vietnamese shrimp products

- ✓ ***In national regulations***

A summary of the pressure of the mandatory traceability regulations of the markets of the importing countries on Vietnamese shrimp products are shown in **Table 1**. The results show that all importing markets included traceability requirements in various forms for food products, including seafood products. These requirements were found in traceability laws governing the US and EU markets and/or in food safety regulations of countries such as Japan. The traceability requirements for shrimp products were included in requests for the traceability of food and/or seafood products rather than in separate regulations.

[INSERT TABLE 1 HERE]

The required information largely focused on the country of origin, name of suppliers, production methods, expiry date, net weight and handling conditions. The traceability rule "one step backward"–"one step forward" was included in the US and EU regulations. Moreover, the information had to be traced across all stages of production, processing and distribution. The results also indicated that the importing countries did not define a particular format for recording, keeping and providing information within the traceability systems. The requirement to record and keep information is presented in greater detail in **Appendix 1.**

In the US, the official mandatory rule regarding traceability for fisheries products, COOL, was first introduced in 2004 (and became effective in 2005) to ensure consumer rights in clarifying information about county of origin and traceability. Its aim was to regulate the responsibility of retailers to provide information to consumers about country of origin and method of production (wild or farm raised) for both domestic and imported commodities at the point of sale.

In EU, the main purposes of traceability systems are to ensure that all food products are safe for European consumers and that products can be traced back to their origin to prevent risks and contaminated products (Charlebois et al. 2014). For fisheries and aquaculture products, EU regulation EC 1224/2009 also specifies the requirement of traceability. Regulation EC 1224/2009 (amended by EU No. 1379/2013), states that, "all lots of fisheries and aquaculture products shall be traceable at all stages of production, processing and distribution, from catching or harvesting to retail stage." Furthermore, in 2014, the new EU food labeling regulation EU 1169/2011 was introduced, requiring the provision of food information to consumers. The regulations require the mandatory labeling of imported fishery and aquaculture products in EU markets to ensure traceability (see **Appendix 1**).

Japan developed traceability systems for domestic beef in 2002 and for imported and domestic rice products in 2011. While the Japanese government has not issued separate traceability regulations and laws for imported seafood products, it has introduced a food regulation concerning the provision of information on food labeling as found in the Food Sanitation Law (Clemens 2003), the Quality Labeling Standard–JAS Law (MAFF, 2013) and other national laws (Japan Retail News 2014). Thus, these regulations require that basic information about the product and its manufacturer (e.g., customer service contact information and company website address or names, addresses, and ID codes for all production facilities) is mandatory provided. Moreover, imported products must state country of origin information and the name and address of the importer on the package label. The labeling must be present at the point of sale from importers to other businesses in the domestic market by JAS Law. Under the JAS, this is now a mandatory requirement for eggs, milk, buckwheat, wheat, peanuts, crab and shrimp.

299 ✓ ***In mandatory quality assurance practices***

300

301 Besides national regulations, importers in the US, EU and Japan also specify
302 traceability requirements as a mandatory standard in quality assurance certificates and practices.
303 These certificates and practices are based on the demand for food safety standards by importing
304 countries and are issued by a third party to ensure the reliability and objectivity of the
305 certificates. Some of more frequently used certificates in recent years include HACCP,
306 GLOBAL GAP, BAP and ASC.

307

308 The main aims of these certificates are summarized in **Table 2**. A key purpose of ASC,
309 GLOBAL GAP and BAP certificates is traceability, as well as food safety and quality, animal
310 health, environmental safety and social responsibility. HACCP certificates largely focus on
311 food safety only. However, information regarding all stages of production, processing and
312 distribution under HACCP standards is required to be traced under the rule "one step
313 backward"–"one step forward", which is also used in ASC, GLOBAL GAP and BAP
314 certificates. Moreover, the attachment of eco-labeling for certified products not only signals
315 quality but can also support final consumers in traceability regarding country of origin and
316 producer information.

317 [INSERT TABLE 2 HERE]

318

319 **The Responses of the implementation of traceability regulations and practices for shrimp**
320 **products in Vietnam**

321

The implementation of traceability regulations by the Vietnam government (**Table 3**) has occurred in response to pressure from importing markets seeking to ensure a minimum set of standards for all of Vietnamese shrimp producers in traceability application procedures.

[INSERT TABLE 3 HERE]

✓ ***At the national level***

In 2011 the Vietnam Directorate of Fisheries issued Circular No. 03/2011/TT-BNNPTNT (Cir. 03) was introduced to formalize the regulation on tracing and the recall of fishery products to meet food quality, safety and traceability requirements. This circular applies to all organizations and individuals involved in fisheries production, from farms to processing companies.

Besides the national traceability regulation for shrimp products, Vietnam's Department of Agricultural and Rural Development has issued other regulations related to food safety and the implementation and monitoring of traceability regarding seafood products including shrimp products. In 2013, Circular No. 48/2013-BNNPTNT (Cir. 48), which was amended by Circular No. 02/2017-BNNPTNT in 2017, was issued to regulate mandatory food safety control applicable to seafood factories, processing companies, pre-processing companies and traders. This circular was based on the essential functions of HACCP standards. All information about the production process must to be recorded and kept by the company for at least 2 years, including all invoices (see **Appendix 2**).

✓ ***In quality assurance practices for shrimp products***

346 Based on the code of conduct of international standards such as the Technical Guideline
347 on Aquaculture certification (FAO), AseanGAP, GlobalGAP, ASC, GFSI, ISO and Codex, the
348 Vietnamese Good Aquaculture Practices (VietGAP) introduced mandatory practices for
349 farmed Pangasius (*Pangasius hypophthalmus* and *Pangasius bocourti*) and Shrimp (*Penaeus*
350 *Monodon* and *Litopenaeus Vannamei*) in Decision No. 1503/2011/QD-BNN-TCTS and
351 Decision No. 3842/2014/QDBNN-TCTS (2014), respectively, by the Department of
352 Agricultural and Rural Development. The main aims of VietGAP were to ensure food safety,
353 animal health and welfare, environmental socioeconomic integrity and traceability. Regarding
354 the latter, the requirements specified in VietGAP included the traceability rule "one step
355 backward–one step forward" for farmed Shrimp and Pangasius products. Regulations about
356 information recording and keeping were also included in VietGAP to enhance the eligibility of
357 certified farms to meet the requirements of global markets.
358
359 Hence, both in national regulations and practices, the Vietnamese government
360 introduced detailed regulations regarding traceability not only for shrimp products but also for
361 the food and seafood industries. These regulations were issued and based on the requirements
362 of various global markets. At the national level, Cir. 03 and Cir. 48 regulated the liability of
363 seafood producers in terms of traceability procedures. Furthermore, mandatory standards about
364 the traceability of shrimp products in VietGAP are now the main indicators for quality
365 assurance and traceability application procedures.
366
367 **Evaluate the level of compliance of Vietnam traceability regulations to the requirements**
368 **of the global markets**
369

✓ ***Vietnamese regulations and practices in response to the national regulations of importing markets***

A comparison between the national traceability regulations and mandatory practices of the importing markets regarding shrimp products (**Table 2**) and the regulations implemented in Vietnam (**Table 3**) was conducted to evaluate the responses of the Vietnam government to the requirements of the global markets (**Table 4**). The five main components of regulations and practices were considered: main purposes, target regulated producers/suppliers, traceability rule, format of information recording and keeping period.

[INSERT TABLE 4 HERE]

Regarding the main aims and target suppliers, the results show that Cir. 03 almost satisfied the specified regulations regarding traceability in the US and EU markets. In contrast, Cir. 48 was developed to ensure food safety as well as outline the procedures regarding the recording, keeping and provision of information (if required) by wholesale agents, processing companies and exporters along all stages of the supply chain. The adoption of this circular was evaluated as "Partially Satisfied" in terms of the main aims and target suppliers because it does not include traceability rule "one step backward"–"one step forward". Thus, this criterion was "Not Satisfied".

In Japan, traceability requirements for shrimp products can be found in food safety laws rather than in separate regulations. The main targets of Japanese laws are importers and retailers in Japan markets. However, to satisfy traceability and country of origin requirements, the comprehensive collaboration of exporters and other producers at all stages of the supply chain

394 is required to record, keep and provide information relating to production, processing and
395 distribution. Hence, in terms of the main aims, Vietnam's national regulations (Cir. 03 and Cir.
396 48) and quality practices (VietGAP) could satisfy Japanese food safety laws. The target
397 supplier indicator was evaluated as "Partially Satisfied." Regarding traceability, Cir. 03
398 satisfied Japanese laws and Cir. 48 did not.
399
400 Regarding the period that information should be kept, the US regulations stated 1 year
401 and this period is unspecified in EU and Japanese law. Therefore, a comparison was not made
402 with the relevant regulation in EU and Japan markets. For the US market, however, the
403 Vietnamese regulations (Cir. 03 and Cir. 48) satisfied this requirement.
404
405 In contrast, the VietGAP standard was developed to apply to agriculture and
406 aquaculture farms in Vietnam, including shrimp farms. The legislation, therefore, targeted
407 certain stages of the production supply chains. The evaluation of this indicator showed that it
408 "Partially Satisfied" to the US equivalents. In contrast, regulated components of VietGAP
409 practices, in response to the requirements of national regulations of the US, EU and Japan
410 markets, were deemed to be "Satisfied". The adoption of regulations regarding the recording
411 and keeping of information for traceability issues to satisfy foreign market requirements is
412 assessed in **Table 5**. Based on the results, Cir. 03 and Cir. 48 satisfy all US, EU and Japanese
413 information regulations. At the farm level, VietGAP standards meet most of the information
414 requirements of US, EU and Japanese national regulations.
415 [INSERT TABLE 5 HERE]
416

417 ✓ ***Vietnam regulations and practices in response to importers' mandatory quality***
418 ***practices regarding traceability for shrimp products***

419 The same comparison procedure was also conducted to assess the appropriateness of
420 Vietnamese regulations and practices in response to the mandatory practices implemented in
421 the US, EU and Japan markets (see **Table 6**). The results confirmed that regulations regarding
422 traceability in Cir. 03 and VietGAP were updated and responded appropriately to establish
423 international practices, both in terms of quality assurance and traceability. However, the same
424 was not achieved for information recording and keeping (Cir. 03). The corresponding
425 Vietnamese regulation, stating that information must be held for 1 year (Cir. 03), was
426 considered "Partially Satisfied".

427 [INSERT TABLE 6 HERE]

428

429 Despite the main aims of Cir. 48, it was assessed as "Satisfied" when compared with
430 the HACCP standard and "Partially Satisfied" for the remaining practices. Regarding
431 traceability rule, Cir. 48 did not meet the requirements of the international standards. However,
432 it specified that information should be kept for a period of 2 years. This met the international
433 standards requirements. The mandatory international standards did not specify a required
434 format that the recording and keeping of information should take. Therefore, it was not
435 evaluated.

436

437 Vietnam's responses (VietGAP) to the mandatory quality practices regarding
438 traceability in international markets are shown in **Table 7**. The comparison results show that
439 VietGAP practices have responded to the specified requirements of traceability in international

quality practices. At the farm level, the required information in VietGAP practices satisfy GLOBAL GAP, ASC and BAP requirements.

[INSERT TABLE 7 HERE]

The State of traceability implementation for shrimp industry in Vietnam

The identification of Pressure and Response indicators, as well as the evaluation of the adaptations level of Vietnamese traceability regulations and practices to the requirements in importing countries show that Vietnamese policymakers have been making significant efforts to contribute to update and improve national traceability regulations. Thus, these regulations provide general guidance regarding the quality assurance and traceability of shrimp products to ensure acceptance into global markets. However, various difficulties still exist regarding the application of traceability systems and governance in Vietnam.

As discussed above, Cir. 03 introduced the traceability rule "one step backward–one step forward" in response to the requirements of global markets. It also requires the movement of information among all agents, from farms to processing companies, along the shrimp supply chain.

As described in Figure 2, the supply chain of Vietnamese shrimp products consists of a local and global side. Shrimp products are distributed along the supply chain under two main flows. First, shrimp products are sold to middlemen (see channels (i) and (ii) in Figure 2) before moving to processing companies (Tran et al. 2013; Suzuki and Nam 2018). Second, shrimp products are directly distributed from farms to processing companies under a contract agreement (see channel (iii) in Figure 2).

[INSERT FIGURE 2 HERE]

On the global side, processing companies and exporters have implemented internal traceability systems to satisfy the requirements of global customers (Loc 2006; SEAFDEC 2016). This approach supports the processing companies to transfer information, "one step forward" to their customers, including information about the production process and production units (e.g., receipts, suppliers, delivery and recipients). This information is printed on the product label. Based on such information, the importers and customers in foreign markets can trace information "one step backward" until the original processors.

On the local side, the complicated distribution channels (as described in flows (i) and (ii) in Figure 2) of shrimp products have led to further challenges for the recording and keeping of information. Local authorities monitor the operation of shrimp intermediaries based on their business registration. However, under Vietnam's Decree No. 15/2018/ND-CP, shrimp collectors and small-scale intermediaries (i.e., operating as family businesses) do not have to obtain any business registration. Such operators are not monitored by the local authorities. Therefore, it is difficult to manage the complex distribution channels and the tracking of information.

Under the usual contract agreements, shrimp products move from farms to processing companies directly (see flow (iii) in Figure 2). In terms of traceability, this process is simpler than that regarding products provided through intermediaries because processing companies are able to control the shrimp input. However, the parties' liability to these contracts is not legislated or subject to government regulation. For example, even though the shrimp farmers

488 sign a contract to sell their harvest to a processing company at a negotiated price, the farmer
489 will sell their product to another buyer if the contract price is lower than the market price at
490 harvest. The contract, therefore, is canceled. The important aspect here is that the farmers do
491 not have to pay any compensation to the processing companies when they breach the contract.
492 In this situation, processing companies face a shortage of shrimp inputs and they have to buy
493 shrimp from other suppliers (e.g., collectors or brokers). This is the key issue facing shrimp
494 processors today. Not only do they have to control quality assurance and implement traceability
495 systems, but they also have to manage the shrimp input quantity.
496
497 The results from the analysis of the PSR indicators also show that traceability
498 regulations are included in the international quality assurance certificates. However, the
499 application costs as well as those for registration, audits and preparation are between US
500 $5,000–$10,000 per farm. In Vietnam, approximately 75% of all farmers are small-scale
501 farmers (Portley, 2015). Thus, the cost to obtain an international certificate is out of reach for
502 most farmers (Lap et al. 2015). The situation is the same in other seafood-exporting countries
503 such as Indonesia, Myanmar, Cambodia, Laos and Bangladesh (Tunxi and Ying 2015; Uddin
504 2009).
505
506 The cost aside, it is difficult to get farmers to perceive the benefits of these certificates.
507 The reason is argued that farm-gate price of output products is not affected by certification.
508 Moreover, shrimp farmers must follow complicated production procedures if they seek
509 international certificates, as well as spend significant time recording and filling out traceability
510 forms (Tran et al. 2013; Suzuki and Nam 2018). These same issues exist in Thailand,
511 Bangladesh and Laos. To help those shrimp farmers and other participants who have

implemented traceability procedures obtain a fair price, both the Thai and Philippine governments have introduced auctions to better distribute aquaculture products from the farms to processing companies and retailers (Uddin 2009; Tunxi and Ying 2015). However, the traceability database is rather limited. The buyers, therefore, are not able to identify those harvested products with traceability systems.

Conclusion

In this study, PSR framework was used to examine Vietnamese shrimp products to determine regulatory responses to international pressure to ensure the traceability of seafood products. The results presented that, at the global level, the development of traceability regulations and requirements of importing countries have taken diverse forms. The main aims of these regulations and requirements are food safety, traceability, environmental and social welfare. The specification of the traceability rule "one step backward"–"one step forward" requires the coordination of all stages the supply chain. However, an agreed format for traceability systems has not yet been specified yet, for either national regulations or quality assurance standards. Overall, seafood-exporting countries contribute and implement traceability regulations to respond to the requirements of global customers. These regulations have been developed and followed to meet the demands of traceability requirements in the importing markets. In the future, the growing concerns in traceability requirements probably reflect to put forward the innovative pressures of the customers in global markets. Therefore, the continuous efforts of seafood exporting countries would be demanded to be able to maintain the responses of traceability policies and regulations to the requirements of importing countries.

In Vietnam, Government has issued national regulations regarding traceability to provide legislative guidance on how to implement traceability procedures, namely Cir. 03 and Cir. 48. The VietGAP has also contributed to the targets for farms and hatcheries based on the international standards, especially those found in GLOBAL GAP and ASC. However, an important point is suggested that the integration of both national regulations and practices need to focus on actual procedures because the national regulations, by themselves, cannot provide the signaling about the application of traceability to consumers in the global markets. It should be noted that the importance of traceability via international certificates has grown in recent years.

Based on the results of the PSR models, the main barriers to implementing traceability, not only in Vietnam but also in other countries exporting seafood products, were found to be the existence of complex distribution channels, small-scale production, price discrimination and the cost of international certificates. The integration and corporation between seafood producers along supply chain would be strongly suggested to allocate the budgets to develop the traceability systems in the seafood exporting countries, where were facing with the limited productions and lack of financing resources.

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562

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565

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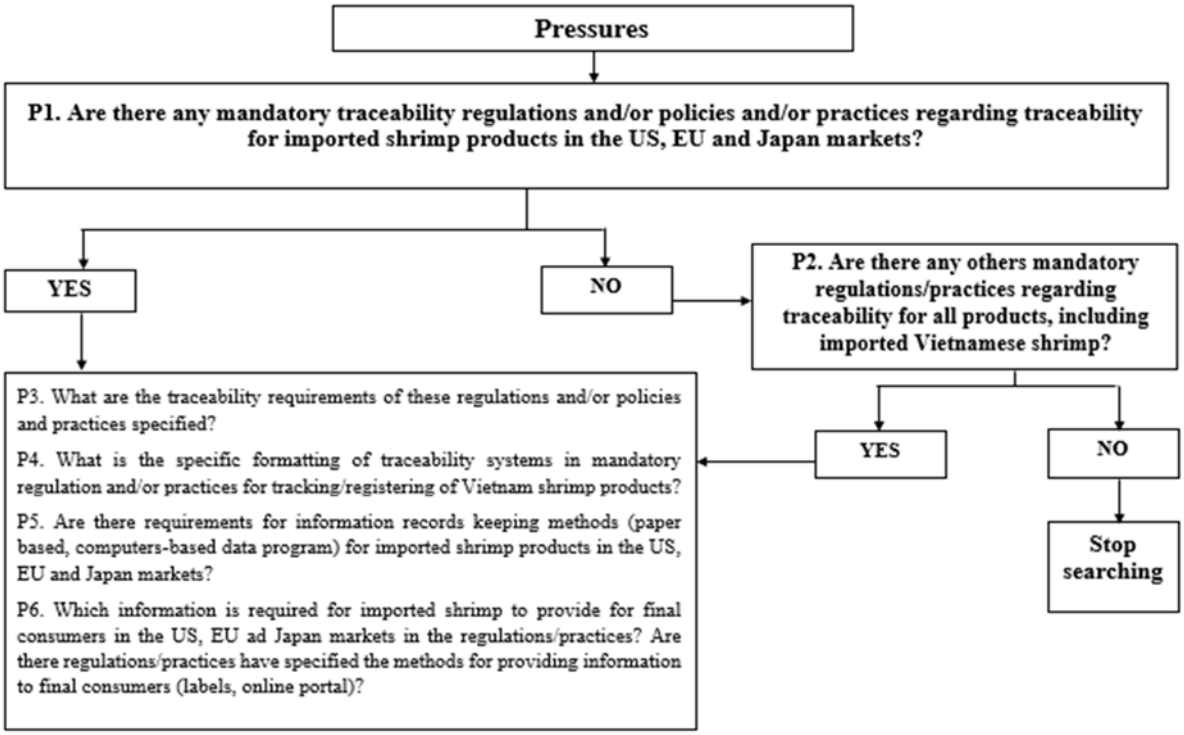
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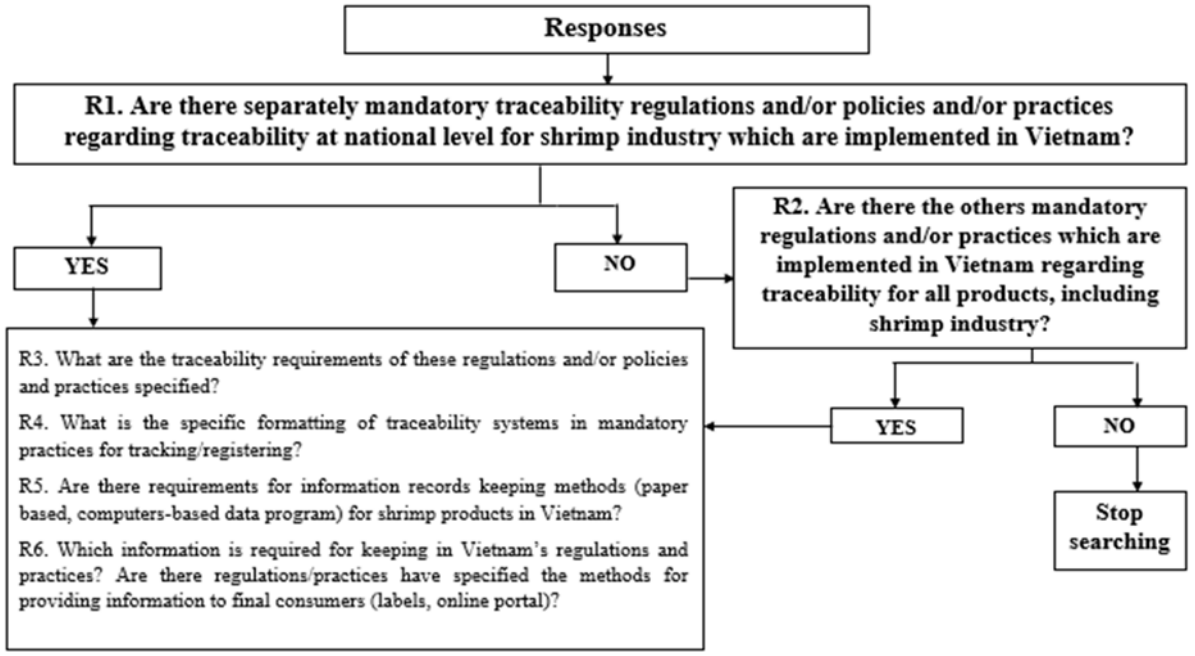
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709 **Lists of figures**



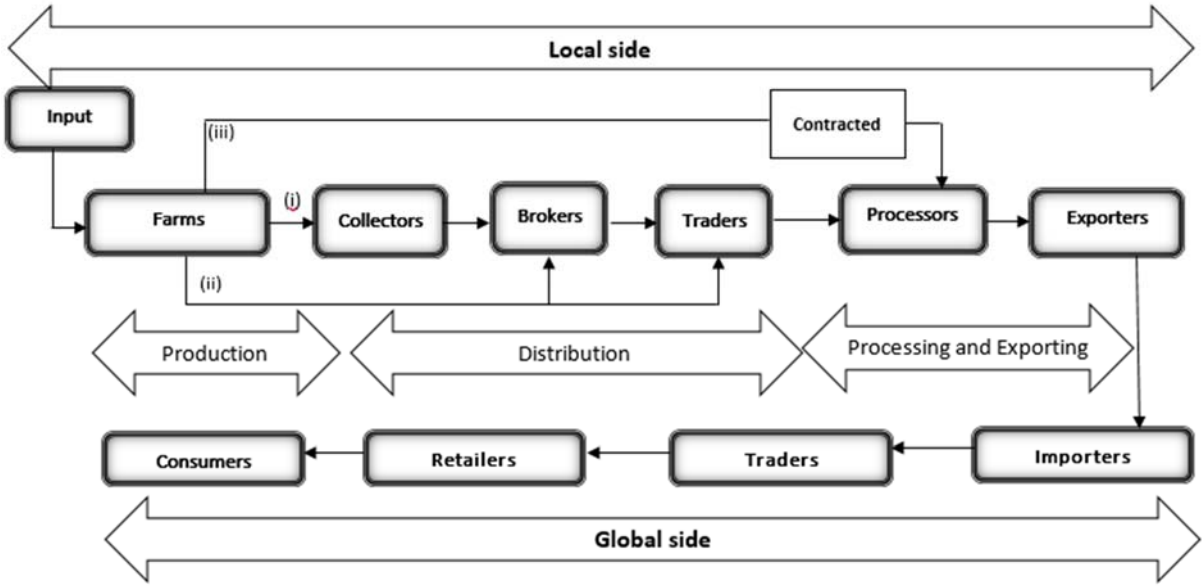
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712 *Source: Authors adapted from* Charlebois et al *(2014)*

713 **Figure 1.** Data collection procedures



714

715 (*Source. Nhuong* et al. *2013, Loc 2006, Suzuki and Nam 2018*)

716 **Figure 2.** Shrimp supply chain in Vietnam

List of Tables

Table 1. Traceability regulations implemented in the US, EU and Japan

Categories		Name of regulation	Main aims	Target producers	Traceability rule	Recording and Keeping of information			
						Periods	Format	Place provided	Responses from producers for product recall
Regulations for seafood products, including shrimp products	US	COOL	Food safety and traceability	All stages of production, processing and distribution	One step backward –one step forward	1 year	Not specified	At point of sale	5 business days
	EU	EU No. 1379 (Amended for EU legislation 1224/2009)	Food safety, traceability and sustainability	All stages of production, processing and distribution	One step backward –one step forward	Not specified	Not specified	At point of sale	10 business days
		EU No. 1169	Food safety and traceability						
Regulations for food and feed products related to shrimp products traceability requirements	Japan	Food Sanitation Law (FSL) and Quality Labeling Standard (JAS)	Food Safety and providing information to final consumers	Retailers, Importers	Not specified	Not specified	Not specified	At point of sale	Not specified

723 **Table 2.** Traceability requirements specified in mandatory quality assurance practices in the US, EU and Japan markets

Issues	HACCP	GLOBAL GAP	ASC	BAP
Regulated by	US and Japan	EU	US, EU, Japan and other countries	US and EU
Main aims	Food safety	Food safety, environmental, social welfare and traceability	Environmental, social welfare, food safety and traceability	Food safety, environmental, social welfare and traceability
Target suppliers	Processors, operators, hatcheries and feed companies	Farms and hatcheries	Farms and hatcheries	Processors, operators, distributors, farms, hatcheries and feed companies
Traceability rules	One step backward–one step forward	One step backward–one step forward	One step backward-One step forward	One step backward–one step forward
Information keeping period			2 years	
Attached eco-label for applicants			Yes	

724
725

726 **Table 3**. Traceability specifications in Vietnamese national laws and practices regarding shrimp products

Issues	Cir. 48	Cir. 03	VietGAP
Main aims	Food safety and keeping information	Food safety and Traceability	Environmental, social welfare, food safety and traceability
Target suppliers	Processors, operators, hatcheries and feed companies	Processors, operators, distributors, farms, hatcheries and feed companies	Farms and hatcheries
Specified traceability rule	Not specific	One step backward–one step forward	One step backward–one step forward
Information keeping period	2 years	1 year	2 years
Format for keeping information	Not specified	Not specified	Not specified
Attached eco-label for applicants			Yes
Referred regulations/practices	COOL, HACCP, EU, JAS	COOL and EU	ASEAN GAP, ISO, ASC, GLOBAL GAP, BAP and specified regulations from imported countries

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728
729

730 **Table 4.** Vietnamese regulations and practices in response to national regulations in the US, EU and Japan markets

Categories	US			EU			Japan		
	Cir. 48	Cir. 03	VietGAP	Cir. 48	Cir. 03	VietGAP	Cir. 48	Cir. 03	VietGAP
Main aims	PS	S	S	PS	S	S	S	S	S
Target suppliers	PS	S	PS	PS	S	PS	PS	PS	PS
Specified traceability rule	NS	S	S	NS	S	S	NS	S	S
Information keeping periods	S	S	S	X	X	X	X	X	X
Format for keeping information	X	X	X	X	X	X	X	X	X

731 *Note:* X: not specified by importing countries. S = Satisfied; PS = Partially Satisfied; NS = Not Satisfied
732

733 **Table 5**. Vietnamese regulations and VietGAP standards in response to information keeping requirements in the national regulations of importing
734 markets

Mandatory information keepingin Vietnamese regulations/quality assurance practice	US			EU			Japan		
	Cir. 03	Cir. 48	VietGAP	Cir. 03	Cir. 48	VietGAP	Cir. 03	Cir. 48	VietGAP
Name of products	S	S	S	S	S	S	S	S	S
Legal name or customary name	X	X	X	S	S	S	X	X	X
Production method	S	S	S	S	S	S	S	S	S
Country of production	S	S	S	S	S	S	S	S	S
Whether the product has been defrosted	S	S	S	S	S	S	X	X	X
Expiry date	S	S	S	S	S	S	S	S	S
Allergens	X	X	X	S	S	NS	S	S	NS
List and quantity of ingredients	X	X	X	S	S	NS	S	S	NS
Net weight	S	S	NS	S	S	NS	S	S	NS
Name and address of business operator	S	S	NS	S	S	NS	S	S	NS
Country of origin	S	S	NS	S	S	NS	S	S	NS
Instructions for use	S	S	NS	S	S	NS	S	S	NS
Nutritional declaration	X	X	X	S	S	NS	S	S	NS
Date of packaging	S	S	NS	S	S	NS	X	X	X
Date of freezing	S	S	NS	S	S	NS	X	X	X
Storage instructions	S	S	S	S	S	S	X	X	X
Barcode	X	X	X	S	S	S	S	S	S

735 *Note:* X: not specified by importing countries. S = Satisfied; PS = Partially Satisfied; NS = Not Satisfied
736

737

738 **Table 6.** Vietnamese regulations and practices in response to traceability requirements in mandatory quality assurance standards

Categories	HACCP			GLOBAL GAP			ASC			BAP		
	Cir. 48	Cir. 03	VietGAP	Cir. 48	Cir. 03	VietGAP	Cir. 48	Cir. 03	VietGAP	Cir. 48	Cir. 03	VietGAP
Main aims	M	S	S	PS	S	S	PS	S	S	PS	S	S
Target suppliers	S	S	PS	PS	S	S	PS	S	S	PS	S	PS
Specified traceability rule	NS	S	S	NS	S	S	NS	S	S	NS	S	S
Information keeping periods	S	NS	S	S	NS	S	S	NS	S	S	NS	S
Format for keeping information	X	X	X	X	X	X	X	X	X	X	X	X

739 *Note:* X: not specified by importing countries. S = Satisfied; PS = Partially Satisfied; NS = Not Satisfied

740

741 **Table 7.** Vietnamese regulations and practices in response to requirements to record and keep information

Mandatory information keeping in Vietnamese regulations/quality assurance practice	HACCP		GLOBAL GAP		ASC		BAP	
	Cir. 03	VietGAP	Cir. 03	VietGAP	Cir. 03	VietGAP	Cir. 03	VietGAP
Name and address of producers	S	S	S	S	S	S	S	S
Name of products	S	S	S	S	S	S	S	S
Legal name or customary name	S	S	S	S	S	S	S	S
Quantity of input products	S	S	S	S	S	S	S	S
Origin of input products	S	S	S	S	S	S	S	S
Name and quantity of drugs and chemicals used	S	S	S	S	S	S	S	S
Name and address of input suppliers	S	S	S	S	S	S	S	S
Origin of drugs and chemicals used	S	S	S	S	S	S	S	S
Date of use of inputs, drugs and chemicals	S	S	S	S	S	S	S	S
Culture/production methods	S	S	S	S	S	S	S	S
Environmental conditions and treatment (water, pond, pH level)	S	S	S	S	S	S	S	S
Productivity/culture pond	S	S	S	S	S	S	S	S
Total harvest quantity	S	S	S	S	S	S	S	S
Date of harvest	S	S	S	S	S	S	S	S
Harvest methods	S	S	S	S	S	S	S	S
Health certificate for outputs	S	S	S	S	S	S	S	S
Name and address of buyers	S	S	S	S	S	S	S	S
Barcode	S	S	S	S	S	S	S	S
Whether the product has been defrosted	S	NS	S	X	S	X	S	X
Expiry date	S	NS	S	X	S	X	S	X
Allergens	S	NS	S	X	S	X	S	X
List and quantity of ingredients	S	NS	S	X	S	X	S	X
Net weight	S	NS	S	X	S	X	S	X
Instructions for use	S	NS	S	X	S	X	S	X
Nutritional declaration	S	NS	S	X	S	X	S	X
Date of packaging	S	NS	S	X	S	X	S	X
Date of freezing	S	NS	S	X	S	X	S	X
Storage instructions	S	S	S	S	S	S	S	S

742 *Note:* X: not be specified by importing countries. S = Satisfied; PS = Partially Satisfied; NS = Not Satisfied

743

Appendices

Appendix 1. The required information in national regulations and practices in the US, EU and Japan markets

Mandatory requirement information	National regulations			Quality assurance certificates			
	US	EU	Japan	HACCP	GLOBAL GAP	ASC	BAP
Name of products	✓	✓		✓	✓	✓	✓
Legal name or customary name		✓					
Production method	✓	✓	✓	✓	✓	✓	✓
Drugs and chemicals used in production					✓	✓	✓
Country of production	✓	✓	✓	✓	✓	✓	✓
Defrosting method	✓	✓					
Expiry date	✓	✓	✓	✓	✓	✓	✓
Allergens		✓	✓				
List and quantity of ingredients		✓	✓	✓	✓	✓	✓
Net weight	✓	✓	✓	✓	✓	✓	✓
Name and address of business operator	✓	✓	✓	✓	✓	✓	✓
Country of origin	✓	✓	✓	✓	✓	✓	✓
Instructions for use	✓	✓	✓	✓	✓	✓	✓
Nutritional declaration		✓	✓				
Date of packaging	✓	✓	✓	✓	✓	✓	✓
Date of freezing	✓	✓		✓	✓	✓	✓
Storage instructions	✓	✓	✓	✓	✓	✓	✓
Barcode	✓	✓		✓	✓	✓	✓

750 **Appendix 2.** Mandatory information in Vietnam national regulation and practices

Mandatory information in Vietnamese regulations/quality assurance practice	Farms		Wholesalers/Distributors			Processors	Exporters	
	Cir. 03	Viet GAP	Cir. 03	Cir. 48	Cir. 03	Cir. 48	Cir. 03	Cir. 48
Name and address of producers	✓	✓	✓	✓	✓	✓	✓	✓
Name of products	✓	✓	✓	✓	✓	✓	✓	✓
Legal name or customary name	✓	✓	✓	✓	✓	✓	✓	✓
Quantity of input products	✓	✓	✓		✓		✓	
Origin of input products	✓	✓	✓		✓		✓	
Name and quantity of drugs and chemicals used	✓	✓	✓		✓		✓	
Name and address of input suppliers	✓	✓	✓	✓	✓	✓	✓	✓
Origin of drugs and chemicals used	✓	✓	✓		✓		✓	
Date of use of inputs, drugs and chemicals	✓	✓	✓		✓		✓	
Culture/production methods	✓	✓	✓	✓	✓	✓	✓	✓
Environmental conditions and treatment (water, pond, pH level)	✓	✓	✓		✓		✓	
Productivity/culture pond	✓	✓	✓		✓		✓	
Total harvest quantity	✓	✓	✓		✓		✓	
Date of harvest	✓	✓	✓		✓		✓	
Harvest methods	✓	✓	✓		✓		✓	
Health certificate for outputs	✓	✓	✓		✓		✓	
Name and address of buyers	✓	✓	✓		✓		✓	
Barcode	✓	✓	✓		✓		✓	
Whether the product has been defrosted			✓	✓	✓	✓	✓	✓
Date of minimum durability ('best before' date)			✓	✓	✓	✓	✓	✓
Allergens			✓	✓	✓	✓	✓	✓
List and quantity of ingredients			✓	✓	✓	✓	✓	✓
Net weight			✓	✓	✓	✓	✓	✓
Instructions for use			✓	✓	✓	✓	✓	✓
Nutritional declaration			✓	✓	✓	✓	✓	✓
Date of packaging			✓	✓	✓	✓	✓	✓
Date of freezing			✓	✓	✓	✓	✓	✓
Storage instructions	✓	✓	✓	✓	✓	✓	✓	✓

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