MINISTRY OF INDUSTRY AND TRADE

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Guideline for Sustainable Consumption and Production in the Seafood Sector in Vietnam

Acknowledgement

The following Guideline for Sustainable Consumption and Production (SCP) in the Seafood Sector in Vietnam was developed as part of the technical support provided to the Ministry of Industry and Trade of Vietnam through the SWITCH-Asia SCP Facility, which is funded by the European Commission.

The European Union launched the SWITCH-Asia programme with a mission to support the transition of Asian countries to low-carbon, resource-efficient and circular economies while promoting sustainable consumption and production patterns within Asia and greener supply chains between Asia and Europe. The programme aims at providing a platform to promote sustainable consumption and production (SCP) policies and practices in Asia and strengthen the awareness and dialogue of local stakeholders. The SWITCH-Asia SCP Facility aims at strengthening the implementation of SCP policies at the national level.

Aim of this publication

The objective of this Guideline is to provide a holistic systems approach to sustainable consumption and production (SCP) in the seafood sector in Vietnam, based on sustainability issues in the different stages of the seafood supply chain, with a particular focus on Pangasius as a species of particular importance to the Vietnamese seafood sector. The Guideline aims to assist decision-makers in the seafood supply chain along with policymakers who need to know how to sustainably source, manufacture, and export seafood products and apply for certification schemes for eco-labels to improve the market recognition of their products. The Guideline will also help consumers and consumer groups to understand the consumption aspects of SCP in the seafood sector.

Authors:

Institute for Global Environmental Strategies (IGES): Dwayne Appleby, Atsushi Watabe, Pham Ngoc Bao, Caixia Mao, and Peter King

VNCPC: Le Xuan Thinh and Dinh Manh Thang

Supervision and Coordination: Arab Hoballah, Zinaida Fadeeva, Loraine Gatlabayan (SWITCH-Asia SCP Facility) and Thanh Hoang (EU Delegation to Viet Nam)

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ABBREVIATIONS

ASC	Aquaculture Stewardship Council
ASEAN	Association of Southeast Asian Nations
BAP	Best Aquaculture Practices
BOD5	Biological oxygen demand (over 5 days) - a standardised unit for measuring organic water pollution
BRC	British Retail Consortium
BSCI	Business Social Compliance Initiative
CoC	Chain of Custody
COD	Chemical Oxygen Demand - measures the quantity of oxygen required to degrade through oxidation all the organic and inorganic matter in wastewater
EMS	environmental management system
EU	European Union
EVFTA	EU-Vietnam Free Trade Agreement
FAO	Food and Agriculture Organization of the United Nations
FIP	Fisheries Improvement Projects (a part of MSC)
FSIS	Food Safety Inspection Agency
Global GAP	Global Good Agricultural Practices
GHG	Greenhouse gas
GMP	Good Manufacturing Practice
GRAISEA	Gender Transformative & Responsible Business Investment in South East Asia
ha	hectare
HACCP	Hazard Analysis and Critical Control Points
ICAFIS	International Collaborating Centre for Aquaculture and Fisheries Sustainability
IFS	International Food Standard for safety
IGES	Institute for Global Environmental Strategies
ISO	International Organization for Standardization
JSC	Vietnam-Australia Joint Stock Company
LCA	Life cycle assessment
LEP	Law on Environmental Protection
LPG	liquified petroleum gas
MSC	Marine Stewardship Council (NGO to stop over-fishing)
n.d.	no date
NGO	Non-governmental organisation
NH3	hydrogen nitride (ammonia)
R22	chlorodifluoromethane (freon), a refrigerant

RECP	resource efficiency and cleaner production
SDG	United Nations Sustainable Development Goals
SMETA	Sedex Members Ethical Trade Audit
SIMP	Seafood Import Monitoring Program
SQF 2000	Safe Quality Food
SUPA	Sustainable Pangasius project
SuSv	Sustainable and Equitable Shrimp Production and Value Chain Development in Vietnam
tCO_2e	Tons of carbon dioxide equivalent
TPM	total productive maintenance
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNIDO	United Nations Industrial Development Organization
US	United States of America
USD	US dollar - $
VietGAP	Vietnam Good Agricultural Practices

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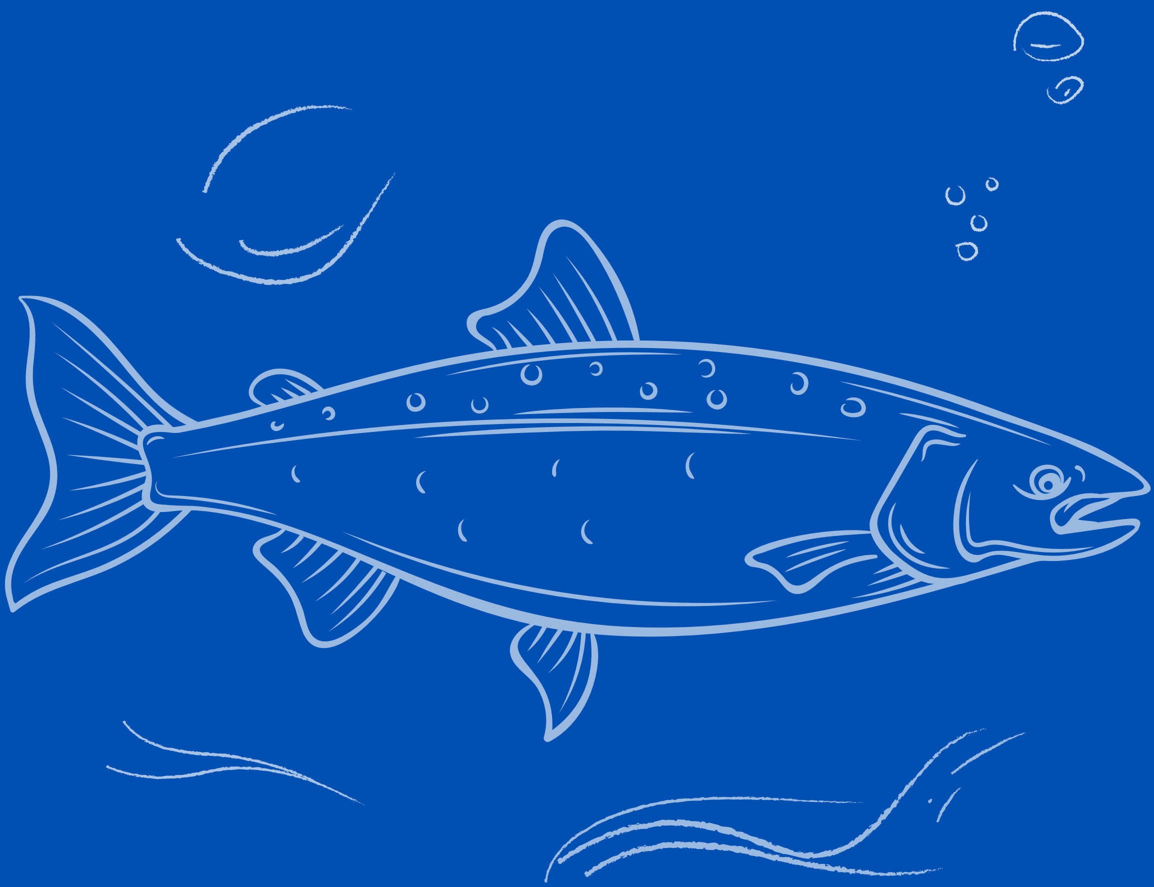
About this Guideline



1. About this Guideline

1.1 Objective

The objective of this Guideline is to provide a systems approach to sustainable consumption and production (SCP) in the seafood sector in Vietnam that considers all stages of the production chain. SCP is conceived as a crucial framework for achieving the social and economic benefits, and minimizing the environmental burden, of Vietnam's seafood sector. This Guideline will contribute to the development and implementation of policies to reorient and restructure the agricultural sector towards improved value-added production and sustainable development.

The Guideline aims to assist decision-makers in the seafood supply chain and policymakers who need to know how to sustainably source, manufacture and export seafood products and apply for certification schemes for eco-labels to improve the market recognition of their products. The Guideline will also help consumers and consumer groups to understand the consumption aspects of SCP in the seafood sector. This Guideline aims to provide the following:

a. A systems approach to the seafood supply chain, covering consumption and production
b. A more in-depth analysis of the *Pangasius* spp. fish sector to further illustrate the practical value of integrating SCP practices into the seafood supply chain in Vietnam
c. Technical guidance on how to evaluate environmental degradation in the seafood processing stages and how to mitigate this negative impact
d. Knowledge and potential solutions for sustainable consumption in the seafood sector

1.2 Scope of the Guideline

Aquaculture currently plays an important role in the seafood sector, especially for exports, and will be increasingly important due to the cumulative threats to the current fish stocks in the wild capture industry. Therefore, this Guideline will cover the production and consumption stages of the supply chain so as to holistically address SCP in all aspects of the seafood sector, but with a principal focus on aquaculture products.

In the aquaculture sector in Vietnam, processing is a key step in adding value to products destined for export, so it is important to control the quality of the products by engaging the support of seafood processors in other steps of the supply chain, such as the farming and retailing stages, to ensure a high quality of sustainable inputs. This Guideline thus focuses mainly on the aquaculture processing segment of the seafood supply chain. Chapter 2 presents a general background and introduction to the seafood sector in Vietnam, outlining aspects of both production and consumption systems. Chapter 3 examines the two most important seafood products for Vietnam: shrimp and pangasius. Chapter 4 details sustainability issues occurring in the processing segment of the value chain, using pangasius as a prime example. Chapter 5 examines sustainable seafood consumption in Vietnam from the perspective of export and domestic markets with an expanded focus on shrimp, pangasius and aquaculture. Chapter 6 presents the costs and benefits of sustainable seafood certification programmes, outlining international standards, challenges for adoption, and experiences from interviews with three Vietnamese seafood firms. Finally, Chapter 7 concludes the Guideline with a set of policy recommendations for four key target groups: policymakers; seafood production and processing facilities; retailers; and consumption outlets and consumers.

1.3 Methodology

The primary data collected and analysed in the assessment process is based on the implementation experience of two grant projects 'Establishing a Sustainable Pangasius Supply Chain in Vietnam (2013–2017)' and 'Sustainable and Equitable Shrimp Production and Value Chain Development in Vietnam (2016–2020)' funded by the SWITCH-Asia Programme. Moreover, additional quantitative data was also collected during the development of this Guideline. This data focuses on the production process in selected processing plants on energy, resources, and chemical use. Qualitative data was obtained by interviewing selected stakeholders in the supply chain and policymakers.

The secondary data used in the Guideline is based on literature review of reports and academic papers published by international organizations, researchers and associations in both English and Vietnamese.

The analytical methodology that was used combined the quantitative and qualitative analyses of primary and secondary data. Based on the analysis, the team organized a multi-stakeholder consultation meeting in April 2021 in Hanoi, to which were invited the Ministry of Industry of Trade, Ministry of Agriculture and Rural Development, Ministry of Natural Resources and Environment, seafood manufacturers, seafood producers, retailers, and consumer associations to discuss and review the draft Guideline. Based on the comments and feedback received in the consultation, the Guideline has been revised and finalised.

1.4. How to use this Guideline

Policymakers: This Guideline is designed to provide a systems thinking framework to consider different stages of the seafood production and supply chain in achieving SCP. It can assist different ministries in designing policies targeting different stages of the seafood production chain that will create the enabling conditions for SCP practices. Moreover, it intends to help the responsible ministries to 1) gain a better understanding of the dependencies on and synergies among other decision-making bodies, 2) monitor the environmental and economic repercussions generated along the seafood supply chain, and 3) develop and propose regulatory measures.

Seafood producers: This Guideline can be used to help processors to assess the resource and energy use and environmental ramifications in seafood processing activities. The Guideline also provides detailed guidance on how to introduce resource efficiency and cleaner production (RECP) in the processing plants, as well as instruction on how to apply for eco-labelling schemes and the benefits of making sustainably produced products more visible to consumers in the export and domestic markets.

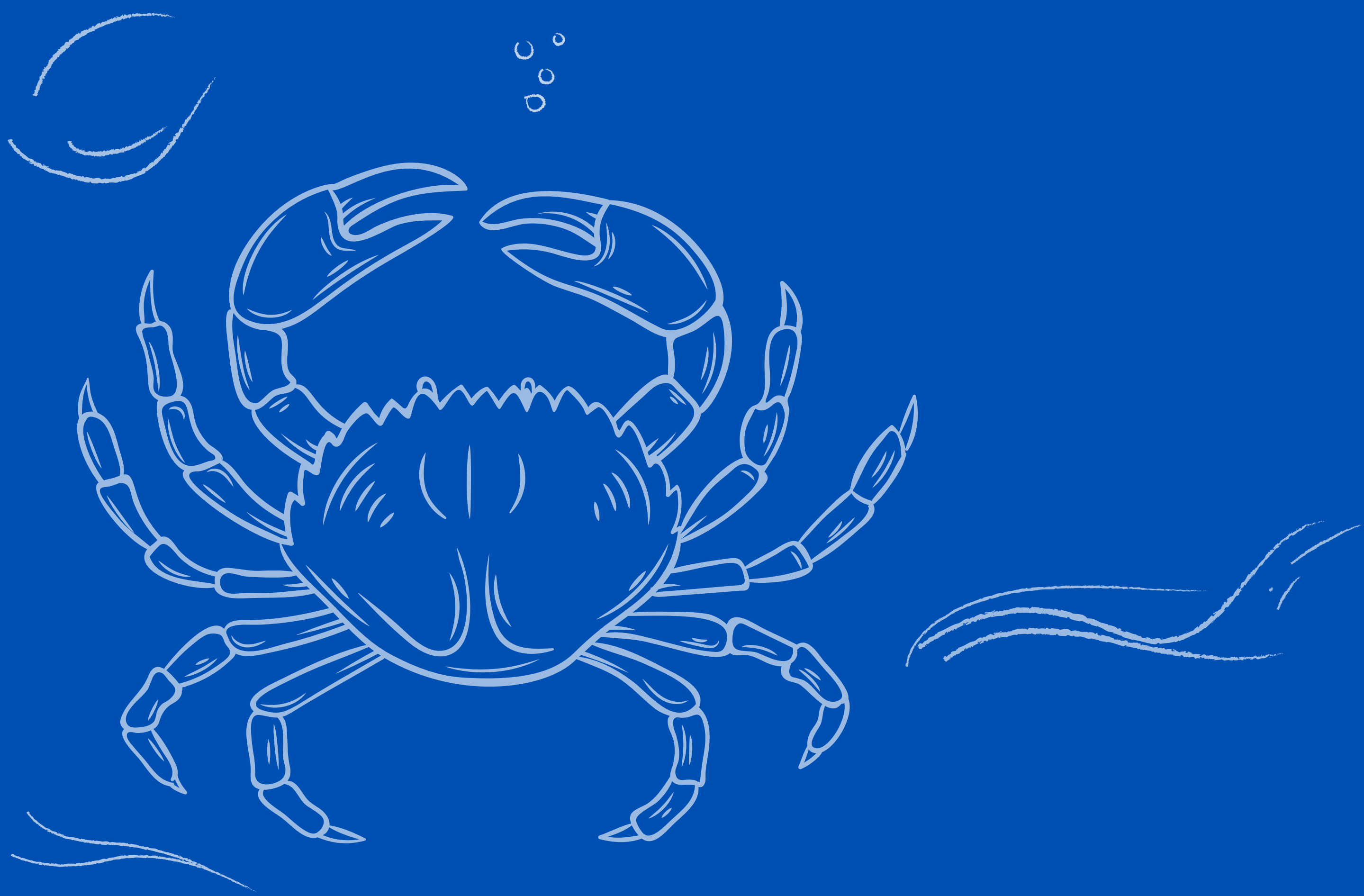
Retailers: Retailers can use this Guideline to determine the criteria for sourcing sustainably produced seafood and better-quality seafood products at their shops. At the same time, retailers may also find the Guideline helpful in understanding the sustainable and unsustainable aspects of upstream and downstream activities in the seafood sector.

Consumption outlets and consumer associations: For consumption outlets like hotels, restaurants, and consumer associations in Vietnam, the Guideline provides some analysis of the increasing importance of domestic seafood consumption that could be used to implement measures facilitating sustainable consumption.

Chapter

02

Background



2. Background

2.1 The Seafood Sector in Vietnam

Seafood is one of the most traded commodities in the world (FAO, 2016). The economic value of global seafood production was estimated to be USD 362 billion, of which aquaculture accounted for USD 232 billion in 2016 (FAO, 2018a). Per capita consumption has increased from 9.0 kg in 1961 to 20.2 kg in 2015 and was estimated to reach 20.3 kg in 2016 and 20.5 kg in 2017. The world's major seafood importers rely on seafood imported from developing countries, consuming roughly 60% of the total quantity of globally exported seafood products and accounting for 54% of the total value of globally traded seafood (FAO, 2018a). As an industry, seafood employs about 19.3 million workers in aquaculture and 40.3 million workers in the capture fisheries sector worldwide (FAO, 2018a).

Due to excessive commercialisation of the industry, however, seafood production is facing grave challenges in terms of sustainability. Environmentally, global seafood ecosystems are in danger of depletion (Myers and Worm, 2003), with about 75% of seafood species stocks overfished or seriously depleted (Garcia and Moreno, 2001). Moreover, about 40% of the ocean is seriously affected by human activities including pollution, fisheries depletion, loss of coastal habitats and so forth. In addition, approximately 13,000 pieces of plastic litter can be found in every square kilometre of the world's oceans (UNDP, n.d.), providing additional threats to marine life. In recognition of these factors, the United Nations Sustainable Development Goal 14 focuses on life below water, to address marine pollution, conservation of marine ecosystems, and regulation of harvesting and ending overfishing. Beyond environmental concerns, the sustainability of the global seafood sector encompasses broader aspects in terms of socioeconomic issues involving global trade dynamics, livelihoods, and social equity.

As a result of the pressure on marine capture fisheries and increasing international demand, the share of aquaculture production has been increasing rapidly since the 1990s and is catching up with wild caught seafood production. Aquaculture production has even exceeded the output of capture fisheries in recent years. The role of aquaculture in the seafood sector is an essential part of the global seafood supply chain today. Of the 171 million tonnes of total global seafood production, aquaculture production shares 47% or 53%, if the use of non-food uses (fishmeal and fish oil) are excluded (FAO, 2018a).

Asia is a key region that has benefited from the growth of the seafood sector. As of 2016, approximately 85% of the labour engaged in fisheries and aquaculture was based in Asia (FAO, 2018a). In Vietnam the rapidly growing seafood sector plays an important role socially, economically, and environmentally. Vietnam is the third largest producer and exporter of seafood in the world, behind China and Norway (FAO 2016). In 2016, Vietnam produced a total of 6.42 million tonnes of seafood, with freshwater and marine capture fisheries accounting for nearly 2.8 million tonnes of seafood production, and aquaculture over 3.6 million tonnes. Seafood production in Vietnam has grown by roughly 86% since 2016 (World Bank, n.d.). According to the Ministry of Agriculture and Rural Development, in 2020 Vietnam produced a total of 8.41 million tonnes of seafood. Freshwater and marine seafood capture reached nearly 3.85 million tonnes in 2020, while aquaculture supplied over 4.56 million tonnes (Ministry of Agriculture and Rural Development, 2020).

Since 1995 Vietnam's capture fisheries capacity has increased by a factor of four, averaging an annual growth rate of 6%. Over the same time period, aquaculture production capacity has grown at an average annual rate of 10%, jumping from 425,000 tonnes in 1995 to 4.6 million tonnes in 2020. The expansion of aquaculture activities has largely been centred on the Mekong Delta, which now accounts for 95% of total output for pangasius and 80% of total output for shrimp species (VASEP, 2021a).

Vietnam exported USD 7.3 billion of seafood products (5.1% of global exports) in 2016 (FAO, 2018a), increasing to nearly USD 8.6 billion in 2019 (VASEP, 2020a) and accounting for roughly 6% of global seafood export value. The most exported seafood products from Vietnam are farmed *Pangasius* spp. fish and shrimp (Nguyen and Jolly, 2020), pangasius and shrimp account for about 62% of total seafood export value (VASEP, 2020b; VASEP, 2020c). Vietnam is the third largest producer in the world of farmed shrimp (FAO, 2020a). For *Pangasius* spp., Vietnam's exports account for 91% of the globally traded volume (Nguyen and Jolly, 2020). While Vietnam exports seafood to 160 countries and territories, the five major import markets are the United States (19.3% of total seafood sector export value), Japan (16.8%), China (16.5%), the European Union (11.4%), and South Korea (9.2%), according to 2020 data (VASEP, 2020a). More specifically, the EU, United States, Japan, and China (Hong Kong) are major shrimp export markets, accounting for nearly 75% of the total shrimp export value of Vietnam, while China (Hong Kong), the United States, the EU and ASEAN (mainly Thailand, Malaysia and the Philippines) are the major pangasius export markets.

Over the past few years the Vietnamese seafood sector has become less competitive as a result of its low productivity levels compared to competing countries such as India and Ecuador, which are expanding their shrimp farming and productivity levels to supply the global market. Meanwhile, China has also been expanding fish farming areas and becoming self-sufficient in domestic raw materials, thus improving their competitiveness in seafood export markets. In addition, high fluctuations in raw material prices have had a direct effect on the selling prices of seafood enterprises. Moreover, due to increasing standards developed by its export markets such as the EU and the US, the seafood sector in Vietnam faces compliance challenges with respect to those standards (Lee et al., 2010; The World & Vietnam, 2017), especially for small-scale producers. The ongoing Covid-19 pandemic and its concomitant lockdowns and restrictions of social activities have severely curtailed the purchasing power of some of the major seafood buyers and distribution channels such as restaurants, hotels, food retail systems, or supermarkets, thus cutting demand for seafood, which in turn has provoked interruptions in transportation and export activities.

Further significant and long-standing challenges for the seafood export industry are the issues surrounding environmental destruction and climate change. The reputation of Vietnamese shrimp and pangasius products has been called into questioned and even refused entry to export markets because of known problems with unsustainable farming conditions, since intensive shrimp and fish farming can create large amounts of semi-solid pollution (excrement) and utilise large quantities of chemicals and antibiotics (for controlling epidemics and diseases). These latter products are in turn discharged or allowed to run off into the adjoining water environment. In order to ensure sustainability and efficiency in shrimp and pangasius farming and production, appropriate actions thus need to be taken to ensure that the environmental degradation and deterioration threatening shrimp and pangasius farm survival fully addressed and minimised.

Enhancing sustainable fisheries practices in the seafood supply chain will thus provide benefits not only for the environment but for the seafood producers themselves by increasing the competitiveness of their products in the global market, especially after the EU-Vietnam Free Trade Agreement (EVFTA) came into effect in 2020 (European Commission, 2019; European Parliament, 2015). Moreover, the seafood supply chain is a complex system with multiple components and actors such as feed mills, hatcheries, local farmers, middlemen, processors, exporters, international/domestic wholesalers, international/domestic retailers, and domestic/foreign customers (Figure 1). Understanding the interactions of all stakeholders in the supply chain is essential to introduce SCP measures into the seafood sector.

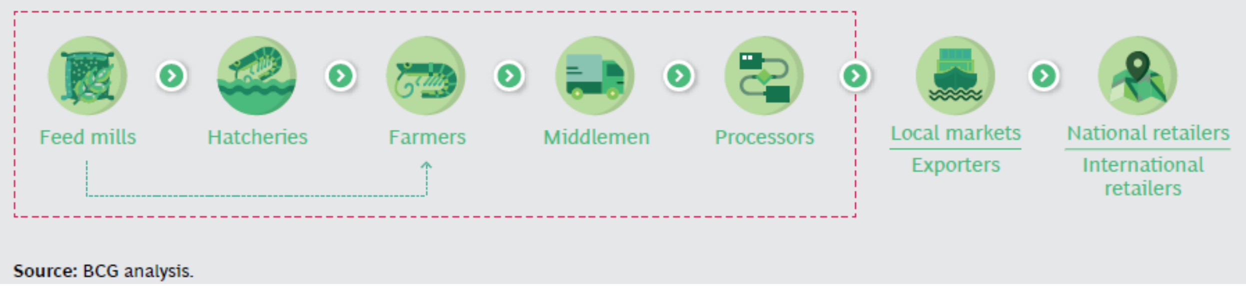


Figure 1. Example of farmed shrimp supply chain in Vietnam (BCG, 2019)

2.2. Main stages of the supply chain in seafood production

Based on the holistic systems approach to SCP adopted by the United Nations Environment Programme (UNEP), there are nine segments of the supply chain for all products and services: (i) sustainable resource management, (ii) design for sustainability, (iii) cleaner production and resource efficiency, (iv) sustainable transport, (v) eco-labelling and certification, (vi) sustainable procurement, (vii) sustainable marketing, (viii) sustainable lifestyles, and (ix) waste management (UNEP, 2012). As illustrated in Figure 2, these nine segments in the supply chain work in a circular process. The Vietnam National Action Plan on Sustainable Consumption and Production (2021–2030), approved by the Prime Minister in 2020 for implementation, adopts this holistic SCP approach. Moreover, within the National Action Plan on SCP, Vietnam has specifically set an objective for the seafood sector: a 5–8% decrease for 2021–2025 and 7–10% decrease by 2030 in resources and materials used for seafood production and processing.

Figure 2. Sustainable Consumption and Production Supply Chain

As we have seen, the seafood supply chain is a complex system in which multiple actors intervene before the products reach the markets abroad. For example, the shrimp supply chain could be divided into the following steps: (i) input supply, (ii) shrimp production, (iii) collection, (iv) processing, and (v) export to overseas markets. In the import market, the process involves (vi) distribution, (vii) branding, (viii) retailing, and (ix) buying. The influence and power of the various actors may originate externally as through international certification bodies, or internally from the national regulatory agencies (Tran et al., 2013). Therefore, although the SCP measures differ depending on each step of the seafood supply chain, an integrated approach to target the entire supply chain is necessary.

2.3. Sustainable consumption and production dimensions in the seafood sector

Dimensions of seafood sustainability: The unsustainability of the current production and consumption practices in the seafood sector place great pressure on aquatic ecosystems. These pressures have resulted in dramatic decreases in marine biomass. The current level of large predatory fish biomass is only about 10% of the pre-industrial level, which could seriously threaten ecosystem dynamics (Myers and Worm, 2003). One study predicted that the result of such unsustainable management of seafood production and the consequences on marine habitats will result in the collapse of marine fisheries by the middle of this century (Worm et al., 2006). Current research on seafood sustainability tends to treat seafood as a key natural resource management concern (Farmery et al., 2015), involving ecosystem-based fishery management (Hilborn et al., 2015), biodiversity concerns (Silva et al., 2009), disease control (Bondad-Reantaso et al., 2005), and chemical use and human health (Burridge et al., 2010).

Research on the seafood supply chain as a holistic system is a relatively recent development (Farmery et al., 2015), coinciding with increasing public demand for social accountability across the supply chain (Lee et al., 2010). In FAO's 'Five Principles of Sustainable Food and Agriculture' the focus areas are resource efficiency, conservation of natural resources, equity and social wellbeing, resilience of people and communities, and effective governance mechanisms (FAO, 2018a). In the special issue on 'The Sustainability of Seafood Production and Consumption' by the Journal of Cleaner Production, a more practical approach was taken. Nine dimensions of sustainability were addressed: (i) seafood harvesting practices, (ii) fishing processing, (iii) life cycle assessment, (iv) eco-efficiency, (v) management of wastes, (vi) seafood distribution and consumption, (vii) total energy costs, (viii) eco-labelling, and (ix) the conservation of resources and biodiversity (Ayer et al., 2009).

Nutrition and food security: Seafood is a key nutrition source for human consumption, providing access to affordable, high-quality protein. The nutritious value of seafood is a major source of n−3 fatty acids which are vital for brain development (Hibbeln et al., 2007), and an excellent source of micronutrients, especially for low-income populations (Roos et al., 2007). Seafood consumption has increased to an unprecedented level, with per capita consumption doubling since 1960 (FAO, 2018a). The rapid increase is attributed to the increased awareness of the health benefits of seafood and the increased demand for luxury seafood in developed countries (Naylor and Burke, 2005). Accordingly, the seafood trade is growing rapidly, especially for products originating in developing countries destined for developed country markets.

As a valuable nutrition source, seafood provides more than 20% of the animal protein per capita for 3 billion people, especially in developing countries (FAO, 2018a). In coastal regions, seafood accounts for 50–90% of animal protein consumption (Bell et al., 2011). Moreover, seafood provides an important source of income and livelihood (Thompson and Amoroso, 2014), which ultimately contributes to food security and better nutrition in developing countries.

Resource efficiency and cleaner production (RECP): RECP is an important instrument to achieve resource and material reductions in seafood production as indicated in the National Action Plan on SCP. RECP utilises a robust lifecycle perspective, taking into consideration the use of resources and effects on the environment from breeding seafood to final consumption and disposal of waste at the other end of the chain. This approach also emphasizes the critical issue of resource scarcity (UNIDO, 2017).

During the production process, numerous resources including raw materials, energy and water are consumed. There are multiple steps involved in seafood production, of which processing is an important one. Moreover, production processes often generate unintended externalities or unforeseen results that damage the environment, human health, and/or social stability. Clear strategic guidance will reduce resource waste and help to ensure fewer negative externalities resulting from production practices. Implementation of RECP practices will also increase the quality and market value of products.

RECP measures 'resource productivity' and 'pollution intensity' and is applicable at the enterprise level. Resource productivity is assessed as product output per unit of energy, material, or water. Pollution intensity is measured for carbon, waste, and wastewater intensity per unit of product output (UNIDO, 2010). There are significant environmental benefits from RECP, including reductions in greenhouse gas (GHG) emissions and improvements in local ecosystems, as well as benefits to human health from reductions in pollution generated during production processes. In addition to these environmental and social benefits, implementation of RECP practices results in many benefits for enterprises including cost-savings derived from reduced waste of materials and energy, improved operating efficiency and product quality, and recovery of wasted materials (UNIDO, 2010).

Seafood waste and loss: Food waste at the seafood consumption stage is an increasing problem. About 35% of the global catch of seafood is not utilised for consumption. North America and Oceania account for the highest seafood loss at 50% (Gustavsson et al., 2011). Post-harvest loss accounts for more than 70% of the total loss across the seafood supply chain (FAO, 2014). The primary causes of seafood loss are the discarding of non-targeted species (bycatch) and food waste at the consumer level (Gunders, 2012). About 27% of the landed fish is lost or wasted between landing and consumption (FAO, 2018a). Several studies conclude that the factors underpinning seafood loss are lack of knowledge and skills in post-harvest handling, inadequate infrastructure and technologies, along with cultural and social dimensions, governance, regulation and enforcement (Diei-Ouadi et al., 2015; Wibowo et al., 2017). Moreover, changes in eating habits and consumption patterns in the rapidly urbanizing cities in developing countries is causing the generation of food waste at the consumer and household level to increase as well (Liu et al., 2020).

Environmental aspects of sustainability: The environmental damage caused by the seafood sector spreads across the entire supply chain, and it continues to rise (Tyedmers et al., 2005). In wild caught fisheries, overfishing and ocean pollution cause the most damage. Aquaculture causes more diverse environmental problems: intensification of high-value species (Paez-Osuna, 2001); loss of fish protein to feed cultured species (Naylor et al., 2000); eutrophication of water sources (Folke et al., 1992); benthos deterioration (Findlay et al., 1995); discharge of chemicals (Hastein, 1995); and depletion of wild species for seed harvesting (Mungkung et al., 2006). Life Cycle Assessment (LCA) tools have been developed to systematically measure the impact of environmental risks. These tools are standardised by the International Organization for Standardization (ISO) to measure 'cradle-to-grave' environmental risks associated with energy and material intensity of products and processes (Pelletier and Tyedmers, 2008). Seafood farming is highly dependent on the health of the surrounding ecosystem, so the environmental impact calculation needs to be expanded far beyond an individual farm.

Quantitative calculation tools such as the 'ecological footprint' are rather static, reflecting multiple underlying factors at a specific moment in time (Folke et al., 1992; Global Footprint Network, 2020). The ecological footprint approach suggests that the environmental damage caused by the seafood sector are concentrated in the production and transportation segments of the value chain, and are significantly influenced by the types of technologies used (Avetisyan et al., 2014). For example, a common ecological footprint measure, 'food miles travelled', is not among the most significant factor causing seafood environmental degradation; rather, the mode of transportation influences such degradation in a much greater degree (Coley et al., 2013; Edwards-Jones et al., 2008). The production phases of capturing and culturing are the major contributors to the carbon footprint of seafood, another key aspect of the ecological footprint assessment model. Therefore, targeting the whole system of seafood production, distribution and consumption is recommended to reduce its environmental impacts (Farmery et al., 2015).

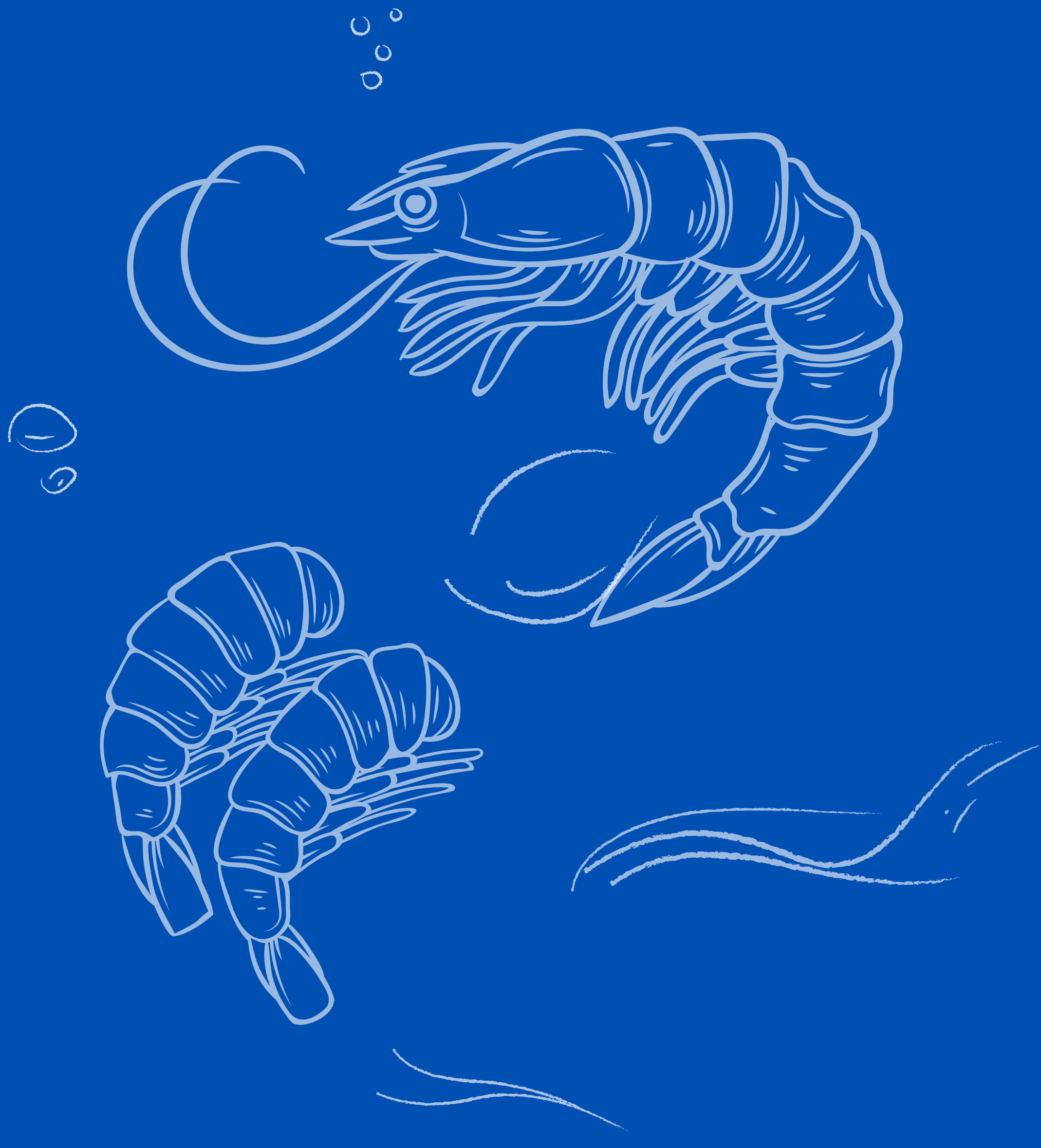
Ecolabelling and certification: Ecolabelling contributes to the visibility of environment- friendly products to consumers through awareness raising campaigns, mainly in the developed country markets (FAO, 2018b: 1). Currently, only about 14.2% of global seafood production is certified with voluntary standards or ecolabelling. Nevertheless, certified aquaculture products are growing faster, at twice the rate compared to seafood from wild capture fisheries (FAO, 2018b: 5). However, ecolabelling could also act as a barrier for producers in developing countries to access global markets if they lack funding and capacity to get third-party certification for their products (FAO, 2014). Such measures are most likely to disadvantage small-scale farmers and producers, where the constraints of resources and knowledge to adopt ecolabelling are more severe. For instance, certification from the Marine Stewardship Council costs from USD 2,000–20,000 for pre-assessment, and another USD 10,000–500,000 for a full assessment and certification. The average cost from Friend of the Sea is USD 5,800 to certify a wild fishery and USD 3,500 for aquaculture. Thus, for many producers, especially small-scale ones, certification costs rely on funding support from government and other organizations such as NGOs and retailers (FAO, 2018b: 6). To be sure, there are critiques that government funding support favours large industrial producers, rather than small-scale producers (Jacquet and Pauly, 2008), and that certification of small-scale producers to support their access to the global market still remains a challenge.

Sustainable seafood consumption: Increasing consumer demand for green products can be a driver towards sustainable consumption. Research shows that when consumers are provided with accurate information on the environmental aspects of products they are buying, e.g. the carbon footprint, their behaviour in purchasing and consuming decisions can change and thus reduce destructive impact on the environment (Vázquez-Rowe et al., 2013). Consumer campaigns, often run by NGOs, can help to encourage a shift in demand toward green products. It is also argued that more responsibility should be put on producers rather than consumers, so that NGOs, government and industry can develop better accountability in the supply chain to change production patterns, in addition to shifting consumer demand, but as yet campaigns on seafood sustainability have brought about little industry change, mainly due to their focus on specific seafood species and lack of means of enforcement against reluctant producers (Iles, 2007). Linking producers and consumers through information transparency in the supply chain is critical to drive the seafood sector towards sustainability. If governments and NGOs were to take specific steps to inform seafood producers about what needs to be done with specific supply chain processes, it would be more effective than focusing only on ecolabelling and recommendations (Iles, 2007).

The sustainability issues in Vietnam's entire seafood supply chain are examined in more depth in Annex 1.

Chapter 03

SCP in shrimp and pangasius production in Vietnam



3. SCP in shrimp and pangasius production in Vietnam

3.1 Shrimp and pangasius production and export in Vietnam

Shrimp and pangasius are the major aquacultured seafood species in Vietnam, and by value they are also the top two exported seafood products. Shrimp exports have reached an annual growth rate of 4% in the past 5 years, thanks to the rapid growth of white leg shrimp in the export markets (VASEP, 2020c). In 2020, shrimp accounted for 44.5% of the seafood export market value and reached USD 3.73 billion, representing a 5% drop compared to 2018 on account of increased supply and low export prices. Pangasius accounted for 17.7% of the total seafood export value, reaching USD 1.5 billion, a drop of 11.7% compared to 2018, resulting from the oversupply of pangasius in 2018 and early 2019 (VASEP, 2020b).

Vietnam's black tiger shrimp production is in first place worldwide, with white leg shrimp in fifth place. The total shrimp production increased from 280,000 tonnes in 2004 to 718,000 tonnes in 2018. In 2019, shrimp farming covered 720,000 hectares (ha) and produced 750,000 tonnes of brackish-water shrimp. Of this total, black tiger shrimp accounted for 270,000 tonnes and white leg shrimp accounted for 480,000 tonnes (VASEP, 2020c). The top 5 export markets for Vietnam shrimp are the EU, the US, Japan, China and South Korea, which account for more than 80% of the total export value. The EU and the US are the top two markets. The EU market increased by 25.7%, from USD 548 million in 2015 to USD 690 million in 2019.The US market remained almost unchanged, decreasing slightly by 0.5% from USD 657 million in 2015 to USD 654 million in 2019. The Chinese and South Korea markets showed the highest growth rate in the past five years. For the Chinese market, the export value increased by 55% from USD 350 million in 2015 to USD 543 million in 2019. South Korea's market increased by 34.5% from USD 251 million in 2015 to USD 337.5 million in 2019. Exports to Japan increased 6% from USD 584.3 million in 2015 to USD 619 million in 2019 (VASEP, 2020a).

Pangasius farming covers about 6,600 ha, and output reached 1.42 million tonnes in 2019, generating around USD 2 billion in total income (VASEP, 2020b). The top five largest destinations for pangasius export are China, the US, EU, ASEAN and Mexico, with 28% growth from 2015-2019. This export performance has resulted mainly on account of the rapid growth of Chinese and ASEAN markets, which increased by 310% and 44% respectively. The Chinese market reached USD 662.5 million, or 33% of the overall export trade. The ASEAN market export value was USD 195 million, with 44% growth from 2015–2019. The remaining three markets all decreased. In particular, the EU market experienced the sharpest decline with a 35% decrease. There was an 8.8% decrease in the US market and a 3.6% decrease in the Mexican market. The EU market's export value decreased from USD 285 million in 2015 to USD 185 million in 2019. The US market decreased from USD 315 million to USD 287 million. The market in Mexico took a slight drop from USD 95 million in 2015 to USD 92 million in 2019 (VASEP, 2020a).

3.2. Export market issues for Vietnamese shrimp and pangasius

Brackish water shrimp: In the major shrimp export market, the EU-Vietnam Free Trade Agreement (EVFTA) that became effective in July 2020 could reduce the import tax of most raw shrimp from the basic 12–20% to 0%, and the import tax for processed shrimp will also be reduced to 0%, seven years after the agreement became effective. At the same time in 2020, the EU issued a regulation to prohibit ethoxyquin in aquatic feed. This will require seafood processors to check aquaculture feed to ensure that the prohibited ingredients are not being used, and processing plants have the responsibility to declare that ethoxyquin is not used and which antioxidants are being used by feed suppliers, as well as any toxic substances the new antioxidants contain. This regulation would generate demands for improved labelling and traceability of the products, and the replacement of antioxidants in feed would increase the feeding price and production costs. Similarly, the US market is implementing the Seafood Import Monitoring Program. Seafood from Vietnam needs to declare and keep records of seafood to prevent illegal, unreported, and unregulated fishing products as well as faulty products. For South Korea, the incentives from the Free Trade Agreement between Vietnam and South Korea have not yet been fully utilised by Vietnamese businesses. The COVID-19 pandemic also caused some disruption to the markets on account of import delays from markets and the decline in the consumption of imports (VASEP, 2020a; VASEP, 2020c).

Pangasius: Similarly, for the pangasius export markets, the COVID-19 pandemic caused disruption by reductions in purchasing power, increases in production costs, the closure of some ponds (leading to supply chain interruption), and an increase in cold storage inventories. The US market presents additional challenges from the catfish inspection program and an imposed antidumping tax which is creating new barriers. The 2014 Farm Bill transferred catfish safety management from the Food and Drug Administration to the US Department of Agriculture, so that the production of raw materials in countries of origin, and the importation of pangasius is under compulsory and continuous inspection. In November 2019, the Federal Register announced that the Food Safety Inspection Service (FSIS) recognized Vietnam as eligible in exporting Siluriformes (i.e. catfish) and fish products to the US. FSIS also states that Vietnam's Siluriformes fish inspection system is equivalent to that of the US. In 2020, the anti-dumping tax rate also fell sharply for the two Vietnamese pangasius exporting companies, NTSF Seafood Joint Stock Company and Can Tho Seafood Import-Export Joint Stock Company. This drop could decrease the barrier to exporting to the US market. For the EU, all major markets except the UK reduced their pangasius imports from Vietnam in part due to negative consumer perceptions of Vietnamese pangasius production practices (VASEP, 2020a; VASEP, 2020b).

3.3. Opportunities and challenges for Vietnam in introducing SCP for shrimp and pangasius

Shrimp and pangasius export markets are facing increasing regulation in the inspection and quality control of the products from Vietnam and increased competition from other competitors. Producers in Vietnam should understand and respond to the increasing regulations in a timely manner and combined with proper communication efforts to improve the image of Vietnamese producers. Introducing the SCP approach to the shrimp and pangasius supply chain is essential to maintain Vietnamese producers' competitiveness in the global market, because – among other reasons – consumer concerns about the safety and environmental sustainability of seafood products are increasingly widespread in export destinations such as the EU and the US.

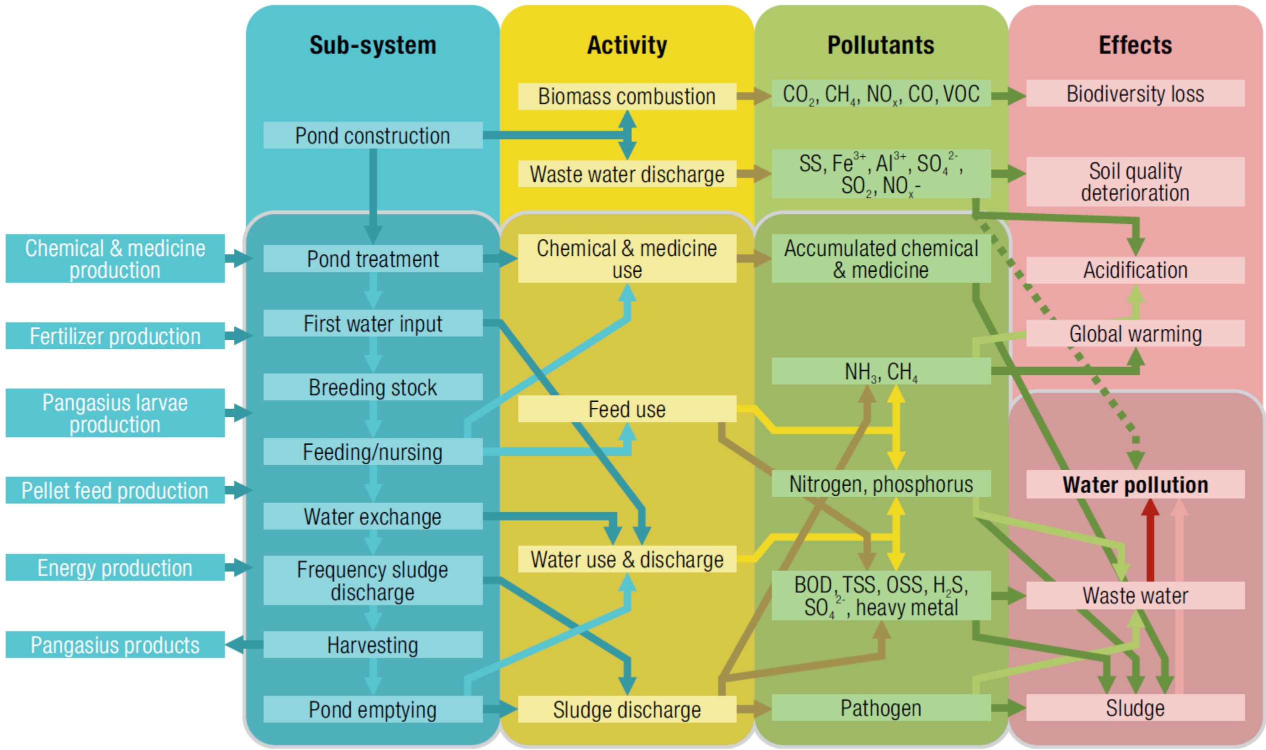
To introduce SCP for shrimp and pangasius in Vietnam, measures should be taken to target both production and consumption. For production processes, RECP helps not only to produce safe and high-quality products but could also save the unnecessary wasting of resources such as water and energy. At the same time, producers in Vietnam should remain updated about new trade regulations to be able to meet the latest requirements. Applying for different certification schemes will help Vietnamese products to become more visible as competitive, high-quality products.

Low productivity level: Vietnamese pangasius farming also needs to improve its efficiency to compete in world markets. There are about 220,000 shrimp farms in Vietnam and 65% of them are small family farms with average farming output of about 1.3 metric tons per hectare per year, compared to 6.6 metric tons per hectare per year for shrimp farmers in competing nations. In addition, these small-scale farmers often lack technical expertise and financial resources, which prevents them from introducing and implementing advanced farming technologies and farm management techniques to improve productivity and efficiency (BCG, 2019). Major challenges for enhancing the performance of pangasius production are inadequate management skills in using capital assets (technical inefficiency of 42%), and improper methods for producing fish (technical inefficiency of 30%) (Ngoc et al., 2018). As farmers with higher levels of education and more years of experience tend to have better management techniques and skills in managing pond areas, using fish food, and producing fish yields, they are able to serve as better mentors to their peers and help to raise capacity across the farm production segment.

In general, it is often observed that farmers with higher levels of education and more years of experience tend to have better management techniques or skills in managing pond area, using fish food and producing fish yields.

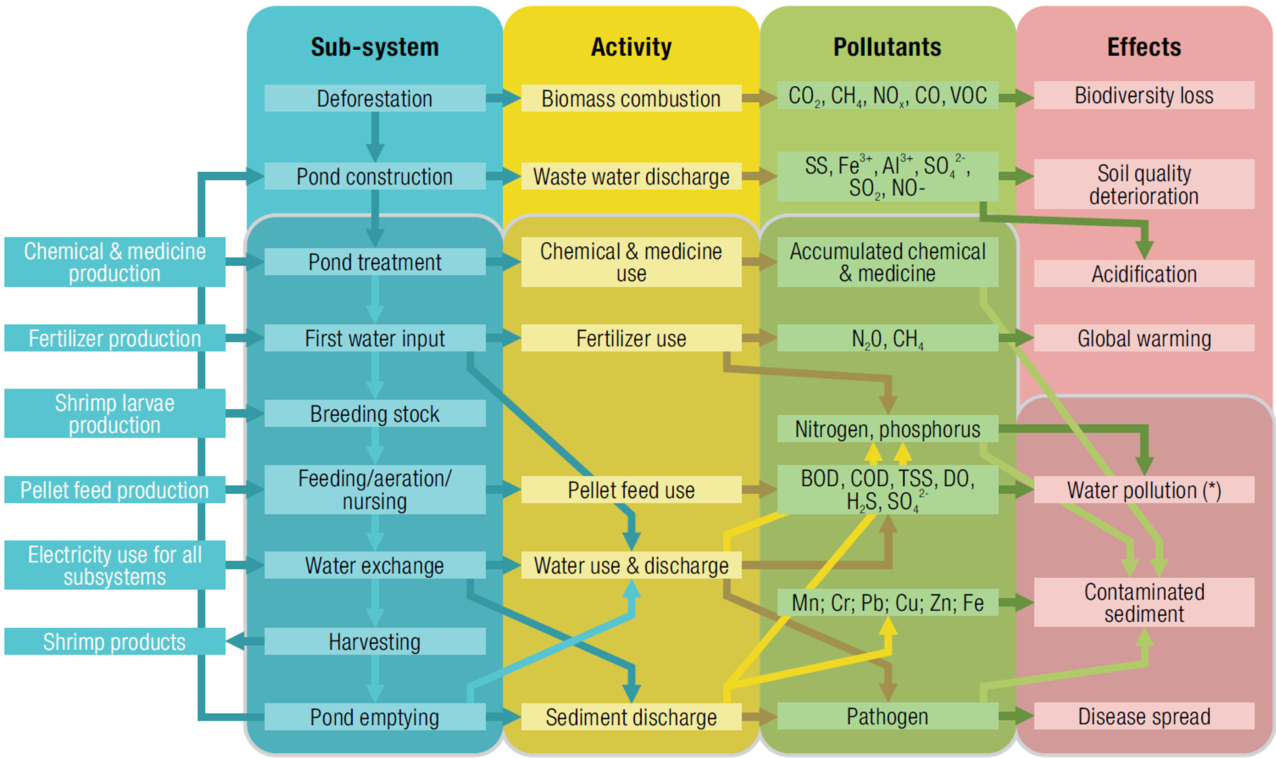
Diseases and environmental degradation: Similar to other countries, Vietnam's seafood sector also suffers from risks of complicated disease outbreaks, and it is becoming more difficult for farmers to manage diseases, especially newly emerging ones. For example, the Mekong Delta, a major shrimp and pangasius farming area in Vietnam (particularly the provinces of Ca Mau, Bac Lieu, Soc Trang, and Tien Giang) has been affected by multiple disease outbreaks in recent years (BCG, 2019). To address the risks of common diseases, farmers have made excessive use of freshwater to ensure a clean environment for shrimp and pangasius farming, and have overused antibiotics (e.g. enrofloxacin, florphenicol, sulfamethoxazole, trimethoprim, amoxicillin, oxytetracylin, ciprofloxacin), chemicals (for water treatment) and other drugs to prevent associated diseases – all of which has not only reduced productivity but also caused widespread environmental degradation with potential health consequences for consumers.

For shrimp and pangasius production, untreated wastewater is often discharged into the waterways during and after every harvest (Figs. 3 and 4). In pangasius farming in the Mekong Delta, where most of this fish is raised, it is estimated that about 37–38% of feed is left in the pond after harvest (in the form of uneaten feed and excreta), which is gradually discharged to nearby waterbodies, causing severe water quality degradation and polluting water sources. In addition, large quantities of chemicals are used during the production process to improve pond water quality. These chemicals also gradually leach into the environment, creating more pollution and further increasing disease risks. About 3.3 billion m^3 of wastewater from shrimp farming in Vietnam leaks into rivers and waterways annually (BCG, 2019).



Source: Anh et al. 2010a.

Figure 3. Environmental pollutants and their effects from Pangasius farming



Source: Anh et al. 2010b.

Figure 4. Environmental pollutants and their effects from shrimp farming

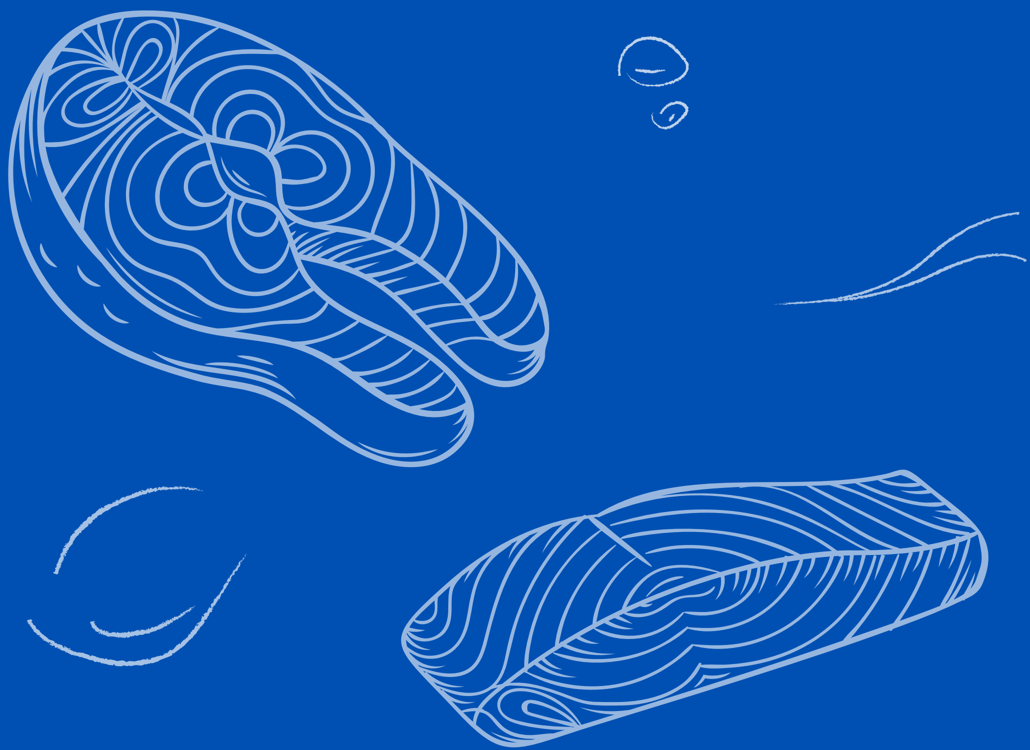
Lack of traceability increases the risk of more import refusals: In recent years, import authorities in major shrimp-importing nations have increased their requirements for traceable products and started scrutinizing imports for drug contamination. The US Seafood Import Monitoring Program, for example, requires product traceability for farmed shrimp, and the EU requires preapproval of export companies in their trade databases. Vietnam's shrimp industry has already experienced many entry line refusals to the US, the EU and Japan because of drug and chemical residuals. From 2012 through 2017, the US refused about 155 entry lines of Vietnamese shrimp, the EU refused 48 and Japan 169, accounting for about 30% of all rejected entry lines for shrimp. In 2018, South Korea issued an explicit warning after discovering that shrimp imports from Vietnam were contaminated with nitrofuran and other antibiotics. High use of chemicals and antibiotics in Vietnamese shrimp farming remains a common practice: many small farms continue to use drugs and chemicals to control diseases and treat polluted water (BCG, 2019). Consequently, improving traceability will help mitigate refusal risks in Vietnam's important seafood export industry by ensuring sustained market access that will in turn make it possible for Vietnam to tap into potential new markets.

Threats from climate change: According to a recent report by Germanwatch's Global Climate Risk Index, Vietnam is among the top 10 most vulnerable countries affected by climate change (Kreft et al., 2017). Vietnam has a long coastline which is vulnerable to typhoons, flooding, sea-level rise and salinity intrusion, especially in low-elevation coastal areas. The seafood-processing sector is thus very vulnerable to climate change. Sea cage farms are located offshore where they are exposed to typhoons, while shrimp farms are often located in low-lying areas that are affected by rising sea levels and salinity intrusion. The most significant climate change threats include: (i) increased intensity of storms, (ii) warming temperatures, (iii) increased prevalence and reduced predictability of weather and disease outbreaks, and (iv) reduced ability to maintain consistent pond temperature and salinity levels. As a result of climate change, the average temperature of ocean water has increased sharply over the past 20 years, significantly altering the survival, growth and production of shrimp, especially during the summer months. Increased typhoon intensity, along with rainfall abnormalities and more frequent droughts have also damaged infrastructure for shrimp and pangasius farming, reduced the salinity of shrimp ponds, and reduced the ability to maintain consistent salinity levels (Johnson and Hung, 2020).

Chapter

04

Resource use and environmental pollution in seafood production processes in Vietnam: the case of *Pangasius* spp.



4. Resource use and environmental pollution in seafood production processes in Vietnam: the case of *Pangasius* spp.

4.1 Introduction

Pangasius is a strategic seafood export product for Vietnam and the second most important farmed white fish product in the global market. In the period 2010–2019, the area under pangasius farming increased slowly at an average annual growth of 2.2% per year (from 5434 ha in 2010 to 6600 ha in 2019). The area under pangasius farming fluctuates in response to the sale price of commercial fish products. The output of pangasius increased by 1.1% during this period, from 1028 million tonnes to 1150 million tonnes. Average annual growth of export turnover for pangasius products over this period was 3.2%, from USD 1.42 billion to USD 1.9 billion (Directorate of Fisheries, 2020). This rapid growth trajectory has made Vietnam the leading exporter of *Pangasius* spp., accounting for roughly 91% of global exports in 2020 (Nguyen and Jolly, 2020). The pangasius sector thus provides an ideal case for examining sustainability repercussions as well as opportunities for the seafood sector in Vietnam.

This chapter examines the production segment of the pangasius value chain to illuminate sustainability opportunities and challenges in Vietnam's seafood sector. Section 4.2 assesses consumption of raw materials, energy, water, and chemicals in production facilities, while 4.3 examines the environmental and occupational health consequences of production practices, with a focus on wastewater, emissions and solid waste. Finally, section 4.4 outlines opportunities for introducing resource efficiency and cleaner production practices with a view to water savings, reduction of material and energy consumption, and reduction of pollutant load discharge.

4.2 Consumption of raw materials, energy and other resources

4.2.1 Consumption of raw materials

Frozen pangasius fillet processing plants. The main products of the pangasius industry are frozen fillets for export, with the main import markets located in the EU, USA, ASEAN, China, Hong Kong, Mexico, Brazil, Egypt, Saudi Arabia, Colombia and Australia, among others.

Raw materials used for processing frozen fillet products are pangasius raised in the company's own farming areas or satellite farming areas belonging to farmers who have an off-take contract for aquaculture products with the fillet plants. The average weight of Pangasius fish transported to the fillet processing plants is about 1–1.5 kg.

The raw material consumption norm depends on the weight of the fish, the type of final product, the quality of the ingredients (including other fish), the size of the processing plant, and the rate of glazing[1] of the product. The average raw material consumption per ton of product is given in Table 1.

Table 1. Raw material consumption of fillet processing plants

Raw material	Unit	Average consumption
Raw fish	Ton/ton of frozen fillet products	1.9–2.5

Data source: VNCPC-SUPA, 2013

Pangasius by-products plants. The pangasius by-product processing plants purchase input materials such as heads, bones and other pangasius solid waste from frozen pangasius fillet processing plants in neighbouring industrial parks, which are shipped directly to the plants for processing on the same day. The plants produce two products from the fish by-products: fishmeal and fish oil, and in the process, they are able to collect an additional by-product for food processing, namely bubbles from the fish swim bladders. Raw material consumption figures are given in Table 2.

Table 2. Raw material consumption of by-products plants

Raw material	By-product	Average consumption
Wastes of frozen pangasius fillet plants	Tons/ton of swim bladder bubbles	34.0–34.6
	Ton/ton of fishmeal	5.1–5.2
	Ton/ton of fish oil	4.9–5.0

Data source: VNCPC-SUPA, 2013

4.2.2 Energy consumption

Frozen pangasius fillet processing plants. The frozen pangasius fillet processing industry consumes high levels of energy; almost 100% of frozen pangasius fillet processing plants are significant energy users. The energy used in the frozen fillet plant is mainly electricity, plus a small percentage derived from liquified petroleum gas for the cooking needs of workers. The boiler is only used in the plants processing pangasius by-products (fishmeal and fish oil).

Electricity is used in this industry to operate refrigeration machinery (freezing, flake ice, cold storage), lighting, to pump cold water, plant air conditioning, hot water, wastewater treatment, and other processes. Energy consumption fluctuates greatly from one plant to another depending on the production processes used, the rate of product glazing, whether there is a cold storage element for storing products or just intermediate cold storage. The average amount of energy consumption per ton of product is given in Table 3.

1 Glaze is a protective layer of water added to the frozen seafood surface. The amount of glaze depends on the temperature of the product and the water, surface area of the product, and glazing time. From 8–12 % glaze is common, but up to 40% is seen in the marketplace.

Table 3. Energy consumption – Frozen pangasius fillet processing plants

Energy	Unit	Average consumption
Electricity	kWh/ton of frozen fillet products	720–1300

Data source: VNCPC-SUPA, 2013

The average electrical energy distribution in frozen pangasius fillet processing plants is shown in Figure 5.

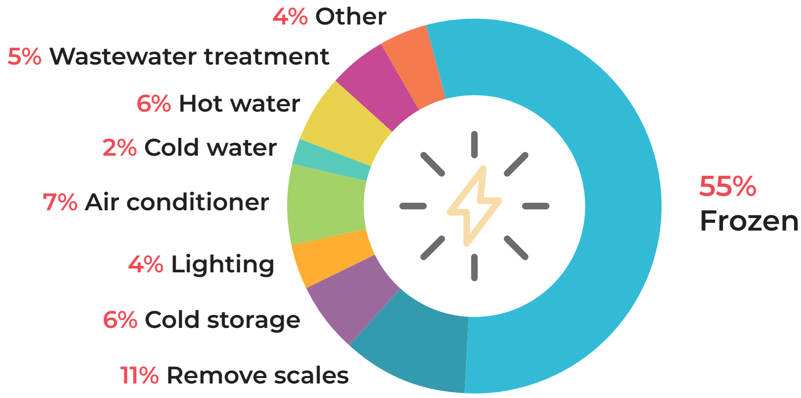


Figure 5. Energy distribution in frozen pangasius processing plants (Data source: project SUPA–VNCPC)

Pangasius by-products plants: The electrical energy used in the pangasius by-product processing plants includes electricity and heat (from boilers). Since the plants use the same raw material to produce many different products, and there is no electrical meter for each production stage, it is not possible to allocate energy consumption for each type of product. The energy consumption must be calculated according to the input material instead. Energy consumption per ton of raw materials is given in Table 4.

Table 4. Energy consumption – Pangasius by-products plants

Energy	Unit	Average consumption
Electricity	kWh/ton of raw material	34–42
Heat	MJ/ton of raw material	3,192–3,878

Data source: VNCPC-SUPA, 2013

4.2.3 Water consumption

Frozen pangasius fillet processing plants. These installations use large quantities of water, normally about 500–2,000 m^3/day. The water source for the plants is usually river or well water treated for use in the fillet production process. Such water sourced from rivers and underground sources is significantly cheaper than water drawn from the industrial park supply. Thus, only a few plants located in the industrial zone use water purchased from the infrastructure supply company.

Consumption in the plants includes water used for:

- evaporation of the cooling tower (with small-capacity refrigeration system-cooling tower-condensers) or condenser (with large capacity refrigeration system-condenser);
- processing to wash raw materials, semi-products and/or products, and to clean the plants as well as processing tools (knives, baskets etc.);
- watering plants in and on the plant premises;
- Personal/bathroom use by plants workers.

Plant water consumption depends on (i) the technological process; (ii) the type of input materials (fresh fish or frozen products from other plants); (iii) the level of interest in maintaining the company's water system; (iv) the practical skills of processing workers; (v) workers' impression of saving water; and (vi) RECP measures implemented during production processes. Water consumption as m^3 per ton of product is given in Table 5.

Table 5. Water consumption in fillet processing plants

Water consumption	Unit	Average consumption
Water	m^3/ton of frozen fillet products	15–50

Data source: VNCPC-SUPA, 2013

Pangasius by-product processing plants. The pangasius by-product processing plants consume less water, including use for:

- processing, mainly for cleaning the plants, machinery and equipment and boiler feed water;
- drinking water and other personal use by plant workers;
- watering plants on plant premises.

Water consumption per ton of raw materials is given in Table 6.

Table 6. Water consumption in by-product plants

Water consumption	Unit	Average consumption
Water	m^3/ton of raw materials	0.13-0.14

Data source: VNCPC-SUPA, 2013

4.2.4 Chemical consumption

Pangasius processing plants use very few chemicals, just chlorine disinfectants and detergents (soap) for production tools. LPG is used for workers' cooking needs. Depending on the geographical location of the plants, rodenticides and insecticides may be used to control local pests.

In the frozen pangasius fillet processing plants, the refrigeration system uses NH3 (ammonia) or R22 chemicals (freon) as the refrigerant (note: pangasius by-product processing plants do not have refrigeration systems). Depending on their properties, these substances can cause various human health issues (such as skin rashes or allergies) as well as physical effects such as fire, explosion, and emission of toxic gas. Improper storage and control and use of these substances can lead to environmental and health consequences.

4.3 Environmental issues

4.3.1 Wastewater

Frozen pangasius fillet processing plants use large volumes of water, so they also discharge a large volume of wastewater. Wastewater from frozen pangasius fillet processing plants comes from three sources.

- Wastewater from production auxiliary systems (e.g. cooling towers, condensers): condensers or cooling towers use circulating water to cool the condensed gas into a liquid. During the cooling process, the water will continuously evaporate, causing the dissolved solids in the circulating water to become concentrated, and when the dissolved solids become saturated, it creates deposits on the heat transfer pipes, causing serious damage and high energy loss. Therefore, the cooling water must be disposed of periodically. This type of wastewater is very hard because it contains calcium, magnesium and silicon, in addition to high levels of sludge and micro-organisms (slime).
- Bathroom/personal use wastewater: wastewater from workers' toilets includes organic pollutants such as faeces, urine, pathogenic viruses and suspended sediment, of which the main pollutant components are BOD5 (biological oxygen demand over 5 days), COD (chemical oxygen demand), nitrogen and phosphorus. Wastewater from the kitchen area for workers' cooking includes pollutants with high levels mainly of grease, food particles and organic waste.
- Production wastewater: including water for washing raw materials (fish and fish by-products) and semi-finished products; water for cleaning the plants, equipment and processing tools; and melted ice. Wastewater from the production process contains high amounts of fish blood, organic matter, suspended solids, fish crumbs and fish oil: pH = 6.5–7.0, SS = 500-1,200 mg/L, BOD5 = 500–1,500 mg/L; COD = 800–2,500 mg/L, total nitrogen = 100–300 mg/L, total phosphorus = 50–100 mg/L, total lipid = 250–830 mg/L. With such a high content of protein and nutrients, wastewater often has a foul odour (due to the decomposition of amino acids and proteins) and is a favourable milieu for microorganisms to grow and cause disease from rotting aquatic carcasses, which can affect the quality of the receiving water. In addition, if waste is accumulated, it can cause eutrophication in surrounding ponds and lakes.

4.3.2 Emissions

Emissions in the frozen pangasius fillet processing plants are the smell of raw materials, semi-products, disinfecting chlorine, and possibly the odour of NH3 leaking from the cooling/freezing machinery in the workshop along with scrap smells from the solid-waste storage area. Leaking NH3 odours from the refrigeration compressor may occur if the plants use piston refrigerant compressors. In plants processing pangasius by-products, the exhaust gas carries a strong odour from pangasius waste (from the collection area of input materials at the plants). The pangasius by-product processing plants always have a boiler burning coal, fuel oil, or biomass, so there are boiler exhaust gases (from the production auxiliary area). In the plants, there is a drying oven, which also creates high odour and dust that pollute the working environment.

Emissions of high odour pollution, in polluting the surrounding environment, cause workers to tire easily, reduce work efficiency, and often provoke occupational diseases such as joint disease and calf and/or ankle swelling.

4.3.3 Solid waste

Solid waste from frozen pangasius fillet processing plants is composed of heads, bones, skin and offal. These are organic substances with high protein, calcium and phosphorus content, which ferment, decay, and decompose quickly under hot and humid weather conditions. If not properly collected and transported to the pangasius by-product processing plants according to the correct process, the decomposition of organic matter in this solid waste will cause very unpleasant odours and air pollution.

4.4 The potential of introducing Resource Efficiency and Cleaner Production (RECP)

4.4.1 Water saving

Freshwater is a limited and overexploited resource. Saving water will contribute to environmental protection and reduce production costs.

As described in section 4.2.3 above, water is used for four purposes: cooling water for refrigeration systems, personal-use water, production water, and for watering green plants. As most water sources are river and well water, and thus either not paid for or costing very little, frozen pangasius processing plants tend to use it very wastefully. Experience has shown that 10–30% of water use can be saved if water-saving measures are applied in the plants. The potential for water saving in the frozen pangasius fillet processing plants is thus very significant.

Solutions to save water include the following measures:

- Improve water system maintenance by
  - detecting and immediately repairing underground burst water pipes,
  - avoiding overflow or puncture of the condenser water system/cooling tower of the refrigeration system,
  - immediately detecting and repairing leaks/damaged valves in the worker's restrooms.
- Adjust the flow of water used to wash raw materials.
- Carefully fill washbasins so that they are not too full, and avoid overflows when collecting water.
- Use a high-pressure water hose with a locking valve fitted with a nozzle to clean the workshop floor instead of a regular hose and squeezing the mouth of the hose to create spray pressure.
- Turn off the water valve when not in use (e.g. during lunch break).
- Watering plants: use a ø20 plant watering pipe fitted with a sprinkler with a spray volume of 560 litres/hour and a stopcock valve, instead of a ø27 or ø34 pipe with a 3–5 m^3/hour flow.
- Water in the morning or evening to maximize water infiltration into the ground and minimize evaporation. This method can save 30% of water use.
- Adjust the flow valve in the restroom: for hand wash faucets, 5–7 litres/min; for showers: 9–12 litres/min.
- Reuse water whenever possible.

4.4.2 Reduction of material consumption

Improving the quality of input materials and the efficiency of raw materials are important issues to improve the economic efficiency of the production process. The quality of the input materials depends on processing raw materials immediately at the time of harvest, and the time the raw materials must wait to be processed. The rate of fish decay doubles when the temperature is increased by 4 ℃.

Reducing the amount of material used in a product or increasing the yield of a product with a fixed volume of material can be achieved through changes either in technology or in production control and management. For companies in the pangasius industry, reducing the number of raw materials is related to the amount of input fish and ancillary materials (carton packaging, plastic, wrapping wire, etc.) calculated per unit of frozen product. Also, these companies can increase the reuse of waste from the manufacturing process to create useful by-products.

Material consumption can be reduced through internal control and management. Good internal control and management practices generally range from employee education and training to instructions on standard technical operating procedures for product processing, equipment maintenance and material storage. Companies can also improve workers' knowledge of process inputs and outputs including raw materials, chemicals, heat, electricity and water, and product outputs, wastewater, flue gas, sludge, solid waste, and by-products. Workers can often provide suggestions for reduced material consumption if they are consulted.

The main environmental benefits that can be achieved through good internal control and management are savings in production costs due to reduced consumption of raw materials, chemicals, auxiliaries, water, energy, and minimizing solid waste and pollutant load in wastewater and exhaust dust. At the same time, workplace conditions can also be improved.

Employee education and training is an important factor for efficient resource use and environmental management. All employees should clearly understand the precautions necessary to avoid waste of resources and pollution.

Senior management should have a clearly expressed commitment to environmental improvement, preferably in the form of an environmental policy and implementation strategy that is made available to all employees.

Technological improvement needs to accompany good sanitation and environmental management. Good management of potentially polluting processes requires the implementation of many elements of an Environmental Management System (EMS). The implementation of a monitoring system for input and output processes is a prerequisite for identifying priority areas and options for improving environmental performance.

4.4.3 Reduction of pollutant load discharged

Frozen pangasius fillet processing plants produce a large amount of wastewater and a very high pollutant load. The main wastewater is production wastewater (about 15–50 m^3/ton of frozen products), because the processing process uses large quantities of washing water. In addition, personal wastewater is also significant because the plant employs many workers (each plant has 1,000–4,000 workers, and each worker discharges an average of 100 litres of personal/bathroom wastewater per day).

A large amount of wastewater and high pollutant load often overloads wastewater treatment systems and pollutes the environment. Wastewater treatment costs will be significantly reduced if organic waste can be removed from the wastewater before treatment. Applying RECP to the frozen pangasius fillet processing plant involves waste stream pollution reduction, mainly focused on avoiding loss of raw materials and products into the waste stream.

Solutions to reduce solid waste loss into the waste stream

- Use baskets at the worker's worksite to collect solid waste that can be reused as a by-product, instead of washing it down the drain.

- Clean fish by vacuuming and collecting blood and organs in an organ filter instead of discharging them into the sewage system.
- Install filters at manholes in the workshop to limit solids drifting into the waste stream. Install grease 'traps' on the waste stream (if possible).
- Use dry cleaning techniques where possible by scraping, scrubbing equipment before washing, cleaning with an air gun, and cleaning the floor with a rubber broom.
- Separate the liquid waste stream with its high pollutant load and treat it before release into the central conditioning tank of the centralized treatment system.

4.4.4. Reduction of electricity consumption

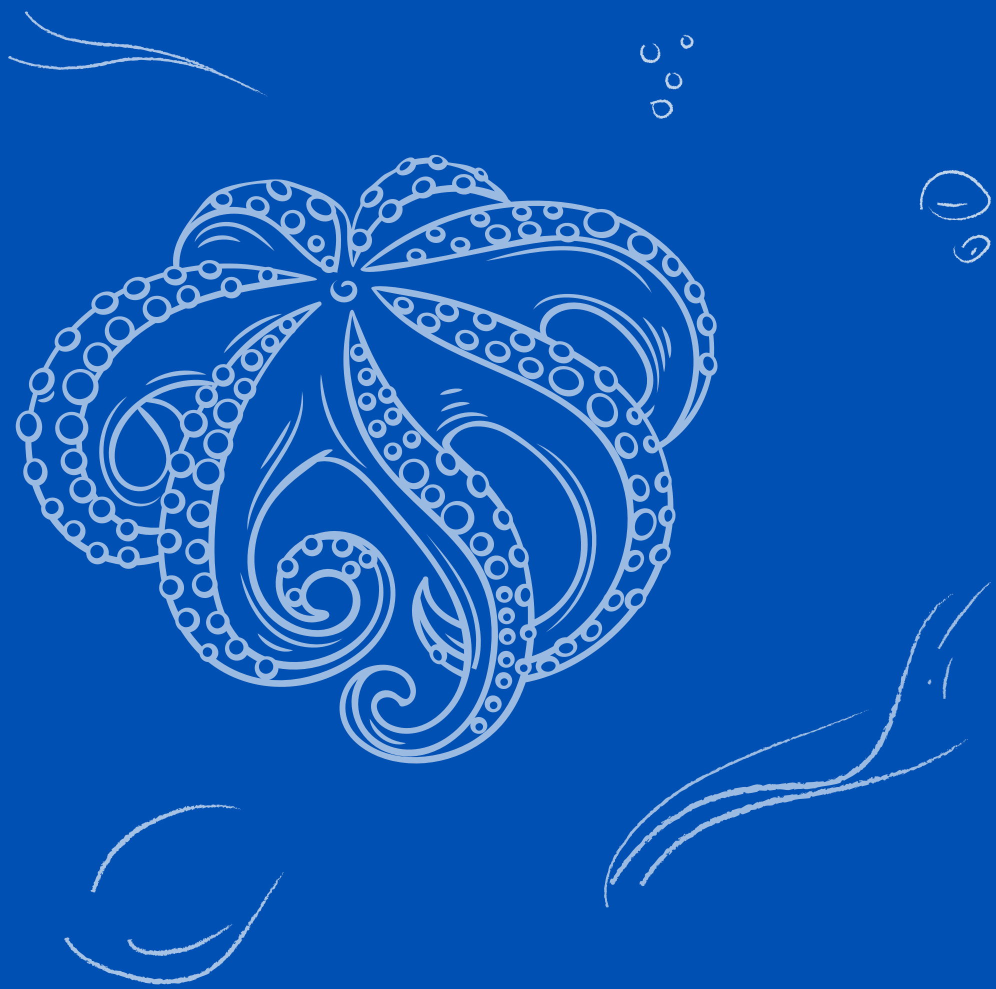
Pangasius processing plants use large amounts of electrical and thermal energy. The power consumption norms of companies fluctuate considerably, thus indicating a very high potential for saving electricity.

Practical experience from pangasius processing plants shows that it is easy to save 5–25% of energy consumption with simple solutions such as:

- Build an ISO 50001 energy management system, energy-saving potential 3–5%.
- Review and select optimal operating procedures, disseminate this knowledge and train staff in the process.
- Perform an energy audit, energy-saving potential 3–5%.
- Perform total productive maintenance (TPM), energy-saving potential 10–20%.
- Apply automatic lubrication, energy-saving potential 7.5%.
- Optimize operations of freezing system, cold storage, refrigeration, air conditioning systems, etc.; and install, maintain and ensure thermal isolation for pipelines, equipment in cooling, ventilation, lighting systems, etc.
- Neatly arrange goods for freezing and preserving to improve the performance of equipment.
- Replace incandescent and fluorescent lamps with LED bulbs; install automatic, smart electrical appliances for automatic switch-off when they are not in use.
- Use rooftop solar energy: the pangasius processing plants are located mostly in the Mekong Delta region with long hours of sunshine, so solar panels are feasible. The amount of electricity generated would only partially be used for production, and the excess could be sold to the grid.

Chapter 05

Sustainable Consumption in Vietnam's Seafood Sector



5. Sustainable Consumption in Vietnam's Seafood Sector

5.1 Sustainable consumption of seafood from export markets

Consumers in the export markets, especially in the EU and the US, are sensitive to media reported images of seafood products. In particular, the image of pangasius from Vietnam has been negatively affected in the EU and the US following damaging media reports and campaigns (VNCPC, 2013). To improve the image of this fish and restore consumer confidence in Vietnamese seafood, sustainable production is becoming a crucial factor, and food safety, animal health, price and quality, traceability, environmental and social sustainability are now very important considerations (VNCPC, 2013). At the same time, retailers in the European markets are utilising certification schemes to guarantee the quality of imported seafood for their consumers. As mentioned in previous sections, incorporating sustainable consumption and production (SCP) should be holistically achieved by ensuring the sustainability of each step in the supply chain and in the production stages. Sustainability of seafood products should be independently certified with traceability, and communicated to consumers through effective communication and marketing campaigns to establish a trustworthy image of Vietnamese seafood. Such efforts are becoming more important to ensure overseas market access in an increasingly competitive global seafood market.

Several studies have shown that certified seafood products could receive a 10–20% price premium. For instance, in the UK, MSC certified haddock products increased 10% price for processors and wholesalers (Sogn-Grundvåg et al., 2014). Moreover, when the Marine Stewardship Council (MSC) certified Vietnam's Ben Tre clam fishery, it increased prices by 30–50% in markets such as the EU and North America (WWF, 2015). On the other hand, a study in three Japanese fish markets showed that MSC certification did not cause any price premium compared to non-certified fish in terms of the direct price paid to fishermen for their catch (Wakamatsu, 2014). The preferences for consumers' willingness to pay for certified products differs. In a study conducted in the UK, consumers preferred labelling that focused on sustainability and the quality of the products (Jaffry et al., 2004). French consumers were willing to pay a maximum 10% price premium for certified products, but such willingness correlates to factors such as income and environmental concerns, and trust concerning certification issues by NGOs (Salladarré et al., 2016). Certification heavily depends on consumers' knowledge of labelling for sustainability, and in Asia, where consumer awareness is low, ecolabeling is still lagging behind (FAO, 2018b). A study conducted in Japan showed that Japanese consumers were willing to pay a 20% premium for certified products, and their willingness to pay increased when the information about ecolabeling was provided (Uchida et al., 2014). Certification by itself is not a panacea for consumer trust and premium prices; it may also require raising consumer awareness along with marketing campaigns.

Although there has been a decline in Vietnamese pangasius sales in the EU and the US, and even though the image in the export markets is mixed, this fish remains a popular choice for consumers. On the one hand, it is considered by consumers to be affordable, mild flavoured, boneless and easy to cook. On the other hand, consumers also have concerns in terms of food safety, quality, social and environmental issues, and animal health and welfare. Moreover, although certification is considered a key factor for quality assurance, existing studies show that consumers are not willing to pay higher prices for certification alone but they are willing to pay additional prices for better quality products (VNCPC, 2013). Because customer knowledge of the criteria for different types of certification remains somewhat limited, certification would only be one of the instruments in an integrated SCP approach for pangasius in the export market. Moreover, pangasius is a price-sensitive product as a 'budget-minded' choice for consumers (VNCPC, 2013), so it poses the additional challenge for producers to bear the cost for certification without increasing the retail prices.

For shrimp, both the EU and the US markets have become increasingly strict in their requirements for imported seafood. In 2020, the EU introduced a regulation to ban ethoxyquin in aquatic feed. According to the regulations by Vietnam's Ministry of Agriculture and Rural Development, the current allowance level of ethoxyquin is relatively higher than other exporting markets, which makes it difficult for producers in Vietnam to control the ethoxyquin residues. In the US, the Seafood Import Monitoring Program (SIMP) for seafood from Vietnam requires the declaration and recording of seafood products in order to prevent illegal, unreported or unregulated seafood products, or faulty products. For shrimp exporting to the US, importers need to obtain an International Seafood License. Such regulations put pressure on Vietnamese seafood producers to increase the traceability and certification of their products to be accepted by the EU markets. For the other major export destinations in Asia, such as China, Japan or South Korea, economic factors in those countries play a key role in the consumer demands for Vietnamese products. Thus, the current COVID situation which has caused an economic downturn in those countries could be an obstacle (VASEP, 2020a).

5.2 Sustainable consumption of seafood by consumers in Vietnam

While aquaculture in Vietnam targets mainly export markets in Europe, the US and East Asia, only 5% of shrimp and 10% of pangasius produced in Vietnam are consumed in the domestic market (Entzian, 2015). The domestic market does however still hold an important role. First, Vietnamese people's dietary habits have substantially changed over the last decades due to economic growth, urbanisation and the introduction of western cultures (Harris et al., 2020; Thi et al., 2015). The drastic reduction in rice consumption (Thi et al., 2015) and a sharp increase in meat, dairy products and sugar-laden food and beverages are notable changes (Hansen, 2018; Nguyen-Anh, Umberger, and Zeng, 2020; Sharma, Nguyen, and Grote, 2018; Ton et al., 2011), followed by a steady rise in seafood consumption (Ton et al., 2011). Vietnamese consumers consume 36.3 kg of seafood per year per person, nearly twice as much as the world average (Xuan, 2021). Additionally, against the backdrop of the tough competition from other seafood-exporting countries, and in light of the disturbance of international demands brought about by the COVID-19 pandemic, the Government of Vietnam aims to increase the domestic consumption of aquaculture products (Nhân Dân, 2020).

However, for further growth of the domestic seafood market, two interrelated issues, namely safety and inclusiveness, must be addressed. Thanks to rapid economic growth, Vietnam is overcoming the food security issue, i.e., food scarcity and malnutrition in the population. In contrast, the food safety issue, namely the health repercussions of food produced and delivered by unreliable actors, has become a significant source of concern (Figuié et al., 2019; Raneri et al., 2019; Wertheim-Heck and Raneri, 2020). Hundreds of food poisoning and contamination cases have been reported by mass media and shared via social media since the early 2000's (My et al., 2021). Chemical inputs to rice and vegetables are the most frequent concern (Ha et al., 2020), although viruses, bacteria and parasites regularly cause more damage (Nguyen-Viet et al., 2017). Anxieties about food derive from the ‘distanciation (distancing)’ of food chains in association with the modernisation and globalisation of the food systems (Figuié et al., 2018). The food safety issue, which is a critical concern for both food producers and consumers in Vietnam, will need time to be resolved. Food safety cannot be guaranteed only by government and food producers’ efforts to take scientific measures for risk mitigation; it should also be accepted within consumers’ socio-economic and psychological contexts.

First, the technical fix for upgrading the value chains, including the food retail outlets introduced by the Government and suppliers, may not fit the consumers’ day-to-day contexts (Figuié et al., 2018). The Government of Vietnam has supported supermarkets’ accelerated expansion in major cities to replace the traditional street markets and vendors so as to modernise retail outlets and improve food safety (Figuié and Moustier, 2009; Maruyama and Trung 2007, 2011). However, even at the time of writing, most citizens in Hanoi or Ho Chi Minh City do not regularly shop in supermarkets. Traditional markets allowed urban families to buy food in the early morning and enjoy communication with neighbours, which were activities that formed an integral part of their daily lives. However, supermarkets are usually located far away and open later, so they discourage similar practices (Wertheim-Heck and Raneri, 2020; Wertheim-Heck, Vellema, and Spaargaren, 2014, 2015). On the other hand, younger nuclear families are more positive about buying from supermarkets (Figuié et al., 2018). It is suggested that stakeholders strengthen support to small-scale retail outlets for more effective safety management and information sharing on food safety issues, given the co-existence of the modern and traditional retail channels for the time being.

Second, Vietnamese consumers place little trust in food safety information provided by the Government or actors in the food chain (Ha, Shakur, and Pham Do, 2020). Many food items are ‘credential goods’ that they cannot evaluate even after consumption and thus they should trust the information provided (Le et al., 2020).[2] It is essential that the information on the quality and safety in the forms of product packages, labels, or certificates be trustworthy. However, Vietnamese consumers do not trust those who provide such information. That said, consumers have different levels of trust, depending on their conditions and information types. For example, a study on certified rice revealed that consumers from higher-income groups tend to prefer certified rice more than do lower-income groups (My et al., 2021). Thus, promoting certified seafood products may not be attractive to all consumer groups although it is generally a desirable direction. Another study on consumers’ choices of certified shrimp products showed that many consumers in Ho Chi Minh City are willing to pay a premium for certified shrimp products, particularly with ASC certification. The same study also showed that individuals who believe consumers can affect the producers’ behaviour are more willing to pay a higher premium (Xuan, 2021). These studies indicate it may not be easy to gain trust among consumers only by promoting certified products. However, it will help to improve the entire system of providing seafood products by providing improved information along with products at affordable prices in accessible shopping places.

Overall, there is no single remedy leading to improved food safety and trust among consumers. All stakeholders should work on these objectives from multiple angles as follows. First, small- and micro-scale retailers in traditional and modern channels should receive more substantial support to improve their safety/hygiene management. The improvement in these smaller retail outlets will complement the continuous efforts of modernising retailers, including the spread of supermarkets (Maruyama and Trung, 2011). Second, further efforts should be made to improve the information provisions on safety and other aspects of certified seafood products (My et al., 2021). Third, public and private actors should disclose the process of upgrading their safety/hygiene management in the entire food systems to the public (Nguyen-Viet et al., 2017). Consumer organisations could play a significant role in these efforts. Due to the separation of food production and consumption (‘farm to fork’), individual consumers are left out of the process of controlling and verifying safety. Thus,

2 In terms of consumers’ trust, all goods are categorised into ‘search goods‘ which consumers can evaluate the quality in advance to purchase; ‘experience goods‘ which they can evaluate the quality when they consume; or ‘credential goods‘ (i.e. warranting credit or confidence) which they cannot evaluate (Le et al., 2020).

they must decide if they trust their usual retailer, or the labels certified by the authorities. Consumer organisations can work with retailers, wholesalers, processors, farmers, and the public sector – in the spirit of the sustainable production and consumption systems encouraged by ‘farm to fork’ initiatives[3] – to build a more inclusive system to control and qualify seafood product safety, in which consumers can play an active role.

3 The EU’s Farm to Fork Strategy aims to accelerate the transition to a sustainable food system that elminates negative environmental impacts, mitigates climate change, reverses biodiversity, ensures food security and access to affordable, nutritious food that generates fair economic return for producers. https://ec.europa.eu/food/horizontal-topics/farm-fork-strategy_en

Chapter

06

Sustainable certification schemes for Vietnam's seafood sector in Vietnam

6. Sustainable certification schemes for Vietnam's seafood sector in Vietnam

6.1 International Standards

Increasing demand for ensuring strict food safety, quality standards for seafood products and improved sustainability in seafood export activities (specifically related to the shrimp and pangasius export industries) have placed enormous pressure on market participants, which has consequently required the Government of Vietnam to adopt its own domestic as well as international standards and certification schemes, especially for export-oriented seafood products like these two seafood products. Domestic and international standards, which influence different stages of the shrimp and pangasius production process in Vietnam are described in Tables 7 and 8. According to Nguyen et al. (2019), Vietnamese pangasius and shrimp have been subjected to a series of strict food safety standards established in the EU and United States related to all stages of the supply chain. Commonly applied standards include: (i) Global Good Agricultural Practices (Global GAP), (ii) Best Aquaculture Practices (BAP), (iii) Safe Quality Food (SQF), and (iv) the Aquaculture Stewardship Council (ASC). To improve and strengthen the adoption of elements of all these standards and certification requirements, the Government of Vietnam has established and adopted the Vietnam Good Agricultural Practices (VietGAP) and developed a Strategy for Sustainable Development of the Fisheries Sector, which provides guidance on the application of VietGAP standards for shrimp and pangasius.

Table 7. Example of various standards influencing different stages of the shrimp production process in Vietnam (Source: Nguyen et al., 2019)

Specific Targets	General Product Certification	Standards	Production System Certification	Processing Certification	Product Certification
Farming	ASC, GLOBAL GAP, BAP, VietGAP	GLOBAL GAP, BAP, VietGAP	GLOBAL GAP, BAP, VietGAP	GLOBAL GAP, BAP, VietGAP	HACCP, GLOBAL GAP, BAP, VietGAP
Chemicals	ASC, GLOBAL GAP, BAP, VietGAP	GLOBAL GAP, BAP, VietGAP	GLOBAL GAP, BAP, VietGAP	GLOBAL GAP, BAP, VietGAP	HACCP, GLOBAL GAP, BAP, VietGAP

Specific Targets	General Product Certification	Standards	Production System Certification	Processing Certification	Product Certification
Environment	ASC, GLOBAL GAP, VietGAP, BAC ASC	GLOBAL GAP, BAP, VietGAP	GLOBAL GAP, BAP, VietGAP	GLOBAL GAP, BAP, VietGAP	HACCP, GLOBAL GAP, BAP, VietGAP
Social	ASC, GLOBAL GAP, BAP	GLOBAL GAP, BAP, VietGAP	GLOBAL GAP, BAP, VietGAP	GLOBAL GAP, BAP, VietGAP	HACCP, GLOBAL GAP, BAP, VietGAP

Table 8. Examples of various standards and certification schemes commonly applied in the Vietnamese pangasius sector (Trifković, 2014)

Standard	Scope and certifier
(a) Standards applied at the farm level	
GlobalGAP	An internationally recognized set of farm standards dedicated to Good Agricultural Practices (GAP)
SQF 1000	Safe Quality Food Program for safety and quality management developed by the SQF Institute, and recognised by Global Food Safety Initiative (GFSI)
ASC	Aquaculture Stewardship Council standard for sustainable aquaculture developed through Pangasius Aquaculture Dialogues by WWF (World Wildlife Fund) and IDH (Dutch Sustainable Trade Initiative)
BAP	Best Aquaculture Practices standard for environmental and social responsibility, animal welfare, food safety and traceability – developed by the Aquaculture Certification Council
(b) Standards for processing companies	
HACCP	Hazard Analysis and Critical Control Points is a risk management tool that ensures product safety from biological, chemical and physical hazards – Application guidance by International HACCP Alliance and the Codex Alimentarius Commission
BRC	Global Standard for Food Safety assuring Safety and quality management – Developed by British Retail Consortium, a UK trade organisation that represents retailers' interests
SQF 2000	Safe Quality Food Program for safety and quality management developed by SQF Institute, recognised by Global Food Safety Initiative (GFSI)
ISO 9001	Quality Management System developed by International Organisation for Standardisation (ISO)
IFS	International Food Standard for safety and quality management developed by European retailers mostly from Germany and France
ISO 14001	ISO Standard for environmental management
ISO 17025	ISO Standard for the competence of testing and calibration laboratories

Standard	Scope and certifier
Halal	Practices permitted under the Islamic Law – Religious bodies in each market carry out oversight without international consensus
ISO 22000	ISO Standard for food safety management

6.2 Challenges for eco-certification

Although certification does not guarantee increased market access and a price premium for seafood products, it is an important risk management mechanism in response to emerging regulations in the export markets. Especially in the EU and the US markets, the increased requirements for quality control and traceability in the supply chain certification scheme helps to clear market access barriers, even though recognition at the consumer levels is not guaranteed. At the global level, only 14.2% of the total seafood production is ecolabel certified, of which 20% is for aquaculture production (FAO, 2014). At the same time, certification poses numerous challenges for seafood producers, especially the smaller scale producers in terms of cost and data availability. Ecolabeling can thus be a barrier for entry by producers from developing countries into the global market, when capacity building and funding support is not in place (FAO, 2014).

The cost for certification differs depending on the issuing organizations. The cost of certification from the Marine Stewardship Council ranges from USD 2,000–20,000 for pre-assessment, and another USD 10,000–500,000 for full assessment and certification (FAO, 2018b). The average cost from Friend of the Sea is USD 5,800 to certify a wild fishery and USD 3,500 for aquaculture. The cost is normally covered by the seafood producers for pre-assessment and periodic re-assessment (Macfadyen and Huntington, 2007). After producers obtain certification, they need to go through annual audits and make improvements in the production process and be re-assessed periodically (Peacey, 2001). Due to the cost barrier particularly for small-scale producers, government funding support is an important resource (FAO, 2018b).

In addition to the cost constraint, there are critiques that ecolabeling favours developed economies and industrialised seafood supply chains (FAO, 2018b). In developed economies, certification is led by large multinational corporations such as Walmart and Unilever, which is unrealistic for the small-scale retailers in Asia and other developing countries to follow. Another key barrier is data availability for the assessment in the certification process. Most developed economies with established supply chain data have the technical knowledge to carry out the data collection and management processes required (Gutiérrez et al., 2012), which poses another challenge for producers in developing economies, and especially for medium- and small-scale producers. Moreover, certification mostly serves the export market interests rather than the domestic consumers' needs (FAO, 2018b). Thus, eco-certification could marginalise small-scale producers in accessing the global market (Ponte, 2020).

In Vietnam the Government has made several efforts with the industry to increase certification of seafood products. The Directorate of Fisheries developed the Vietnam Good Agricultural Practices (VietGAP) to help Vietnamese aquaculture farmers meet international production and certification standards. VietGAP developed standards for seafood exports which encompass international standards and allow producers to prepare for certification of international standards bodies (VASEP, 2018). Nevertheless, increased international standards have created additional burdens for seafood producers in Vietnam, especially small-scale aquaculture farmers who face additional barriers to investment in the equipment and knowledge required to meet these standards (Tran et al., 2013). One approach is to help small-scale producers to horizontally and vertically integrate, thus reducing the transitional cost of meeting the standards (Bijman et al., 2010). Among Pangasius spp. farmers who have not yet followed VietGAP's standards, 70% have looked at the standards and thought they were difficult to follow, 26.7% said they had heard about the standards but thought them too difficult to follow, and 3.3% said they had never heard of the standards (Nguyen and Jolly, 2020). The major difficulties raised are the lack of infrastructure (76.3%), capital constraints (8.5%), complicated culture techniques (1.7%) and satisfaction with their current culture methods (6.8%) (Nguyen and Jolly, 2020).

6.3 Case studies on certification for pangasius, shrimp, and tuna in Vietnam

In this section, the results of interviews with 3 companies proactively applying for labelling schemes are provided. The cases illustrate the drivers for the companies to apply for the labelling schemes, changes in their production process and investments to meet the standards, and the available and desirable support from national and international partners to promote their application.

Case 1: A Global-scale Pangasius Exporter

The company has over 23 years of business operation and now is one of the top five pangasius exporters in the world. Half of its pangasius sales are to the U.S., 25% to U.K. and China, and the rest is for other traditional markets such as Belgium, Switzerland, Canada, and Australia.

Its holistic approach with products starts from sourcing raw materials from their supply chain, continues through production, and finally ends with value-added services. Most of the facilities are certified with ISO 9001 Quality Management System, ISO 22000 Food Safety Management System, ISO 17025 General Requirements for the Competence of Testing and Calibration Laboratories, Good Manufacturing Practice (GMP), Hazard Analysis and Critical Control Points (HACCP), Aquaculture Stewardship Council (ASC), four-star Best Aquaculture Practices (BAP) – the highest certification level under BAP, Global Good Agricultural Practices (GlobalGAP), International Featured Standards (IFS) certifications and ISO 14001 Environmental Management System. All farms have been certified by ASC/ GlobalGAP/BAP. More than 17 years ago, when participating in the farming field, the company oriented to build farming areas that aligned with the sustainable development certifications.

The company applies for these labelling/certification schemes taking account of the market demands. For example, BAP is required by the North American market, ASC and GlobalGAP are needed mainly by the E.U. While each market has different certification requirements, the farming area has to apply for two to three certification programmes, pushing up the production costs, and knowing that customers do not accept correspondingly high prices.

The company has responded to the market request for certification in more than just a passive manner. It created the first international pangasius certification programme in 2008, the Green Farm programme, which covers guidelines on environmental protection, caring for social communities, and ensuring food safety and traceability. The programme provided a technical basis for the company to apply for other international schemes. It also determined the company's orientation for sustainable development. Today it has a mission to guide the path of sustainable development through continuous improvement of production processes, product quality, and company operations to ensure environmental friendliness.

Having such a mission to guide sustainable development through sustainable production, the company has made substantial improvements in the production processes and continues to improve the sustainability of its value chains. Environmental protection, food safety and traceability have been improved over the years. Relationships with local communities were also improved to follow the standards of ASC. The company often organizes and participates in meetings with the community to understand the aspirations of local authorities and people, helping to improve the relationship with local authorities and people and resulting in more timely responses to any concerns.

These actions to meet certification standards pushed up production costs by 5 to 15%. This resulted in increased prices for its products, but until now the certification schemes have granted the company competitive advantages and selling points in the global market. The company has secured technical support from the Sustainable Pangasius (SUPA) project under the SWITCH-Asia grant programme in applying for the ASC. Further support would be desirable, however, such as financial support to help cover certification fees, training for standards, consultations, and marketing support. It hopes more and more fish farmers will apply for the standards, as together they can create a good brand of Vietnamese premium pangasius on the international market. While all aquaculture producers share the same natural resources, they should aim for the same direction of sustainable development.

Case 2: A Shrimp Exporter

In this case, the company sells more than 5,000 tons annually of shrimp to international markets, including the EU, Asia, North America and Australia. It has obtained ASC certification for the farming area, and the Business Social Compliance Initiative (BSCI), ASC Chain of Custody (CoC) certification for the plants to meet the market demand in these countries. Application for these certification schemes encouraged the company to make substantial changes in its production processes. In the farming area, aquaculture farms were improved and a specialized division was established. The company invested in the upgrading of household farms to meet the ASC's requirements, and 50% of the seed costs were invested for households. Plant infrastructure was also upgraded. For example, fire prevention systems and labour safety systems were updated; more equipment for labour protection was purchased; and insurance premiums for employees were improved. Moreover, the company provides funds for emulation, reward, productivity, and team building.

So far, their product prices do not reflect the cost of upgrading farms and plants to apply for the certifications. However, the application of the certificates certainly improved the opportunities to access international markets.

The company has secured support from the Shrimp Chain Project – SusV, ICAFIS, and the GRAISEA project. They supported (i) hiring a consultant to complete environmental and social upgrading in the farming area; (ii) hiring another consultant for the gap assessment for the plant; (iii) provided capacity building training for the staff members; and (iv) supported the evaluation system of the employees' satisfaction. The company hopes international organizations can continue such support for applying and maintaining certifications. They could also help the industry by sharing good practices and providing continuous training to develop farmers' capacities and awareness. In the meantime, the company also hopes the government will adjust some requirements on aquaculture farming areas to be more suited to the reality in which individuals, and not companies, often own the large farming areas.

Case 3: A Tuna Exporter

This company produces and sells tuna products to the international market. It has obtained various types of certifications: Marine Stewardship Council (MSC); Fisheries Improvement Projects (FIP) code; Dolphin Safe; British Retail Consortium (BRC); International Food Standard for safety (IFS); HACCP; Kosher; Halal; BSCI; and the Sedex Members Ethical Trade Audit (SMETA), to meet the requirements of customers and the international markets. These certification schemes help the company meet stringent market requirements on product quality, protection of marine ecological environment, and social responsibility, thus providing more opportunities to export its products to international markets.

Application to these schemes prompted the company to invest in changing its production processes, such as repairing and upgrading plants and production lines, modifying the workshop layout, and enabling proper production arrangement. Training and guidance for workers in distinguishing the types of materials, products and packages corresponding to each type of certification (e.g. MSC, FIP, Dolphin Safe) were also necessary.

The actions to keeping various certifications cost the company about USD 15,000 a year. However, the certificates are worth the cost since the labelling schemes contribute to improved product sales. Because they meet the requirements of importing markets, the product is more likely to be bought by customers, and the possibility of returning to purchase the same product will be higher. This would seem to suggest that other seafood producers should apply for labelling schemes, as the end result is positive in terms of sales. In their view, financial support from the Government combined with regular and adequate information by association organizations can be instrumental to help increase the number of seafood producers apply for labelling.

Chapter

07

Recommended Actions

7. Recommended Actions

The preceding analysis has demonstrated the central role of the seafood sector for Vietnam's economy. A critical part of further development of the sector will be ensuring that growth is sustainable, taking into consideration resource use, local and global environmental consequences, and implications for society and human health. Such development will ensure that the seafood sector in Vietnam remains viable not only domestically in terms of sustainably managed habitats, processing facilities, and good working conditions and compensation for workers, but also internationally as access to Western markets increasingly relies on adherence to internationally accepted standards of production, environmental stewardship, and labour practices.

The authors acknowledge that further research is needed to refine a set of recommendations for government agencies that cover the role of such agencies in regulating seafood sector activities. These recommendations would cover the range of activities undertaken by such agencies in their role of managing the market to achieve resource efficiency and enhanced profitability, including policy incentives in fisheries, development of sustainable supply chains, production segment coordination, and processing.

The following sections outline a set of actions that can be taken by four key groups of stakeholders to further strengthen the sustainability of Vietnam's seafood sector.

7.1 Policymakers

Climate change adaptation – climate change threatens the seafood sector in multiple ways (e.g. sea-level rise, saline intrusion, water scarcity, increased extreme weather events, storm surges, increasing water temperatures). The development of aquaculture in vulnerable areas like the Mekong Delta and along the coastline exposes aquaculture farmers to increasing climate change risks and exacerbates existing risks such as price volatility, export market regulations, and overseas competition.

Recommendation 1: Conduct an extensive awareness-raising campaign backed by scientific evidence of the current and future impacts of climate change to make aquaculture farmers aware not only of the climate change risks but also of the options available for responding to those risks.

Recommendation 2: Based on detailed evidence of which areas are likely to suffer from the impacts of climate change first, offer a package of financial incentives (such as low-cost loans) that would enable aquaculture farmers to relocate, invest in climate change adaptation measures, or leave the industry.

Environmental controls – Globally, the seafood sector is under pressure due to perceived poor environmental management of the industry, both for the wild capture and aquaculture sectors. For Vietnam's seafood export markets, improved environmental control is vital to maintaining and growing the support of importing countries. All aspects of the seafood supply chain would benefit from improved environmental management and strong national enforcement of laws, regulations and standards.

Recommendation 1: Conduct a nation-wide audit of environmental control issues in the seafood sector and publish the results to (i) provide the basis for major reforms that would involve the revision of regulations, standards and enforcement mechanisms; and (ii) provide the evidence to give confidence to importing countries that Vietnam is serious about improving the environmental management of the seafood sector.

Recommendation 2: Create a database about the seafood supply chain environmental control efforts through partnerships among government, research institutions and the industry to monitor and evaluate negative environmental consequences and the effects of increased control measures.

Recommendation 3: Targeted environmental protection and SCP awareness raising should be implemented in aquaculture farming and processing facilities, including awareness raising focused on regulations and requirements from expert markets.

Misinformation - Widespread misinformation on seafood products sold in supermarkets and restaurants in both domestic and export markets has created distrust for the entire industry. Often, the seafood being sold is not labelled as the correct species that consumers believe they are buying, and substituting cheaper or less desirable species is common practice in the industry – undermining consumer trust in products.

Recommendation 1: Enforcement of DNA testing of seafood to ensure that seafood species are labelled correctly by producers, use of blockchain for controlling the chain of command through the entire supply chain, and campaigns to build the trust by retailers towards consumers.

7.2 Seafood Production Industry

Quality control – The quality of the products because of antibiotics and synthetic chemicals in the aquaculture production stage of the seafood sector has become a major issue in the export market. Currently, small-scale farmers are mostly excluded from the exporting market as they are often unaware of the implications of using antibiotics and chemicals. Feed suppliers might be more aware but may still use banned antioxidants if they are cheaper than the alternatives.

Recommendation 1: Seafood associations and large-scale producers should provide support to the smaller-scale farmers to introduce sustainable aquaculture practices and production controls.

Recommendation 2: Seafood associations can start awareness-raising campaigns targeting enterprises to inform them of the economic and environmental benefits of introducing sustainable production in the aquaculture and manufacturing process (i.e. better price and resource-saving benefits).

Recommendation 3: State agencies are recommended to support and provide sufficient information on technical barriers and regulations on fishery products, which enables Vietnamese enterprises to be fully aware of market requirements from importers

Tracking requirement – The Government has increased requirements for the tracking of wild catches for the regulation of overfishing, which has become a barrier to compliance for small-scale fishers.

Recommendation 1: Develop vertical integration to allow large scale enterprises to help the smaller ones to improve the traceability of their products.

Recommendation 2: Form cooperatives among smaller-scale enterprises so they can jointly invest in better technology.

Waste in the wild capture – Large quantities of seafood are abandoned or discarded during the capture stage of wild seafood fishing. Unwanted or non-targeted species caught in the nets are simply thrown overboard (which leaves them to die in the ocean). Some products like shark fin kill at least 100 million animals every year, as the fins are cut off and the bodies, alive or dead, are thrown overboard.

<u>Recommendation 1</u>: Redesign the capture equipment and techniques to allow smaller seafood species to escape during the capture process.

<u>Recommendation 2</u>: Require surveillance cameras on board fishing vessels to prevent illegal and unregulated capture of endangered or protected species.

Negative product images – Due to adverse media reporting on the safety of the seafood products in Vietnam, consumers in both export and domestic markets have developed negative perceptions about Vietnamese seafood products, which they refuse to purchase.

<u>Recommendation 1</u>: Create seafood export associations (in addition to VASEP) to launch communications campaigns targeting the export markets, especially in the EU and US, and domestically to improve consumer confidence concerning the safety and quality of Vietnamese seafood.

<u>Recommendation 2</u>: Seafood farmers can apply for certification schemes that are applicable in the export market as proof for the quality guarantee of their products according to international standards. Seafood associations in Vietnam can share the information about the new regulations and standards imposed by major export markets to help the industry to respond quickly.

7.3 Retailers

Lack of consumer trust – In the supermarkets, consumers still show low trust in the quality of seafood products from Vietnam in both export and domestic markets. As global competition for seafood supplies increases, Vietnam stands to lose its market share unless consumer trust is restored.

<u>Recommendation 1</u>: Retailers can use their power in the supply chain to source sustainably produced seafood by requiring farmers and producers to introduce sustainable production practices.

<u>Recommendation 2</u>: Seafood associations, supermarkets and restaurants can launch consumer campaigns about the health, economic and environmental benefits to domestic consumers.

<u>Recommendation 3</u>: Seafood associations and supermarkets can develop a website to share the information on ‘eco-seafood’ products.

Plastic packaging – Currently there is excessive use of plastic materials in the packaging process in supermarkets, and the current packaging is not adequate for longer shelf life, which is leading to excessive food waste.

<u>Recommendation 1</u>: Seafood manufacturers can introduce environmentally friendly technology such as modified atmosphere packaging. This could also help to reduce food waste and restore consumer confidence in the products.

7.4 Consumption outlets and consumers

Food waste at consumption stage – Due to modern eating habits and consumption pattern changes domestically towards mass consumption, waste generation at 'all you can eat buffet' and tourism centres are increasing.

Recommendation 1: Restaurants can launch information campaigns to raise or improve consumer awareness on seafood waste to build trust and customer loyalty.

Recommendation 2: Local government can introduce a certification to allow hotels and restaurants to let customers to take home leftover food and to involve consumers through campaigns, especially in tourism centres.

Recommendation 3: Increase the dishes and products to use all parts of the seafood by retailers and restaurants, especially in tourism centres, and to reuse and recycle seafood waste properly.

Annex 1

Sustainability in other stages of the seafood value chain

Sustainability in other stages of the seafood value chain

1.1. Introduction

Vietnam's Fishery Development Strategy to 2030, with a Vision to 2045[4] has set a seafood production target of 9.8 million tonnes (aquaculture 7 million tonnes, capture fishery 2.8 million tonnes) by 2030 (VASEP, 2021a). Export value will reach USD 14–16 billion annually, creating jobs for 3.5 million workers. By 2045, Vietnam will be one of the top 3 seafood producing and exporting countries in the world.

In 2019, seafood exports from Vietnam reached USD 8.6 billion, 20.8% of the agricultural exports. Currently shrimp and *Pangasius* spp., most of which are farmed, make up most of the seafood export market (USD 3.37 billion and USD 2.0 billion respectively in 2019) (VASEP, 2020a).

1.2. Harvesting and fishing of seafood species

1.2.1. Shrimp

From 2015–2019, the shrimp farming area increased by 1.4% per annum, while production rose by 5.7% annually, supporting an export market worth more than USD 3.8 billion (VASEP, 2020c). As of 2019, there were more than 700,000 ha of brackish water shrimp ponds in Vietnam producing 762,000 tonnes annually, mostly of whiteleg (Penaeus vannamei) and black tiger shrimp (*Penaeus monodon*) species. The giant freshwater prawn (*Macrobrachium rosenbergii*) is grown mainly in the rice fields and consumed domestically. Marine shrimp exports in 2019 were USD 318 million, making up 8.4–9.4% of total shrimp exports.

Brackish water shrimp production is concentrated in the Mekong Delta (80–83%), with smaller volumes in the North Central and Central regions and the Red River Delta. The Mekong Delta has warmer year-round temperatures, so farmers can produce 2 crops annually, while the north has cooler temperatures from November to March, allowing only one crop annually.

In 2019, there were 2,362 registered producers (1,750 for black tiger shrimp and 612 for whiteleg shrimp). Brood stock is mainly imported from the US, Singapore and Thailand.

Dense production conditions, increasing temperatures and salinity (due to reduced upstream flows and sea level rise) have made the shrimp ponds more susceptible to infections such as bacterial spore disease, triggering the use of antibiotics. Whiteleg shrimp tend to be faster growing and more

4 http://asemconnectvietnam.gov.vn/default.aspx?ZID1=14&ID8=113916&ID1=2

resilient to changes in growing conditions, and they show higher disease resistance. Extensive efforts are being made to control antibiotic contamination of shrimp products in the export market. The antioxidant ethoxyquin, which used to be an important ingredient of shrimp food, has been banned or limited in shrimp in most developed country markets starting with Japan in 2012.

The shrimp industry is guided by the National Plan on the Development of Vietnam's Shrimp Industry until 2025 and the Master Plan for the Development of Vietnam's Brackish Shrimp Industry to 2030. When farmers switched to shrimp production 15–20 years ago, the typical practice was to remove the coastal mangroves, line ponds with plastic or tarpaulins, and pump out groundwater to fill the ponds. Wild-caught gravid females provided the brood stock. Wastewater after each harvest was dumped into the nearest waterway from where it could be pumped and used by other farmers, thus concentrating contamination, which included chemicals to reduce organic matter in the water, flocculants for water clarity and antibiotics for disease control (some of which were banned but continued to be used). There is no question that this early development of the shrimp aquaculture wrecked enormous environmental damage.

The industry is also being perturbed by external environmental events over which they have little control, including reduced upstream flow, severely restricted sediment deposition, sand mining, and sea level rise driving saline water far into the interior reaches of the delta. Tidal levels in the delta are increasing by 2 cm/yr, and salinity in the channels is increasing by 0.2–0.5 PSU/yr, largely due to 2–3 metre incisions in the riverbed level due to sediment starvation from upstream and sand mining downstream (Eslami et al., 2019).

Some improvements to these practices and environmental concerns are being trialled in Vietnam. The IUCN's Mangroves and Markets project, started in 2013, trained farmers in raising shrimp in mangrove-forested waterways. These 'eco-shrimp' are produced at half the cost of intensive shrimp farms, but provide only a quarter of the yield, partly offset by a price premium and organic certification by the German Naturland certification body.

At the other end of the scale, the Vietnam-Australia Joint Stock Company (JSC) is trialling super-intensive production under greenhouse conditions and producing 300 tonnes/ha of shrimp annually, which is 10–15 times standard production levels (Chin, 2018).

1.2.2. Pangasius spp.

From 2015–2019, pangasius (*Pangasius bocourti* and *Pangasianodon hypophthalmus*) accounted for 21–25% of the total seafood export value, with record revenues of $2.26 billion in 2018. Pangasius is farmed mainly in the Mekong Delta, reaching 6,600 ha total area of aquaculture and producing 1.58 million tonnes in 2019 (VASEP, 2020b). There are 200 pangasius breeding facilities with 3,000 ha of nursing fish, producing 21 billion fry and 2.1 billion fingerlings. In 2020, all the 60,000 individual brood stock was expected to be replaced. As for shrimp, saltwater intrusion into the Mekong Delta is an emerging constraint on expansion of pangasius farming.

When pangasius production accelerated in Vietnam in the 1990s, individual farmers raised the fish in a variety of cages and ponds. As larger enterprises entered the business, the farming method moved to ponds and the use of industrial pelleted feed, and there was a species shift as well from *Pangasius bocourti* to *Pangasianodon hypophthalmus*, and a trend towards vertical integration (with their own feed mills, grow-out farms, and processing plants) (Seafood TIP, 2021). While the early stages of the industry undoubtedly caused environmental damage, the key stakeholders have since been implementing improvements across the supply chain (Bosma, Hanh & Potting, 2009). Most of the farms now have environmental certification (ASC, GlobalGAP, BAP and Naturland) and well-managed operations.

Nevertheless, Thi et al. (2018) state that most pangasius farmers still discharge organic and nutrient-laden wastewater directly into waterways linked to the Mekong River, causing eutrophication (Thi et al., 2018). The use of polluted water contributes to diseased fish, which in turn triggers the use of antibiotics and chemicals. The high organic load of the wastewater is due to excessive feed, which also results in a high sludge load at the bottom of the ponds. As feed is the main production cost, pangasius farmers could improve revenues by optimising the feed supply and thus improving water quality and reducing sludge discharge costs. In areas affected by saline intrusion, farmers must limit their stocking frequency to once a year and thus face reduced annual yields.

The effect of climate change on the aquaculture sector in Vietnam may be the most serious threat in the near future. In particular, reduced rainfall in the dry season and higher temperatures will test some aquaculture systems already on the edge of sustainability. Some species will be unable to tolerate the extreme temperatures or have difficulty breeding at higher temperatures (Carew-Reid et al., 2013). Higher temperatures may also increase the rate of decomposition of organic matter in ponds, reducing dissolved oxygen to unsustainable levels. Increased storm intensity on the coastline may also damage aquaculture ponds and cause release of sludge, wastewater and fish/ shrimp into coastal waters. Freshwater aquaculture production may have to move further inland as saline intrusion continues to reach hundreds of kilometres upstream.

1.2.3. Capture fisheries

In 1999, total fisheries production in Vietnam was 1.8 million tonnes, of which 1.2 million tonnes was derived from marine capture fisheries and 0.6 million tonnes from aquaculture (Son, 2003). Twenty years later, in 2019, the situation has changed remarkably. Total fisheries output was 8.15 million tonnes, with capture output at 3.77 million tonnes and aquaculture 4.38 million tonnes. Capture fishing uses trawling nets, purse seine nets, and gillnets. Key species are tuna ($719 million), molluscs ($676 million), cephalopods ($577 million), crabs and other crustaceans ($149 million, and other finfish ($1.67 billion), as of 2019.

Vietnam's tuna resources are estimated at 600,000 tonnes, with skipjack as the major species. Yellow fin and bigeye tuna are caught from December to June (European Commission, 2018). The offshore fleet is about 33,000 vessels, mostly simple wooden boats with second-hand truck engines, and few with the mandated satellite positioning equipment. Each vessel employs 8-10 people, suggesting that 250,000-300,000 fishermen are employed in the offshore industry.

The main direct environmental degradations caused by the capture fishery are (i) destruction of nearshore habitats (e.g. coral reefs) by fishing gear, (ii) bycatch of forage species or juveniles of target species, (iii) marine pollution (plastics) from lost fishing gear, (iv) over-exploitation of target species, and (iv) oil spills, waste discharge, and other pollution from liveaboard vessels.

1.3. Preservation and storage in the distribution process and in processing plants

The Vietnam Fisheries Law 2017 requires traceability of caught fish at 57 designated fishing ports across the country, requiring fishermen to keep a logbook and trans-shipment vessels to report on trans-shipments, enabling the local Fisheries Department to certify seafood products to purchasing and processing companies. Paper-based records, however, are impractical and not suitable for archiving records. A pilot scheme of electronic tracing of the seafood supply chain will take place from 2021–2023, and then implemented nationwide (VASEP, 2021b). Electronic tracing could then be extended throughout the distribution chain.

The traditional storage and preservation method on Vietnamese fishing vessels was to use salt or foam rubber, but this has been mostly replaced by ice to keep the fish temperature at 0–5 °C. Ice can prolong preservation up to 10 days, but as fish stocks close to shore have been decimated, vessels are now fishing offshore for 45–60 days, and ice is no longer a suitable method. New methods are being promoted such as onboard freezers and liquid nitrogen, but these may be more suitable for new steel vessels.

The Vietnam Fisheries Law 2017 establishes that all aquatic products on commercial fishing and transport vessels, ports, production facilities and markets must be stored and preserved in compliance with food safety laws and regulations. Organizations and individuals are responsible for maintaining the quality, safety and hygiene of the product during the entire distribution process. The use of chemicals and other additives in processing and packaging is similarly required to align with a list of approved substances (Socialist Government of Vietnam, National Assembly, 2017). These regulations continue those established in the Aquaculture chapter of the Vietnam Fisheries Law of 2003 (Socialist Republic of Vietnam 2017). Under these laws, organizations and individuals manufacturing and exporting seafood are required to obtain a certificate of inspection confirming compliance with the relevant food safety and hygiene standards (Socialist Government of Vietnam, 2012).

During production, ice and freezers are used to maintain a stable temperature for seafood products. A 2003 sustainability audit of a seafood processing plant in Saigon estimated the energy consumption in shrimp processing as 150–220 kWh per ton of frozen shrimp. The cold storage units used to store the finished product for shipping accounted for roughly half of all energy consumption in the production process (Nguyen et al., 2003).

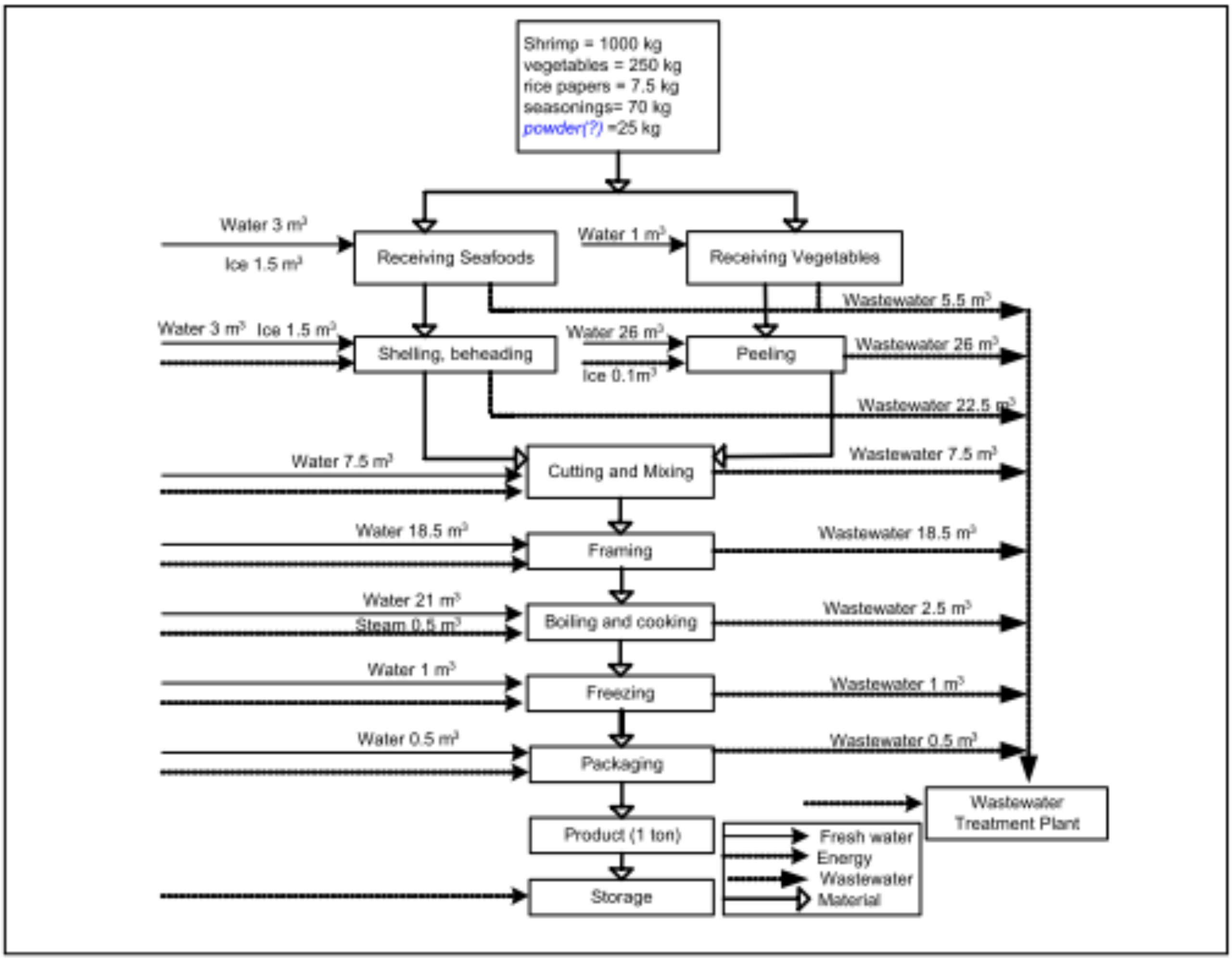


Figure 6. Water usage throughout the production process. Source: Ngyuen et al., 2003.

Similarly, large amounts of fresh water are consumed throughout the production process, in most cases drawn from local municipal water supplies. Water efficiency is a critical concern for the sustainability of seafood processing, as 'excessive use of water increases the amount of matter being washed out' (Phuoc et al., 2003) into common drainage, increasing the environmental degradation caused by the wastewater stream. Water is used to wash the raw inputs, as well as to clean the machines and containers, and to flush out the working floor. It is used to create ice for temperature regulation and during the freezing process prior to storage and shipping. In the above sustainability audit, more than 80% of the water used by the plant was consumed by processing units, with a much smaller proportion of water being used during the freezing and storage segments of the production chain.

1.4. Packaging stage

The Vietnamese seafood sector exports more than USD 8.6 billion of packaged frozen seafood for export markets. During the packaging stage of seafood processing, energy and materials are consumed, and wastewater and solid wastes are produced.

As the seafood sector grows, so does the use of plastic and metal packaging. In 2016 alone, packaging used by the seafood sector in Vietnam increased by roughly 4% (Orbis, 2017). Since 2004, when Vietnam implemented its Law on Environmental Protection (LEP), the seafood sector has faced increased requirements related to packaging. In a more recent draft revision of the 2014 LEP, packaging has become a key focus for an extended producer responsibility framework, building on the 2004 and 2017 Fisheries Laws (IUCN, 2020).

Soft, flexible plastics are the most common type of packaging for fresh seafood throughout the seafood supply chain. This type of packaging material remains a standard as it easily accommodates the low temperatures associated with freezing, shipping, and storing seafood products to global markets. For shelf-stable seafood, metal packaging such as cans and tins is often used. Packaging in the seafood sector globally has seen little innovation, with producers and manufacturers focusing their sustainability efforts on the production and distribution segments of the supply chain (Euromonitor International, 2020). A few seafood producers are beginning to use modified atmosphere packaging, where air is flushed out and a mixture of gases is added to the sealed packaging to slow down oxidation and bacterial growth (Ha, 2021).

The continued widespread use of plastic packaging is a major impediment to the sustainability of the seafood sector. This packaging is usually made from virgin plastics, is single-use and often ends up in landfills or in the ocean, damaging marine habitats and threatening the ecosystems on which the seafood sector relies. Plastic packaging can leak toxins into the environment, entangle, damage and even destroy marine wildlife, and pollute drinking water supplies (Godswill and Gospel, 2019).

1.5. Shipping and transport

Vietnamese seafood exports are transported primarily via sea in large transport containers to reach primary export markets (van Dujin, et al., 2012). The top shrimp importing markets are the EU, the US, Japan, China, and South Korea (81–85% of the total shrimp import value). Shrimp makes up almost 40% of the total seafood export value. Pangasius exports from Vietnam are 80–90% of the global trade in this species. Given the importance of the export market for these two 'products', the environmental damage caused by shipping and transport add to the sustainability concerns of the seafood supply chain.

The seafood sector uses oceanic freight as a primary means of getting products to export markets, and while oceanic shipping is the most energy-efficient form of freight transport, it relies heavily on fossil fuels and thus leaves behind a large footprint in terms of total greenhouse gas emissions.

With the rapid growth of oceanic shipping, it is estimated that by 2050 ship-sourced greenhouse gas emissions could increase by as much as 250% from 2012 levels. These emissions are projected to grow from 2% of global CO_2 emissions in 2020 to roughly 17% of CO_2 emissions by 2050 (van Dujin et al., 2012).

The relatively large environmental footprint of oceanic shipping comes not only from transport vessels, but also from port facilities and associated activities. The damage to the environment and climate directly related to port operations includes air pollution from ship engine exhaust such as CO_2, nitrogen oxides (NOx) and sulfur dioxide (SO_2), exhaust particles from port machinery, various dust particles from freight, and the discharge of ballast water from transport vessels. Such discharged water may contain invasive species or bacteria, chemicals, or hazardous by-products from ballast water management systems designed to eliminate invasive species (Matej et al., 2018). Outside of ports, additional environmental problems are associated with near-port shipping and ground transport systems, including road and rail traffic that take products to and from the port. These transport activities are associated with increased air pollution from vehicle emissions (OECD, 2011). Chief among these concerns are the discharge of ballast water, release of alien invasive species, marine litter, and the contributions to air pollution and climate change.

1.6. Other concerns for sustainability along the seafood value chain

Labour issues: Of increasing concern to Western markets are the issues of forced labour, child labour, human trafficking, and human rights violations in the global seafood supply chain (Nakamura, 2018). In 2017, the US downgraded Vietnam from Tier 2 to the Tier 2 Watch List for Trafficking in Persons, the international gold standard for assessing human trafficking. This status remains in effect for Vietnam, presenting a challenge for future trade should it slip further to Tier 3 (Department of State, 2020). The US has also expressed increased concerns over labour conditions in Vietnamese fishing fleets and is monitoring the situation closely (Chase, 2019; Drew, 2019).

Climate-change adaptation: Vietnam is one of the developing countries most at risk for the negative impact resulting from climate change. The country's geography places extensive coastal districts – housing roughly 25% of the population – at increased risk of erosion, flooding, tidal surges and severe storms (King and Espach, 2019; Thanh et al., 2004). Natural barriers to these effects of climate change, including coastal mangrove forests and salt marshes, are endangered. Warming and increasingly acidic oceans also pose a significant threat to fisheries, as marine migratory patterns are expected to change for vital species (Adger et al., 2007).

Adapting Vietnam's pangasius and shrimp fisheries to cope with climate change comes with many benefits but also potential costs. Studies of pangasius and shrimp farms in the Mekong Delta have indicated that the pangasius industry operates 'close to the edge of economic viability' (Shelton, 2014), and may require significant restructuring to cope with climate change. The shrimp industry, on the other hand, has proven more capable of tolerating the costs of adaptation efforts, especially for small-scale farmers. The analysis suggests that for both fisheries, government supported adaptation efforts, such as dyke construction and upgrading for rivers and sea, provides more benefits than if farmers and fishers were left to fend for themselves (Kam et al., 2012).

Continued storage or diversion by dams in the Lancang River portion of the Mekong River, combined with sea level rise due to climate change, is making saline intrusion in the delta region a long-term sustainability issue. To end on a positive note, rice-shrimp culture in the Mekong Delta has been shown to be a potential adaptation to climate change (Dang, 2020), and could provide solutions to some of the sustainability concerns in Vietnam's fisheries and aquaculture sector.

References

Adger, N. et al. (Summary drafting authors). 2007. 'IPCC, 2007: Summary for Policymakers'. In: M.L. Parry et al. (Eds.), *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge U. Press, Cambridge, UK, 7–22. Retrieved on April 20, 2022: https://www.ipcc.ch/site/assets/uploads/2018/03/ar4_wg2_full_report.pdf

Anh, P. T., C. Kroeze, S. R. Bush, and A. P. J. Mol. 2010a. Water Pollution by Pangasius Production in the Mekong Delta, Vietnam: Causes and Options for Control. *Aquaculture Research* 42: 108–128: https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1365-2109.2010.02578.x

Anh, P. T., C. Kroeze, S. R. Bush, and A. P. J. Mol. 2010b. Water Pollution by Intensive Brackish Shrimp Farming in South-East Vietnam: Causes and Options for Control. *Agricultural Water Management* 97: 872–882. https://doi.org/10.1016/j.agwat.2010.01.018

Ayer, N., Côté, R. P., Tyedmers, P. H., & Martin Willison, J. H. 2009. Sustainability of seafood production and consumption: An introduction to the special issue. *Journal of Cleaner Production* 17, 321–324. https://doi.org/10.1016/j.jclepro.2008.09.003

Bijman, J., Muradian, R., & Cechin. A. 2010. Agricultural cooperatives and value chain coordination. In A. Helmsing & S. Vellema (Eds.), *Value Chains, Social Inclusion and Economic Development: Contrasting Theories and Realities*. Routledge. https://www.taylorfrancis.com/chapters/edit/10.4324/9780203816806-12/agricultural-cooperatives-value-chain-coordination-jos-bijman-roldan-muradian-andrei-cechin-jos-bijman-roldan-muradian-andrei-cechin

Bosma, R.H., Hanh, C.T.T. & Potting, J. 2009. *Environmental impact assessment of the pangasius sector in the Mekong Delta*. Wageningen University. https://edepot.wur.nl/8332

Boston Consulting Group (BCG). 2019. *A Strategic Approach to Sustainable Shrimp Production in Vietnam*. http://media-publications.bcg.com/BCG-A-Strategic-Approach-to-Sustainable-Shrimp-Production-in-Vietnam-Aug-2019.pdf

Carew-Reid, J., Ketelsen, T., Koponen, J., Vinh, M. K. 2013. *USAID Mekong ARCC Climate Change Impact and Adaptation Study: Summary*. https://doi.org/10.13140/RG.2.2.34024.37120

Chase, C. 2019. EJF study finds child labor, illegal fishing issues within Vietnamese fleet. *SeafoodSource,* November 20. https://www.seafoodsource.com/news/supply-trade/ejf-study-finds-child-labor-illegal-fishing-issues-within-vietnamese-fleet

Cherry, D. 2019. US downgrades Vietnam in latest labor-abuse report. *Intrafish*, 24 June. https://www.intrafish.com/news/us-downgrades-vietnam-in-latest-labor-abuse-report/2-1-625153

Chin, S. 2018. *Vietnam goes for eco-shrimp*. The ASEAN Post, 28 July. https://theaseanpost.com/article/vietnam-goes-eco-shrimp

Dang, H. D. 2020. Sustainability of the rice-shrimp farming system in Mekong Delta, Vietnam: a climate adaptive model. *Journal of Economics and Development* 22, 21–45. https://doi.

org/10.1108/JED-08-2019-0027

Directorate of Fisheries, Vietnam. 2020. *Aquaculture production results in 2019*. Electronic Information, General Headquarter of Fisheries. https://tongcucthuysan.gov.vn/Tin-t%E1%BB%A9c/-Tin-v%E1%BA%AFn/doc-tin/014196?2020-01-15=Banner+002 [in Vietnamese]

Entzian, M. 2015. *The Seafood Industry in Vietnam*. Vietnam Briefing. https://www.vietnam-briefing.com/news/seafood-industry-vietnam-aquaculture-year-plans-tpp.html/

Eslami, S. et al. 2019. Tidal amplification and salt intrusion in the Mekong Delta driven by anthropogenic sediment starvation. *Scientific Reports* 18746. https://doi.org/10.1038/s41598-019-55018-9

European Commission. 2018. *Research for PECH Committee – Fisheries in Vietnam*. Policy Department for Structural and Cohesion Policies, Directorate-General for Internal Policies PE 629.175 – October. https://knowledge4policy.ec.europa.eu/publication/research-pech-committee-fisheries-vietnam_en

European Commission. 2019. EU-Vietnam Trade Agreement, Investment Protection Agreement. Signed June 30. https://ec.europa.eu/trade/policy/in-focus/eu-vietnam-agreement/

European Parliament, Directorate General for Internal Policies, Policy Department A: Economic and Scientific Policy. 2015. *Emission Reduction Targets for International Aviation and Shipping*. IP/A/ENVI/2015-11 November, PE 569.964, EN

FAO. 2016. *The State of World Fisheries and Aquaculture 2016 (SOFIA): Family Farming Knowledge Platform*. https://www.fao.org/family-farming/detail/en/c/465805/

FAO. 2018a. *The State of World Fisheries and Aquaculture (SOFIA) 2018: Meeting the Sustainable Development Goals*. https://www.fao.org/documents/card/en/c/I9540EN/

FAO. 2018b. *Seafood certification and developing countries: Focus on Asia*, by Tsantiris, K., Zheng, L., & Chomo, V. FAO Fisheries and Aquaculture Circular No. 1157. https://www.fao.org/3/I8018EN/i8018en.pdf

FAO. 2020a. *GLOBEFISH Highlights April 2020 Issue, with Annual 2019 Statistics - A quarterly update on world seafood markets*. https://doi.org/10.4060/ca9528en

FAO [retrieved April 2022]. National Aquaculture Legislation Overview – Viet Nam. Text by Murekezi, P. Fisheries and Aquaculture Division [online]. https://www.fao.org/fishery/en/legalframework/nalo_vietnam

Figuié, M. & Moustier, P. 2009. Market appeal in an emerging economy: Supermarkets and poor consumers in Vietnam. Food Policy 34, 210–217. https://doi.org/10.1016/j.foodpol.2008.10.012

Figuié, M., Moustier, P., Bricas, N., Nguyen, T.T.L. 2019. Trust and Food Modernity in Vietnam. In: Ehlert, J., Faltmann, N. (Eds.) *Food Anxiety in Globalising Vietnam*. Palgrave Macmillan, Singapore. https://doi.org/10.1007/978-981-13-0743-0_5

Figuié, M., Bricas, N., Nguyen-Thanh, V. P., & Truyen, N. D. 2004. Hanoi consumers' point of view regarding food safety risks: an approach in terms of social representation. *Vietnam Social Sciences* 3, 63–72. https://agris.fao.org/agris-search/search.do?recordID=FR2019101510

Folke, C., Kautsky, N., Berg, H., Jansson, A., & Troell, M. 1998. The ecological footprint concept for sustainable seafood production: A review. *Ecological Applications* 8, S63–S71. https://esajournals.onlinelibrary.wiley.com/doi/epdf/10.1890/1051-0761%281998%298%5BS63%3ATEFCFS%5D2.0.CO%3B2

Global Footprint Network. 2020. *Ecological Footprint Accounting: Limitations and Criticism*. https://www.footprintnetwork.org/content/uploads/2020/08/Footprint-Limitations-and-Criticism.pdf

Godswill, C., & Gospel, C. 2019. Impacts of Plastic Pollution on the Sustainability of Seafood Value Chain and Human Health. In *International Journal of Advanced Academic Research*. https://www.researchgate.net/publication/337312788

Gunders, D. 2012. Wasted: How America Is Losing Up to 40 Percent of Its Food from Farm to Fork to Landfill. *NRDC Issue Paper*, *12-06-B*. https://www.nrdc.org/resources/wasted-how-america-losing-40-percent-its-food-farm-fork-landfill

Gutiérrez, N. L et al. 2012. Eco-Label Conveys Reliable Information on Fish Stock Health to Seafood Consumers. *PLOS ONE* 7, e43765. https://doi.org/10.1371/journal.pone.0043765

Ha, T. M., Shakur, S., & Pham Do, K. H. 2020. Food risk in consumers' eye and their consumption responses: evidence from Hanoi survey. *Journal of Asian Business and Economic Studies* 28, 86–100. https://doi.org/10.1108/JABES-12-2019-0126

Hansen, A. 2018. Meat consumption and capitalist development: The meatification of food provision and practice in Vietnam. *Geoforum* 93, 57–68. https://doi.org/10.1016/j.geoforum.2018.05.008

Harris, J., Nguyen, P.H., Tran, L.M. et al. 2020. Nutrition transition in Vietnam: changing food supply, food prices, household expenditure, diet and nutrition outcomes. *Food Security* 12, 1141–1155. https://doi.org/10.1007/s12571-020-01096-x

IUCN, International Union for Conservation of Nature. 2020. *Extended Producer Responsibility: an approach to improving solid waste management in Viet Nam*. https://www.iucn.org/news/viet-nam/202008/extended-producer-responsibility-approach-improving-solid-waste-management-viet-nam

Jacquet, J. L., & Pauly, D. 2008. Trade secrets: Renaming and mislabeling of seafood. *Marine Policy* 32, 309–318. https://doi.org/10.1016/j.marpol.2007.06.007

Jaffry, S., Pickering, H., Ghulam, Y., Whitmarsh, D., & Wattage, P. 2004. Consumer choices for quality and sustainability labelled seafood products in the UK. *Food Policy*, 29, 215–228. https://doi.org/10.1016/j.foodpol.2004.04.001

Jaffry, S., Glenn, H., Ghulam, Y., Willis, T., & Delanbanque, C. 2016. Are expectations being met? Consumer preferences and rewards for sustainably certified fisheries. *Marine Policy*, 73, 77–91. https://doi.org/10.1016/j.marpol.2016.07.029

Johnson, A., & Hung, P. Q. 2020. Impacts of climate change on aquaculture in Vietnam: A review of local knowledge. *Aquaculture*, February, 8–14. https://www.researchgate.net/publication/339353491_Impacts_of_climate_change_on_aquaculture_in_Vietnam_A_review_of_local_knowledge

Hibbeln, J.R., Davis, J.M., Steer, C., Emmett, P., Rogers, I., Williams, C., Golding, J. 2007. Maternal seafood consumption in pregnancy and neurodevelopmental outcomes in childhood (ALSPAC study): an observational cohort study. *The Lancet* 369, 578–585. https://doi.org/10.1016/S0140-6736(07)60277-3

Kam, S. P., Badjeck, M., Teh, L., Teh, L., & Tran, N. 2012. *Autonomous adaptation to climate change by shrimp and catfish farmers in Vietnam' s Mekong River delta*. January, 1–24. http://pubs.iclarm.net/resource_centre/WF_3395.pdf

King, M. D., & Espach, R. H. 2009. *Global Climate Change and State Stability*. August, 1–36. https://www.cna.org/CNA_files/PDF/D0020868.A2.pdf

King, M. D. 2015. Climate Change and Vietnam Fisheries: Opportunities for Conflict Prevention. *Briefer* 26, 1–9. https://climateandsecurity.org/wp-content/uploads/2012/04/climate-change-and-vietnamese-fisheries-opportunities-for-conflict-prevention_briefer-263.pdf

Koilo, V. 2019. Sustainability issues in maritime transport and main challenges of the shipping industry. *Environmental Economics* 10, 48–65. https://doi.org/10.21511/ee.10(1).2019.04

Kreft, S., Eckstein, D., & Melchior, I. 2017. *Global Climate Risk Index 2017. Who Suffers Most from Extreme Weather Events? Weather-related Loss Events in 2015 and 1996 to 2015*. https://www.germanwatch.org/en/12978

Le, A. T., Nguyen, M. T., Vu, H. T. T., & Nguyen Thi, T. T. 2020. Consumers' trust in food safety indicators and cues: The case of Vietnam. *Food Control*, 112, 107162. https://doi.org/10.1016/j.foodcont.2020.107162

Macfadyen, G., & Huntington, T. 2007. *Potential costs and benefits of fisheries certification for countries in the Asia-Pacific region*. Asia–Pacific Fishery Commission, Food and Agriculture Organization of the United Nations, Regional Office for Asia and the Pacific. Bangkok. https://www.fao.org/apfic/publications/detail/en/c/419733/

Manh Son, D. et al.. 2003. *Assessment, Management and Future Directions for Coastal Fisheries in Asian Countries*. In *WorldFish Center Conference Proceedings,* Vol. 67. https://hdl.handle.net/20.500.12348/2168

Maruyama, M., & Trung, L. V. 2007. Traditional bazaar or supermarkets: A probit analysis of affluent consumer perceptions in Hanoi. *The International Review of Retail, Distribution and Consumer Research* 17, 233–252. https://doi.org/10.1080/09593960701368804

Maruyama, M., & Trung, L. V. 2011. Review article: Modern Retailers in Transition Economies: The Case of Vietnam. *Journal of Macromarketing* 32, 31–51. https://doi.org/10.1177/0276146711421932

Matej, D., Linders, J., Gollasch, S., & David, J. 2018. Is the aquatic environment sufficiently protected from chemicals discharged with treated ballast water from vessels worldwide? – A decadal environmental perspective and risk assessment. *Chemosphere 207*, 590–600. https://doi.org/10.1016/j.chemosphere.2018.05.136

Ministry of Agriculture and Rural Development. 2020. *Tổng cục thủy sản – VietNam Fisheries*. https://tongcucthuysan.gov.vn/en-us/vietnam-fisheries/doc-tin/015764/2021-04-19/fishery-production-in-2020-continues-to-maintain-growth

My, N. H. D., Demont, M., & Verbeke, W. 2021. Inclusiveness of consumer access to food safety: Evidence from certified rice in Vietnam. *Global Food Security* 28, 100491. https://doi.org/10.1016/J.GFS.2021.100491

Nakamura, K. et al. 2018. Seeing slavery in seafood supply chains. *Science Advances* (American Association for the Advancement of Science) 4. https://www.science.org/doi/10.1126/sciadv.1701833

Ngoc, P. T. A. et al. 2018. Technical inefficiency of Vietnamese pangasius farming: A data envelopment analysis. *Acquaculture Economics and Management* 22. https://doi.org/10.1080/13657305.2017.1399296

Nguyen, P. D., Visvanathan, C. & Kumar, S. 2003. Cleaner Production Potentials in Seafood Processing Industry: A Case Study from Ho Chi Minh City, Vietnam. https://www.researchgate.net/publication/237335283_Cleaner_Production_Potentials_in_Seafood_Processing_Industry_A_Case_Study_from_Ho_Chi_Minh_City_Vietnam

Nguyen, T. A. T., & Jolly, C. 2020. Global value chain and food safety and quality standards of Vietnam pangasius exports. *Aquaculture Reports* 16, 100256. https://doi.org/10.1016/J.AQREP.2019.100256

Nguyen, T. A. T., Nguyen, K. A. T., & Jolly, C. 2019. Is Super-Intensification the Solution to Shrimp Production and Export Sustainability? *Sustainability* 11, 5277. https://doi.org/10.3390/SU11195277

Nguyen-Anh, D., Umberger, W. J., & Zeng, D. 2020. Understanding Vietnamese Urban Consumers' Nutrition Label Use, Health Concerns, and Consumption of Food and Beverages with Added Sugars. *Nutrients* 12, 3335. https://doi.org/10.3390/nu12113335

Nguyen-Viet, H., Tuyet-Hanh, T. T., Unger, F., Dang-Xuan, S., & Grace, D. 2017. Food safety in Vietnam: where we are at and what we can learn from international experiences. *Infectious Diseases of Poverty* 6, 1–6. https://doi.org/10.1186/S40249-017-0249-7

Nhan Dan Online. 2020. *PM urges for boosting domestic seafood consumption*. June 11. https://en.nhandan.vn/business/economy/item/8757902-pm-urges-for-boosting-domestic-seafood-consumption.html

OECD. 2011. Environmental impacts of ports. https://www.oecd.org/greengrowth/greening-transport/environmental-impacts-of-ports.htm To download the full report: *Environmental Impacts of International Shipping: The Role of Ports*, https://www.oecd-ilibrary.org/environment/environmental-impacts-of-international-shipping_9789264097339-en

Orbis. 2017. *Processed Meat and Seafood Packaging in Vietnam*. https://www.orbisresearch.com/reports/index/processed-meat-and-seafood-packaging-in-vietnam

Peacey, J. 2001. The Marine Stewardship Council Fisheries Certification Program: Progress and Challenges. *IIFET 2000 Proceedings*. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.1014.5215&rep=rep1&type=pdf

Ponte, S. 2020. The hidden costs of environmental upgrading in global value chains. *Review of International Political Economy*. https://doi.org/10.1080/09692290.2020.1816199

Raneri, J. E. et al. 2019. *Determining key research areas for healthier diets and sustainable food systems in Viet Nam*. International Food Policy Research Institute – CGIAR – Bioversity International. CGIAR Research Program on Agriculture for Nutrtition and Health. IFPRI Disucussion Paper 01872. https://ebrary.ifpri.org/digital/collection/p15738coll2/id/133433

Rubel, H. et al. 2019. *A Strategic Approach to Sustainable Shrimp Production in Vietnam: The case for improved economics and sustainability*. Boston Consulting Group (BCG). http://media-publications.bcg.com/BCG-A-Strategic-Approach-to-Sustainable-Shrimp-Production-in-Vietnam-Aug-2019.pdf

Salladarré, F., Brécard, D., Lucas, S., & Ollivier, P. 2016. Are French consumers ready to pay a premium for eco-labeled seafood products? A contingent valuation estimation with heterogeneous anchoring. *Agricultural Economics* 47, 247–258. https://onlinelibrary.wiley.com/doi/10.1111/agec.12226

Seafood TIP. [n.d.] *Vietnam - Pangasius*. Retrieved February 28, 2021, from https://seafood-tip.com/sourcing-intelligence/countries/vietnam/pangasius/

Sharma, R., Nguyen, T. T., & Grote. 2018. Changing Consumption Patterns – Drivers and the Environmental Impact. *Sustainability* 10, 4190. https://doi.org/10.3390/SU10114190

Shelton, C. 2014. Climate Change Adaptation in Fisheries and Aquaculture: Compilation of initial examples. *FAO Fisheries and Aquaculture Circular* 1088. https://www.uncclearn.org/sites/default/files/inventory/fao195.pdf

Socialist Government of Vietnam. 2012. Decree No. 38/2012/ND-CP detailing the implementation of the law on food safety, Pub. L. No. Decree No. 38/2012/ND-CP. https://vanbanphapluat.co/decree-no-38-2012-nd-cp-detailing-the-implementation-of-the-law-on-food-safety

Socialist Government of Vietnam, National Assembly. 2017.Law on Fisheries, Law No.: 18/2017/QH14. http://seafood.vasep.com.vn/DATA/OLD_EN/Uploads/image/Phung-Thi-Kim-Thu/file/18_2017_qh14_372768_(2-3-2018-929).pdf

Sogn-Grundvåg, G., Larsen, T. A., & Young, J. A. 2014. Product Differentiation with Credence Attributes and Private Labels: The Case of Whitefish in UK Supermarkets. *Journal of Agricultural Economics* 65, 368–382. https://doi.org/10.1111/1477-9552.12047

Stott, R. 2007. Climate change – 2057. *BMJ 335*, 1318–1319. https://doi.org/10.1136/bmj.39420.654583.25

Thanh, T. D., Saito, Y., Huy, D. van, Nguyen, V. L., Ta, T. K. O., & Tateishi, M. 2004. Regimes of human and climate impacts on coastal changes in Vietnam. *Regional Environmental Change* 41, 49–62. https://doi.org/10.1007/s10113-003-0062-7

The World & Vietnam Report. 2017. Vietnamese exporters face compliance challenges from US market. https://en.baoquocte.vn/vietnamese-exporters-face-compliance-challenges-from-us-market-58452.html

Thi, P. et al. 2018. Technical inefficiency of Vietnamese pangasius farming: A data envelopment analysis. *Aquaculture Economics and Management* 22, 229–243. https://doi.org/10.1080/13657305.2017.1399296

Thi, N. B. D., Kumar, G., & Lin, C. Y. 2015. An overview of food waste management in developing countries: Current status and future perspective. *Journal of Environmental Management* 157, 220–229. https://doi.org/10.1016/j.jenvman.2015.04.022

Ton, V. D., Thang, P. D., Luc, D. D., Son, N. T., & Lebailly, P. 2011. *Modernization of animal products consumption in Hanoi, Northern Vietnam*. Asian Society of Agricultural Economists (ASAE), 2011 ASAE 7th International Conference, October 13-15, Hanoi, Vietnam. https://ageconsearch.umn.edu/record/290610

Tran, N., Bailey, C., Wilson, N., & Phillips, M. 2013. Governance of Global Value Chains in Response to Food Safety and Certification Standards: The Case of Shrimp from Vietnam. *World Development* 45, 325–336. https://doi.org/10.1016/j.worlddev.2013.01.025

Trifković, N. 2014. Certified standards and vertical coordination in aquaculture: The case of pangasius from Vietnam. *Aquaculture* 433, 235–246. https://doi.org/10.1016/j.aquaculture.2014.06.010

Uchida, H., Onozaka, Y., Morita, T., & Managi, S. 2014. Demand for ecolabeled seafood in the Japanese market: A conjoint analysis of the impact of information and interaction with other labels. *Food Policy 44*, 68–76. https://doi.org/10.1016/j.foodpol.2013.10.002

UNEP. 2012. *Global Outlook on SCP Policies: Taking action together*. https://sustainabledevelopment.un.org/index.php?page=view&type=400&nr=559&menu=1515

US Department of State. Office to Monitor and Combat Trafficking in Persons. *2020 Trafficking in Persons Report*. https://www.state.gov/reports/2020-trafficking-in-persons-report/

van Anrooy, R. [n.d.] *Fish Marketing and Consumption in Vietnam: What about Aquaculture Products?* Retrieved December 7, 2021, from https://www.fao.org/3/y4768e/Y4768e04.htm

van Dujin, A.P., Beukers, R. & van der Pijl, W. 2012. The Vietnamese seafood sector – A value chain analysis. https://edepot.wur.nl/237935

Van Hoi, P., Mol, A. P. J., & Oosterveer, P. J. M. 2009. Market governance for safe food in developing countries: The case of low-pesticide vegetables in Vietnam. *Journal of Environmental Management* 91, 380–388. https://doi.org/10.1016/j.jenvman.2009.09.008

VASEP. 2021a. *Vietnam to implement electronic traceability in a fish supply chain*. January 14. http://seafood.vasep.com.vn/combat-iuu-fishing/vietnam-s-action-compaign/vietnam-to-implement-electronic-traceability-in-a-fish-supply-chain-20942.html

VASEP. 2021b. *Vietnam targets to be the world leader in seafood processing and exports*. January 25. http://seafood.vasep.com.vn/why-buy-seafood/vietnam-targets-to-be-the-world-leader-in-seafood-processing-and-exports-20977.html

VASEP. 2021c. *Fishery Profile*. March 11. https://seafood.vasep.com.vn/why-buy-seafood/fishery-profile

VASEP. 2020a. *Seafood export in 2020 can reach 8.6 billion USD*. https://vasep.com.vn/san-pham-xuat-khau/tin-tong-hop/xuat-nhap-khau/xuat-khau-thuy-san-nam-2020-co-the-can-dich-8-6-ty-usd-17953.html

VASEP. 2020b. *Report on Vietnam seafood exports in 2019*. http://seafood.vasep.com.vn/reports/quarterly-report-on-vietnam-seafood-exports/reports-on-vietnam-seafood-export/report-on-vietnam-seafood-exports-in-2019-19918.html

VASEP. 2020c. *Report on Vietnam pangasius sector 2015–2019*. http://seafood.vasep.com.vn/reports/report-on-vietnam-seafood-products/report-on-vietnam-pangasius-sector-2015-2019-19925.html

VASEP. 2020d. *Report on Vietnam shrimp sector 2015–2019*. http://seafood.vasep.com.vn/reports/report-on-vietnam-seafood-products/report-on-vietnam-shrimp-sector-2015-2019-19921.html

VASEP. 2018. *Report on Vietnam Pangasius sector 2008–2017*. http://seafood.vasep.com.vn/reports/report-on-vietnam-seafood-products/report-on-vietnam-pangasius-sector-2008-2017-19906.html

VNCPC. 2013. SUPA Study – Chapter II: A summary of trends and key stakeholder sourcing policies. https://vncpc.org/en/thi-truong-ca-tra-eu-phan-ii-xu-huong-va-chinh-sach-thu-mua-cua-cac-nha-ban-le-hang-dau/ [in Vietnamese: https://vncpc.org/thi-truong-ca-tra-eu-phan-ii-xu-huong-va-chinh-sach-thu-mua-cua-cac-nha-ban-le-hang-dau/]

Wakamatsu, H. 2014. The Impact of MSC Certification on a Japanese Certified Fishery. *Marine Resource Economics* 29, 55–67. https://doi.org/10.1086/676287

Wan, Z., el Makhloufi, A., Chen, Y., & Tang, J. 2018. Decarbonizing the international shipping industry: Solutions and policy recommendations. *Marine Pollution Bulletin* 126, 428–435. https://doi.org/10.1016/j.marpolbul.2017.11.064

Wertheim-Heck, S. C. O., & Raneri, J. E. 2020. Food policy and the unruliness of consumption: An intergenerational social practice approach to uncover transforming food consumption in modernizing Hanoi, Vietnam. *Global Food Security* 26, 100418. https://doi.org/10.1016/j.gfs.2020.100418

Wertheim-Heck, S. C. O., Spaargaren, G., & Vellema, S. 2014. Food safety in everyday life: Shopping for vegetables in a rural city in Vietnam. *Journal of Rural Studies* 35, 37–48. https://doi.org/10.1016/j.jrurstud.2014.04.002

Wertheim-Heck, S. C. O., Vellema, S., & Spaargaren, G. 2015). Food safety and urban food markets in Vietnam: The need for flexible and customized retail modernization policies. *Food Policy* 54, 95–106. https://doi.org/10.1016/j.foodpol.2015.05.002

WWF – World Wide Fund for Nature. 2015. *WWF-US Oceans Program Guidelines for Developing MSC Pre-Assessment and Full Assessment Projects MSC Handbook*. https://seafoodsustainability.org/wp-content/uploads/2015/10/MSC-Handbook-1-12-15.pdf

Xuan, B. B. 2021. Consumer preference for eco-labelled aquaculture products in Vietnam. *Aquaculture 532*, 736111. https://doi.org/10.1016/j.aquaculture.2020.736111

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