T20 INDONESIA 2022 THINK

Policy Brief

STRENGTHENING SUSTAINABLE SMALL-SCALE AQUACULTURE AND FISHERIES THROUGH PROPER INFRASTRUCTURE AND POLICY

Task Force 4

Food Security and Sustainable Agriculture

Ayu Pratiwi, (Turku School of Economics, University of Turku, Finland. Corresponding author: ayprat@utu.fi)

Farikhah, (Muhammadiyah University Gresik, Indonesia)

Yudha Adiputra, (University of Lampung, Indonesia)

Guenwoo Lee, (Japan International Research Center for Agricultural Sciences, Japan)

Ratih Adiputri, (University of Jyväskylä, Finland)

Abstract

Small-scale aquaculture and fisheries actors globally are faced by suboptimal value chain problems, weak environmental planning and waste management, and inadequate food safety and nutrition standards. These limitations hampered the smallholders to effectively participate in the responsible and sustainable value chain processes, consequently threatening their livelihood. This policy brief addresses comprehensive and interlinked recommendations in areas where immediate action is needed, namely to increase investment in fishery/aquaculture supply chain upgrading, to support environmentally responsible water management and biodiversity preservation, and to promote fish as a nutritious food source and synergize social protection programmes in local and national levels..

.

Challenges

According to FAO (2020), aquaculture (20.5 million) and fisheries (38.9 million) employed nearly 59.4 million people globally. Yet, specific constraints and challenges hampering the sustainable growth of the small-scale actors remained.

Small-scale actors are unable to participate efficiently in the value chain due to inadequate infrastructure and limited technological capacity

Small-scale actors, mainly in low- and medium-income countries, including those in the G20, are lagging in the value chain upgrading due to limited physical infrastructure and less-developed technological advances in farming practices. Apart from problems encountered at the production stage, they also experience significant post-harvest losses at the level of storage, processing, and marketing (Obiero et al., 2019; Ongkittikul et al., 2019). While cultivation requires significant upfront investment, traditional financial instruments appear incapable of meeting the needs of smallholders. Smallholders thus rely on the capital owners, making it challenging for them to escape poverty (Ongkittikul et al., 2019; Quagrainie et al., 2010). These deprive smallholders' access to livelihood resources and across actors in the value chains (Suzuki & Nam, 2018). Further, the adoption of more powerful fishing equipment may result in a fleet fishing capacity above what is environmentally viable, hence incentives for capital expenditures may encourage overfishing (Lado, 2020).

Small-scale farmers' incapacity to implement long-term environmental planning could exacerbate ecologically-harmful activities

Temperature changes threaten fisheries and aquaculture in freshwater environments, causing the spread of new diseases (Tallar & Suen, 2016). Small-scale farmers resort to antibiotic use in aquaculture to mitigate the risks of crop failure due to diseases, but such drugs contain substances harmful to human body. With the high product standard requirements in the main importing countries, such products may not be competitive in the export market (Oviedo-Bolanos *et al*., 2021; Dehkordi *et al*., 2022; Mondal *et al*., 2022). Moreover, freshwater farming has been acknowledged as one of the main causes of deforestation in the mangrove ecosystem. Many small-scale fish farmers also struggle to access adequate surface water for their ponds due to limited irrigation canals (Asian Development Bank, 2005). In addition, the effects of untreated industrial wastewater dumped into canals by farmers and industry are worrying considering the importance of water availability and quality to ensure smooth production (Islam & Bhuiyan, 2016). Smallholders are supposed to receive science-based guidance from extension

services, yet there is a severe lack of extension agents in low- and middle-income nations (Cole & Sharma, 2017).

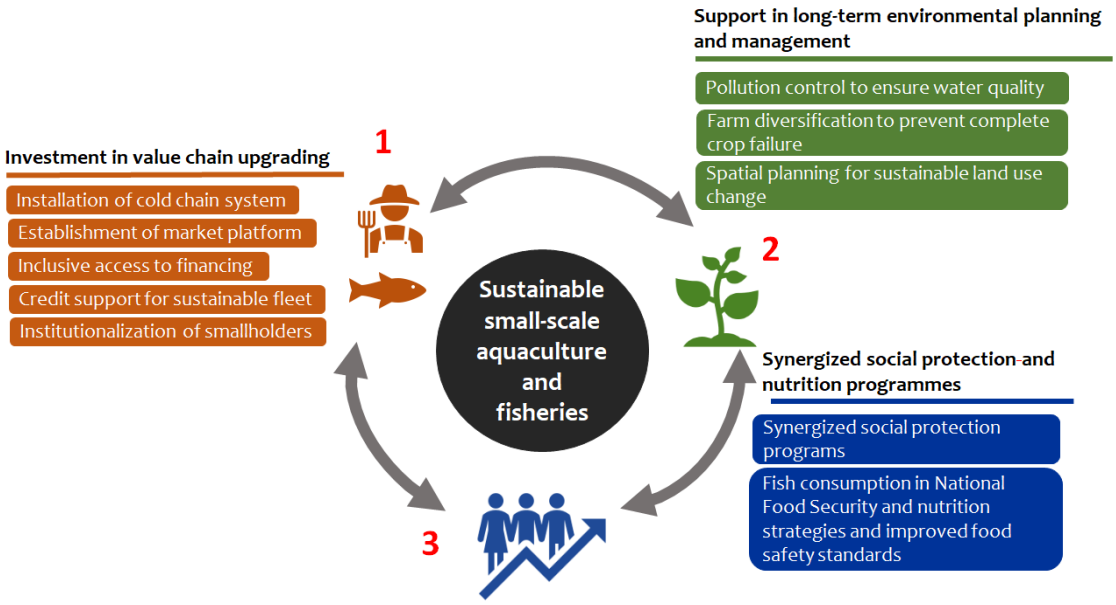
Low fish consumption and lack of awareness regarding its potential nutrition weaken and marginalise the small-scale farmers

Due to irregular income and a lack of access to financial support, smallholders are financially vulnerable (Hanh et al., 2017). This is exacerbated by low consumer demand for aquatic products, especially in regions where people do not often consume fish in significant numbers and have little cultural or culinary experience with fish as a protein source (Louis et al., 2022). This is partly results of the limited awareness of fish as wholesome protein sources and less-developed food safety standards related to aquatic product consumption (Haji & Workagegn, 2021).

Proposals for G20

This policy brief focuses on integrated solutions concerning the empowerment of small-scale actors in fishery and aquaculture value chain; support for long-term environmental planning and management; as well as synergizing nutrition and social protection programs that are practical, economical, and attainable, which framework is shown in Figure 1. Sustainable and responsible value chain upgrades will consequently result in improved biodiversity conservation while sound environmental planning can ensure the contingency of sustainable value chain processes. These initiatives should also be supported by the integration of social protection programmes linked to smallholder actors and the inclusion of aquatic products as sources of nutrition in the national policy, coordinated by the G20 countries.

Figure 1: The frameworks for specific recommendations



Recommendation 1: Increase funding for small-scale value chain participants engaged in aquaculture and fishery, as well as more equitable access to financing.

Improve the quality of aquatic products through more investment in cold chain systems

This is essential for tropical climate regions where aquaculture and fishery production are mostly undertaken. Due to the warm temperature, aquatic production is prone to spoiling during the storage and transport stages. Therefore, the installation of modern cold storage facilities that are reliable and environmentally friendly will be a game-changer for small-scale actors in the value chains. Likewise, small businesses and enterprises must respond to the rising demand for cold chain systems. To assist these operators, the G20 governments should: set up facilities

and fish markets in the hubs of production activities; offer producers credit to help them purchase cold chain facilities; promote investment in cold chain businesses, exempt investments from taxes; and allow foreign investors to own shares (Ongkittikul et al., 2019).

Shorten the supply chains with the establishment of market platforms connecting buyers and sellers.

To prevent a reduction in product quality and a subsequent decrease in price, sellers or producers must establish direct contact with consumers to improve the supply chains. In addition, excellent cultivation practices and efficient post-harvest handling are often necessary for high-value export items. The G20 forum should provide support for more sustainable farming practices that are economically viable and environmentally sustainable, such as selecting species with a wide spectrum of salinity tolerances (e.g. euryhaline species) and low trophic species (namely detritivore and herbivore fishes) to cope with a wide range of uncertainty (cf. Barange *et al*., 2018). Sustainable aquaculture or fisheries certifications such as ASC (Aquaculture Stewardship Council) and MSC (Marine Stewardship Council) should also be introduced to small-scale producers to increase product valorisation and encourage exports. At the same time, vertical links between actors in the value chain should also be strengthened through backwards-forward integration with larger food processing companies (Pratiwi et al., 2021). In addition, contract farming with larger corporations could be encouraged with partial government support to purchase high-quality products from farmers in advance in exchange for finance, technical assistance, and market access (Sriboonchitta & Wiboonpoongse, 2008).

Provide access to financial services and instruments for small-scale actors to overcome financial constraints of production.

The G20 governments should ensure inclusive access to credit and insurance for smallholders to encourage better farm investment. This is particularly relevant for farmers who are starting up or scaling up production. It also has the potential to address the persistent poverty caused by unequal relationships between farmers and money lenders. Financial sensitisation, literacy, and education about savings and credit geared toward smallholders are necessary for farmers to avoid taking high-interest loans to maintain their farm practices (Mandell & Klein, 2009). Credit, savings, and money transfer facilities should reach farmers' geographical locality, namely that the government should attach the financial institutions to the closest public infrastructures such as post offices, local markets, or schools. Reliable financial infrastructure can promote prosperous buyer-seller interactions that eventually lower obstacles to smallholders' access to capital (cf. Villarreal, 2017).

Seek alternatives to fishery subsidies that worsen overfishing by providing aid that removes the incentives to do so

Government assistance to the fishing industry is estimated to be USD 35 billion per year, or nearly 20% of the value of all marine fish caught at sea and transported into ports (Martini, 2019). Many of these incentives can also lead to overfishing and abuse of fishery resources, putting the industry's long-term viability in danger (Martini and Innes, 2018). However, as of June 2022, more than 160 countries have agreed to limit subsidies to fisheries to combat overfishing and improve the condition of the world's oceans (Julin, 2022). The G20 forum should concentrate on new policy alternatives to subsidies by providing assistance that reduces incentives for overfishing. Programs that ensure financial institutions can support the required working capital for small fishing firms are examples of such policies, as are initiatives that improve fishermen's operational or commercial abilities (Martini, 2019). The distribution of benefits to participants in the fishing sector fairly is also accomplished by payments that specifically target fishermen's incomes, such as employment insurance or disaster payment (Martini, 2019). However, addressing overfishing per se might provide only a partial solution, as other economic activities, such as oil exploration, coastal development, or reservoir management, have also had detrimental effects on the water ecosystem (Halpern et al., 2008). The G20 governments should also maintain better fisheries management and monitoring systems to discourage overfishing. These include Maritime Spatial Planning to determine the permitted fishing area across different localities supported by community-based management (Porter, 2004).

Support for union and community institutions to strengthen small-scale actors' bargaining power

Smallholder producers require a cooperative or structured organization to purchase inputs in bulk to benefit from economies of scale, have access to various supports and subsidies, and bargain more effectively with post-harvest dealers. In addition, by maintaining steady supply and demand levels, local producers taking turns during harvest season may be able to better control commodity pricing. Farmers' groups can serve as community institutions for small-scale producers and encourage information diffusion via peer-to-peer learning (Pratiwi & Suzuki, 2017; Pratiwi and Suzuki, 2020), but their effectiveness is limited due to the high cost of information acquisition. G20 governance should support farmers' institutionalization by strengthening extension services and incorporating strong ICTs into such services. While extension services are often plagued by limited outreach in uneven geographical coverage and fiscal sustainability (Fabregas et al., 2019; Lee et al., 2019; Lee & Suzuki, 2020), robust ICT support can aid the farmers' group by encouraging peers' learning and cooperation (Lee & Suzuki, 2020). Additionally, the integration of universities and research institutes into the extension services is indispensable to respond to the timely needs of information or problem-solving for farmers especially to aid decision-making regarding farm management.

Recommendation 2: Assist with integrated environmental planning and inter-actor collaboration to ensure biodiversity conservation.

Support for pollution control and waste management programs to ensure water quality for improved cultivation practices

The effect of untreated wastewater from aquaculture farming on the residents in surrounding villages has serious implications as farmers discharge such water into canals, particularly for producers using river water for domestic and agricultural purposes (Taya, 2003; Pham *et al*., 2010). To deal with such issues, bioremediation using biofilter organisms such as various bivalve species (van der Schatte Olivier et al., 2020) and plant floating beds should be used to revitalise dam operations with improved reservoir functions (Ni *et al*., 2018). Likewise, waste reduction methods such as the use of new generation probiotics or hydroponics are appropriate ways to reduce waste. Water-saving solutions such as biofloc technology should be implemented in intensive and super-intense aquaculture farming operations, in addition to the promotion of new species tolerant to low water quality. In addition, feed management is beneficial to minimize the amount of unconsumed feed and optimize the feed conversion ratio by adopting high-quality diets and efficient feeding methods (Crab et al., 2012; Wu et al., 2015). Improving food supply methods and feed nutrient composition could also be an efficient way to minimize nutrient loads in coastal waters (Jayanthi *et al*., 2018). Further, for aquaculture, the government should encourage subsidies to locally grown inputs, which will incentivize small businesses to meet the rising demand for locally sourced production (Amankwah et al., 2016). For small-scale fishers, as their exploration range is limited and adjacent to the coast, industrial waste is very likely to contaminate the waterways where they fish. The G20 forum should establish and maintain long-term measures of environmental management, such as tools to monitor pollution and waste management in both the coastal area and open water sources. Ultimately, the G20 countries, as one of the global governments, should promote technology transfer and help establish a strong ICT infrastructure so that it can quickly warn regional small-scale actors about potential outbreaks and pollution (Lee & Suzuki, 2020).

Support and provide incentives for farm diversification and best management practices to reduce crop failures caused by recurrent outbreaks

Diversifying farmed species can ensure the viability of the sector for sustaining food production under climate-related shocks and for mitigating the risks of complete crop failures (Metian *et al*., 2020; Pratiwi & Suzuki, 2019). According to FAO (2016), species diversification can be addressed at different spatial levels (local, district, country, global) through several main approaches, namely increasing the number of species being farmed; increasing the evenness of farmed species; and increasing the diversity within currently farmed species by developing new strains. Further, integrated aquaculture-agriculture practices, in particular irrigation-aquaculture,

rice-fish farming, and aquaponics, are especially relevant for smallholders in the regions whose water sources are dependent on rainfed (Barange *et al*., 2018). By allocating more resources to offer farmers evidence-based guidance, the G20 forum could encourage intra- and interregional diversity. Furthermore, antibiotics and anti-parasitic drugs are frequently used to treat infectious diseases caused by bacteria and viruses, but such drugs contain substances harmful to human. The use of such drugs may prevent the products in question from passing quality control for high-value export aquatic commodities, particularly in major importing countries such as the EU, Japan, and the United States (UNIDO, 2013). Accordingly, unless farmers in the exporting countries that commonly use antibiotics in aquaculture change their practices, their market share is expected to be lower than countries with a reputation for drug-free shipments (Lee *et al*., 2019; Suzuki & Vu, 2013; UNIDO, 2013). To safeguard particular species against outbreaks, the G20 countries need to fund more research on diseases and new farm production systems for new fish species, as well as more services and education to disseminate sustainable practices to farmers (Flores-Kossack *et al*., 2020; Lee *et al*., 2019).

Establish careful spatial planning and management in coastal areas since aquaculture development drives the area's land-use change

Simard *et al*. (2008) reported that one-third of the world's mangrove forests have vanished in the last 20 years, with aquaculture accounting for 35% of the loss, which might rise to 60% by 2030. Besides, large-scale conversion of agricultural land into wetland has also been reported (cf. Islam *et al*., 2015), leading to a contestable trade-off between shrimp farming livelihood and coastal resource uses (Jayanthi *et al*., 2020), which include oil exploration and tourism development. Through global governance, the G20 forum needs to establish a spatial planning system for aquaculture zoning that includes consideration of environmental and socioeconomic factors including land type, water quality, water availability, soil characteristics, infrastructure availability, and quality inputs (Jayanthi *et al*., 2020). In particular, geospatial technologies using remote sensing (RS) and Geographical Information systems (GIS) can catalyze long-term sustainable aquaculture development (Rajitha et al, 2007). Some proposed strategic actions to be undertaken are to plan for zoning areas based on particular resource use (cf. Gimpel *et al*., 2018); to implement development project monitoring and environmental impact assessment (Carswell *et al*., 2006; Jayanthi, 2011); to build classification of the site suitability (Hossain & Das, 2010); and to document climatic sensitivity of the regions (Boateng, 2012).

Recommendation 3: Promote greater awareness related to the nutritional advantages and food safety of aquatic food products; and integrate social protection programmes for small-scale aquaculture farmers and fishermen.

Increase awareness of fish as a protein source through incorporation into national food security strategies and basic education and uphold food safety standards

The majority of the countries where fish serves as an important source of animal protein are poor and nutrition-deficient (Béné *et al*., 2015). Fish should be more thoroughly incorporated into different food security plans and initiatives to address nutrition concerns, especially among children and women (High Level Panel of Experts, 2014). Given that women and mothers typically perform the majority of household duties in low- and middle-income nations, they are particularly pertinent and must be included in this movement (cf. Kripa & Surendranathan, 2008). The G20 nations should allocate more funds to marketing and public awareness campaigns through policy dialogue and education, as well as the development of supply infrastructure, in order to boost fish consumption in these markets (FAO, 2020). To maximize consumer utility, produced fish should also be marketed with biological and environmental sustainability indicators, including food safety labeling (Hoque, 2021). Additionally, fish processing facilities should be installed to ensure the quality of the harvested fish, which will promote increased consumption. Fish quality and price point, the two most significant factors in consumer preference, should be continuously monitored by local government bodies and supported by the national government (Uddin et al., 2019). G20 governance should offer veterinary inspections to raise the quality requirements of imported commodities since doing so might potentially limit the flow of contaminated goods that could be hazardous to consumers' health (Urbani, 2016).

Integrate safety net and social protection programs into small-scale actors' livelihoods

In face of climate uncertainty, risk-informed and shock-responsive social protection programmes are critical for mitigating the effects of climate change and natural hazards on the poor and the vulnerable ones (Winder *et al*., 2017). Poor and vulnerable fishermen and farmers may be forced to sell their productive assets, take their children out of school, and migrate (Béné *et al*., 2015). This unforeseen consequence highlights the value of insurance plans, cash transfers, disability benefits, pensions, unemployment benefits, and food handouts, among other things (D'Andrea et al., 2017), to improve people's resilience and capacity to deal with climate and economic shocks (Winder *et al*., 2017). The G20 governments should aim at synergizing plans, in which coherence and coordination between fishery, aquaculture, and social protection interventions can be strengthened. The joint packages of intervention (or “cash plus”), which target the poor and the vulnerable while simultaneously linking them to a wide range of activities and connections with nutrition services can effectively provide multiplier benefits for the poorest groups (FAO, 2017). Furthermore, through strong global governance, the G20 countries can push

for a global insurance program to support vulnerable countries coping with natural disasters and/or pandemics (Barange *et al*., 2018).

References

Amankwah, A., Quagrainie, K. K., & Preckel, P. V. (2016). Demand for improved fish feed in the presence of a subsidy: a double hurdle application in Kenya. *Agricultural Economics*, *47*(6), 633-643.

Asian Development Bank. Operations Evaluation Department. (2005). *An Evaluation of Small-scale Freshwater Rural Aquaculture Development for Poverty Reduction*. Asian Development Bank.

Barange, M., Bahri, T., Beveridge, M. C., Cochrane, K. L., Funge-Smith, S., & Poulain, F. (2018). *Impacts of climate change on fisheries and aquaculture: synthesis of current knowledge, adaptation and mitigation options*. FAO: Rome.

Béné, C., Barange, M., Subasinghe, R., Pinstrup-Andersen, P., Merino, G., Hemre, G. I., & Williams, M. (2015). Feeding 9 billion by 2050–Putting fish back on the menu. *Food Security*, *7*(2), 261-274.

Boateng, I. (2012). An application of GIS and coastal geomorphology for large scale assessment of coastal erosion and management: a case study of Ghana. *Journal of Coastal Conservation*, *16*(3), 383-397.

Carswell, B., Cheesman, S., & Anderson, J. (2006). The use of spatial analysis for environmental assessment of shellfish aquaculture in Baynes Sound, Vancouver Island, British Columbia, Canada. *Aquaculture*, *253*(1-4), 408-414.

Crab, R., Defoirdt, T., Bossier, P., & Verstraete, W. (2012). Biofloc technology in aquaculture: beneficial effects and future challenges. *Aquaculture*, *356*, 351-356.

Cole, S., & Sharma, G. (2017). The Promise and Challenges in Implementing ICT for Agriculture. Working paper.

D'Andrea, M., Franz, N., Poulain, F., Siar, S., & Kalikoski, D. C. (2017). Social Protection to Foster Sustainable Management of Natural Resources and Reduce Poverty in Fisheries-Dependent Communities. *FAO Fisheries and Aquaculture Proceedings (FAO) eng no. 51*.

Dehkordi, S.M.H., Anvar, S.A., Ahari, E.R.H., & Atee, M. (2022). Prevalence, phenotypic and genotypic diversity, antibiotic resistance, and frequency of virulence genes in *Pseudomonas aeruginosa* isolated from shrimps. *Aquaculture International 30*,131-156.

Fabregas, R., Kremer, M., & Schilbach, F. (2019). Realizing the potential of digital development: The case of agricultural advice. *Science*, *366*(6471), eaay3038.

FAO (2016). Planning for Aquaculture Diversification: The Importance of Climate Change and Other Drivers. FAO Fisheries and Aquaculture Department, Rome, Italy.

FAO (2017). FAO social protection framework: promoting rural development for all. Rome. 67 pp. (also available at http://www.fao.org/3/a-i7016e.pdf).

FAO (2020). The State of World Fisheries and Aquaculture 2020 - Sustainable in action. Rome.

Flores-Kossack, C., Montero, R., Köllner, B., & Maisey, K. (2020). Chilean aquaculture and the new challenges: Pathogens, immune response, vaccination and fish diversification. *Fish & Shellfish Immunology*, *98*, 52-67.

Gimpel, A., Stelzenmüller, V., Töpsch, S., Galparsoro, I., Gubbins, M., Miller, D., ... & Watret, R. (2018). A GIS-based tool for an integrated assessment of spatial planning trade-offs with aquaculture. *Science of the Total Environment*, *627*, 1644-1655.

Haji, B. & Workagegn, K.B. (2021). Constraints hindering small scale aquaculture production in southern Ethiopia. *Aquaculture International, 29*, 565-574.

Halpern, B. S., Walbridge, S., Selkoe, K. A., Kappel, C. V., Micheli, F., D'Agrosa, C., ... & Watson, R. (2008). A global map of human impact on marine ecosystems. *Science*, *319*(5865), 948-952.

Hanh, L.M., Phan, V. H., Nghia, N.H., & Jepsen, M.R. (2017). Dependency on aquaculture in northern Vietnam. *Aquaculture International, 25,* 881-891.

High-Level Panel of Experts. (2014). *Sustainable fisheries and aquaculture for food security and nutrition. A report by the high-level panel of experts on food security and nutrition of the committee on world food security*. Rome: FAO.

Hoque, M. Z. (2021). Sustainability indicators for sustainably-farmed fish in Bangladesh. *Sustainable Production and Consumption*, *27*, 115-127.

Islam, G. T., Islam, A. S., Shopan, A. A., Rahman, M. M., Lázár, A. N., & Mukhopadhyay, A. (2015). Implications of agricultural land use change to ecosystem services in the Ganges delta. *Journal of environmental management*, *161*, 443-452.

Islam, S. M. D.- U., & Bhuiyan, A.M. (2016). Impact scenario of shrimp farming in coastal region of Bangladesh: an approach of an ecological model for sustainable management. *Aquaculture International, 24*, 1163-1190.

Jayanthi, M. (2011). Monitoring brackishwater aquaculture development using multi-spectral satellite data and GIS- a case study near Pichavaram mangroves south-east coast of India. *Indian Journal of Fisheries*, *58*(1), 85-90.

Jayanthi, M., Thirumurthy, S., Muralidhar, M., & Ravichandran, P. (2018). Impact of shrimp aquaculture development on important ecosystems in India. *Global Environmental Change*, *52*, 10-21.

Jayanthi, M., Duraisamy, M., Thirumurthy, S., Samynathan, M., Kabiraj, S., Manimaran, K., & Muralidhar, M. (2020). Ecosystem characteristics and environmental regulations based geospatial planning for sustainable aquaculture development. *Land Degradation & Development*, *31*(16), 2430-2445.

Julin, R (2022). WTO Clinches Deal Aimed at Reducing Global Overfishing. Washington DC: Foreign Policy. source: https://foreignpolicy.com/2022/06/17/wto-ocean-conservation-fisheries-subsidies/ accessed 25.6.2022

Kripa, V., & Surendranathan, V. G. (2008). Social impact and women empowerment through mussel farming in Kerala, India. *Development*, *51*(2), 199-204.

Lado, E.P. (2020). Quo Vadis Common Fisheries Policy. Wiley Blackwell. West Sussex, UK. 389 p.

Lee, G., Suzuki A. & Vu, H. N. (2019). The Determinants of Detecting Veterinary Drug Residues: Evidence from Shrimp Farmers in Southern Viet Nam, *Aquaculture Economics & Management*, *23:2*, 135-157.

Lee, G., & Suzuki, A. (2020). Motivation for information exchange in a virtual community of practice: Evidence from a Facebook group for shrimp farmers. *World Development*, *125*, 104698.

Lem, A., Tietze, U., & Ruckes, E. (2004). *Fish marketing and credit in Viet Nam* (No. 468). Rome: Food & Agriculture Organization.

Louis, T.C.S., Filho, M.C. & Flores, R.M.V. (2022). Consumption frequencies, determinants, and habit of aquaculture species in Brazil. *Aquaculture International, 30*, 919-936.

Mandell, L., & Klein, L. S. (2009). The impact of financial literacy education on subsequent financial behavior. *Journal of Financial Counseling and Planning*, *20*(1).

Martini, R (2019). Many government subsidies lead to overfishing. Here's a solution. Paris: OECD. ref: https://www.oecd.org/agriculture/government-subsidies-overfishing/ accessed 25.6.2022

Martini, R. and J. Innes (2018), "Relative Effects of Fisheries Support Policies", *OECD Food, Agriculture and Fisheries Papers*, No. 115, OECD Publishing, Paris, https://doi.org/10.1787/bd9b0dc3-en.

Metian, M., Troell, M., Christensen, V., Steenbeek, J., & Pouil, S. (2020). Mapping diversity of species in global aquaculture. *Reviews in Aquaculture*, *12*(2), 1090-1100.

Mondal, H., Chandrasekaran, N., Mukherjee A., & Thomas, J. (2022). Viral infections in cultured fish and shrimp:current status and treatment methods. *Aquaculture International, 30*, 227-262.

Ni, Z., Wu, X., Li, L., Lv, Z., Zhang, Z., Hao, A., ... & Li, C. (2018). Pollution control and in situ bioremediation for lake aquaculture using an ecological dam. *Journal of cleaner production*, *172*, 2256-2265.

Ongkittikul, S., Plongon V. , Sukruay J., & Yisthanichakul K. (2019), The Cold Chain in Thailand, *In The Cold Chain for Agri-food Products in ASEAN (pp. 8-61). ERIA Research Project Report, No. 11.*

Obiero, K.O., Waidbacher, H., Nyawanda, B.O., Munguti, J.M., Manyala, J.O. & Kaunda-Arara, B. (2019). Predicting uptake of aquaculture technologies among smallholder fish farmers in Kenya. *Aquaculture International, 27,*1689-1707.

Oviedo-Bolanos, K., Rodriguez-Rodriguez, J.A., Sancho-Blanco, C., Barquero-Chanto, J.E., Pena-Navarro, N., Escobedo-Bonilla, C., & Umana-Castro, R. (2021). Molecular identification of *Streptococcus* sp. and antibiotics resistance genes present in Tilapia farms (*Oreochromis niloticus*) from the Northern Pacific region, Costa Rica. *Aquaculture International, 29,*2337-2365.

Pham, T., Kroeze, C., Bush, S., & Mol, A. (2010). Water Pollution by Intensive Brackish Shrimp Farming in South-East Vietnam: Causes and Options for Control. *Agricultural Water Management*, *97*, 872–882.

Porter, G. (2004). Analyzing the resource impact of fisheries subsidies: a matrix approach. *Geneva: United Nations Development Programme.* Retrieved from https://policycommons.net/artifacts/109143/analysing-the-resource-impact-of-fisheries-subsidies/ on 11 Apr 2022. CID: 20.500.12592/3v1zbh.

Pratiwi, A., & Suzuki, A. (2017). Effects of farmers' social networks on knowledge acquisition: Lessons from agricultural training in rural Indonesia. *Journal of Economic Structures*, *6*(1), 1-23.

Pratiwi, A., & Suzuki, A. (2019). Reducing agricultural income vulnerabilities through agroforestry training: evidence from a randomised field experiment in Indonesia. *Bulletin of Indonesian Economic Studies*, *55*(1), 83-116.

Pratiwi, A., & Suzuki, A. (2020). Does training location matter? Evidence from a randomized field experiment in Rural Indonesia. *Agricultural and Food Economics*, *8*(1), 1-23.

Pratiwi, A., Lee, G., & Suzuki, A. (2021). Company–Community Partnership and Climate Change Adaptation Practices: The Case of Smallholders Coffee Farmers in Lampung, Indonesia. In *Climate Change Research, Policy and Actions in Indonesia* (pp. 79-98). Springer, Cham.

Quagrainie, K.K., Ngungi, C.C. & Amisah, S. (2010). Analysis of the use credit facilities by small-scale fish farmers in Kenya. *Aquaculture International, 18*, 393-402.

Rajitha, K., Mukherjee, C. K., & Chandran, R. V. (2007). Applications of remote sensing and GIS for sustainable management of shrimp culture in India. *Aquacultural Engineering*, *36*(1), 1-17.

Simard, M., Rivera-Monroy, V. H., Mancera-Pineda, J. E., Castañeda-Moya, E., & Twilley, R. R. (2008). A systematic method for 3D mapping of mangrove forests based on Shuttle Radar Topography Mission elevation data, ICEsat/GLAS waveforms and field data: Application to Ciénaga Grande de Santa Marta, Colombia. *Remote Sensing of Environment*, *112*(5), 2131-2144.

Sriboonchitta, S., & Wiboonpoongse, A. (2008). Overview of contract farming in Thailand: Lessons learned, *ADBI Discussion Paper, 112*.

Suzuki, A., & Vu, H. N. (2013). Status and constraints of costly port rejection: A case from the Vietnamese frozen seafood export industry. *IDE Discussion Paper*, *No. 395.*

Suzuki, A., & Nam, V.H. (2018). Better management practices and their outcomes in shrimp farming: evidence from small-scale shrimp farmers in Southern Vietnam. *Aquaculture International, 26,*469-486.

Taya, K. (2003). Asia no Ebi Youshoku to Boueki (shrimp aquaculture and trade in Asia) (in Japanese). Tokyo: Seizando.

Tallar, R.Y. & Suen, J.-P. (2016). Aquaculture Water Quality Index: a low-cost index to accelerate aquaculture development in Indonesia. *Aquaculture International, 245*, 295-312.

Uddin, M. T., Rasel, M. H., Dhar, A. R., Badiuzzaman, M., & Hoque, M. S. (2019). Factors determining consumer preferences for Pangas and Tilapia fish in Bangladesh: consumers' perception and consumption habit perspective. *Journal of Aquatic Food Product Technology*, *28*(4), 438-449.

UNIDO. (2013). Meeting standards, winning markets regional trade standards compliance report East Asia 2013. Vienna: United Nations Industrial Development Organization.

Urbani, R. (2016). Veterinary controls in international fish trade. *GLOBEFISH Research Programme*, *121*, I.

van der Schatte Olivier, A., Jones, L., Vay, L. L., Christie, M., Wilson, J., & Malham, S. K. (2020). A global review of the ecosystem services provided by bivalve aquaculture. Reviews in Aquaculture, 12(1), 3-25.

Villarreal, F. G. (2017). Financial inclusion of small rural producers. Santiago: Economic Commission for Latin America and the Caribbean (ECLAC) (also available at https://repositorio.cepal.org/bitstream/handle/11362/42639/S1700575_en.pdf).

Winder Rossi, N., Spano, F., Sabates-Wheeler, R., Kohnstamm, S., & Harvey, P. (2017). *Social protection and resilience: supporting livelihoods in protracted crises and in fragile and humanitarian contexts*. FAO Position Paper. Rome, FAO. Institute for Development Studies. (also available at http://www.fao.org/3/a-i7606e.pdf).

Wu, Y., Han, H., Qin, J., & Wang, Y. (2015). Effect of feeding frequency on growth, feed utilization, body composition and waste output of juvenile golden pompano (Trachinotus ovatus) reared in net pens. Aquaculture Research, 46(6), 1436-1443.