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RESEARCH ARTICLE

Supply and Value Chain Analysis of Freshwater Sardine, *Sardinella tawilis* (Herre 1927), in Taal Lake, Batangas, Philippines

Myla C. Muyot, Rielyn L. Balunan, Maria Theresa M. Mutia*

National Fisheries Research and Development Institute-Freshwater Fisheries Research and Development Center, Butong, Taal, Batangas

ABSTRACT

The supply and value chain of the world's only freshwater sardine, *Sardinella tawilis* endemic to Taal Lake, were studied from January to December 2016. This study aimed to identify the actors in the value chain, evaluate each actor's value addition, identify the roles of men and women in the chain, and identify the issues, concerns, and entry points for intervention. Key informant interviews, focus group discussions, and tracer survey interviews were done to gather data. A semi-structured questionnaire was directed to 189 respondents within and outside Taal Lake. The study showed that the *tawilis* marketing system is limited to the local market. *Tawilis* is traded fresh and processed. The chain's key actors include the fishers, fish buyers (wholesaler, retailer, peddlers, and contracted fish buyers), processors, and consumers. The outcome of the value chain analysis of the *tawilis* industry showed that commercial processors have the highest value-added due to the place, form, and time transformation of the product. Meanwhile, the fishers and small-scale fish buyers have the lowest value-added during lean and peak season, respectively. The *tawilis* industry provides livelihood to the marginal fisherfolk, which is the first supply chain link. Several strategies were recommended in the form of process, product, function, and overall upgrading to uplift the economic benefit of the different actors in the chain and boost the *tawilis* industry. These include the improvement on the fishing operations, upgrading of fishing gear and other paraphernalia, provision of training on post-harvest techniques (handling, preservation, processing, value-adding, product development, etc.), market matching strategies, improvement in farm to market road transportation, establishment of fish processing facilities, and access to credit, loans or grants from the national and local governments.

*Corresponding Author: *tmmutia@yahoo.com*
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1. INTRODUCTION

Sardinella tawilis is the only freshwater species under the genus Sardinella endemic to Taal Lake, Batangas, Philippines (Wongratana 1980; Whitehead 1985; Mutia 2011; Mutia et al. 2018a; Mutia et al. 2018b). It is locally known as *tawilis* that belongs to the family Clupeidae and one of the most commercially important fish species in Taal Lake's inland fisheries (Almazan et al. 2011; Mutia et al. 2011, Mutia et al. 2018b). *S. tawilis* was identified as a sister species of the Taiwanese marine sardinella, *Sardinella hualiensis*, due to morphological similarity (Willette et al. 2014). *S. tawilis* is mainly caught by gill net, beach seine, and motorized push net. It is the top species caught in Taal Lake; hence local fisherfolk depend on this species as their primary source of livelihood and income. However, its production declined from 744 MT in 1996 to 71 MT in 2011 with a high exploitation rate from 0.52 to 0.65, indicating unsustainable fishing practices. This is mainly due to several factors such as illegal use of active fishing gear, proliferation of alien fish species, and increasing pollution load contributed by improper aquaculture practices (Mutia et al. 2011; Mutia et al. 2018a; Mutia et al. 2018b). The International Union for Conservation of Nature (IUCN) has assessed the *Sardinella tawilis* as an "endangered" species due to

the continuing decline in the number of mature individuals and the estimated harvest declined by 49% over the past 10 years (Santos et al. 2018). Several biological studies have been conducted by researchers (Magsino 2012; Mutia et al. 2018a; Mutia et al. 2018b; Papa et al. 2008; Quilang et al. 2011) to conserve and manage this species. Almazan did the potential impact of contracts on the sustainability of the bottled *tawilis* supply chain in 2011. However, studies on the supply and value chain of *tawilis* industry are limited.

Value chain analysis (VCA) is a useful analytical tool that enables industry examination for future development at every step of the chain (De Silva 2011; Brown et al. 2010). It is essential to improve the lives, alleviate poverty, and reduce income inequality among the marginalized people in the country by providing opportunities and an enabling environment for both poor men and women and communities to take part or develop their participation in productive market activities (Brown et al. 2010).

This study aimed to identify effective pathways for the sustainable use and improvement of *tawilis* industry to support inland nearshore communities. Specifically, the study aimed to (1) identify the actors in the value chain; (2) quantify the value addition created in each actor; (3) identify the roles of men and women in the chain; and (4) identify the issues, concerns, and entry points for interventions.

2. MATERIALS AND METHODS

2.1 Conceptual Framework

The study was guided by the VCA research framework (Figure 1) adapted from Brown et al. (2010), which served as a tool in generating and analyzing data which consisted of three major steps: 1) assessment of the existing market; 2) value chain mapping which aimed to answer the following questions: (a) who are the key customers, (b) who are the key actors in the chain and what are their respective roles, (c) what are the activities and processes along the chain, (d) what are the value additions of each actor in the chain, (e) what are the roles of men and women along the chain, and (f) what are the constraints and opportunities or areas that need to be developed for value chain upgrading; and 3) government interventions which include a recommendation for programs, policy, and institutional reforms.

VCA enables the identification of constraints to industry growth and competitiveness and leads to a better understanding of relationships and linkages among the actors in the chain (Brown et al. 2010). It is conducted to identify areas for upgrading the chain, including the process, product, and function

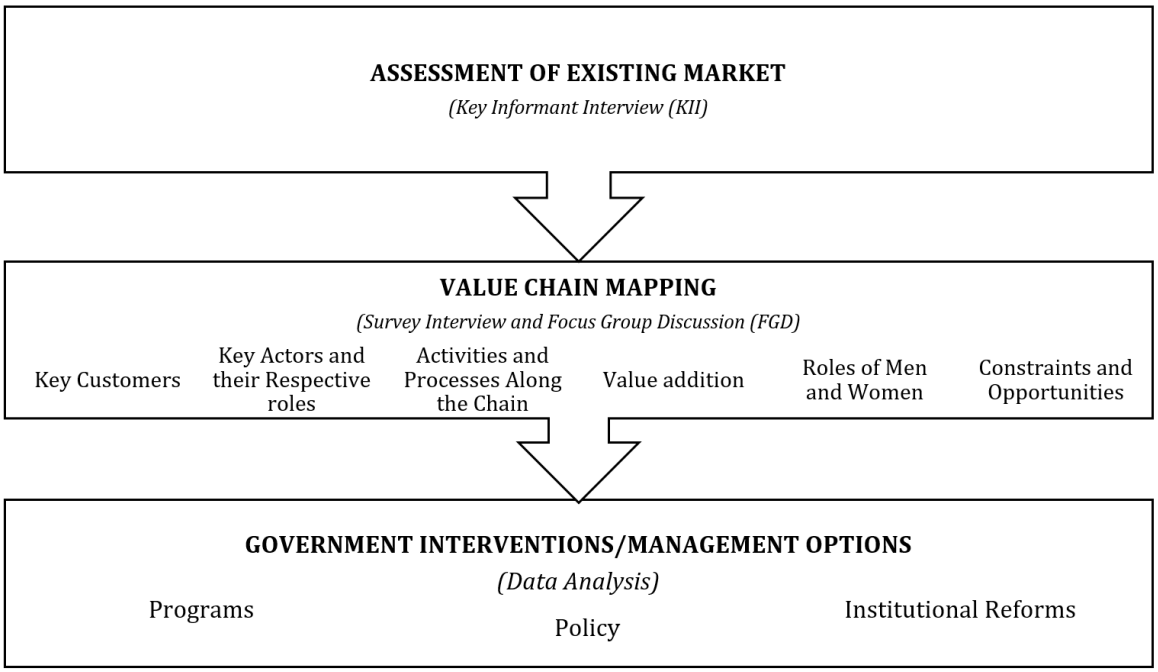

Figure 1. Framework for value chain analysis (Brown et al. 2010)

or overall chain itself. Process upgrading aims to reduce the number of links and friction (bottlenecks, cost incurred, and time to market), reducing cost along the chain. Process upgrading may be achieved by improving the processes within the chain and the efficiency within the business. Product upgrading may be performed by introducing new products or transforming the existing ones, while for function upgrading, it may be achieved by changing the activity procedures. Overall chain upgrading is when the current chain is being transformed into new and higher value products. Upgrading may also be achieved through the external environment's interventions, such as the policy and institutions, to improve infrastructure towards the effectiveness and efficiency of a particular value chain (Brown et al. 2010).

2.2 Study Area and Period

The study covered eight municipalities and two cities surrounding Taal Lake (Figure 2). The study areas include 25 barangays in Agoncillo (Brgy. Subic Ibaba, Subic Ilaya, Pansipit and San Teodoro), Alitagtag (Brgy. Tadlac), Balete (Brgy. Sala), Mataasnakahoy (Brgy. Kinalaglagan, Nangkaan, Lumang Lipa, and Brgy. II-A Poblacion), Sta. Teresita (Brgy. Saimsim, Calumala, and Tambo), Cuenca (Brgy. Don Juan and Sitio Napapanayan), San Nicolas (Brgy. Abelo, Tagudtod, Balete Ilaya, and Pulangbato), Tanauan City (Brgy. Ambulong and Ma. Paz), Talisay (Brgy. Aya, Quiling, and Binintiang Malaki), and Lipa City (Brgy. Tagbakin).

The study areas were identified based on the existing database of the National Stock Assessment Program (NSAP) of the National Fisheries Research and Development Institute (NFRDI) (NFRDI 2016).

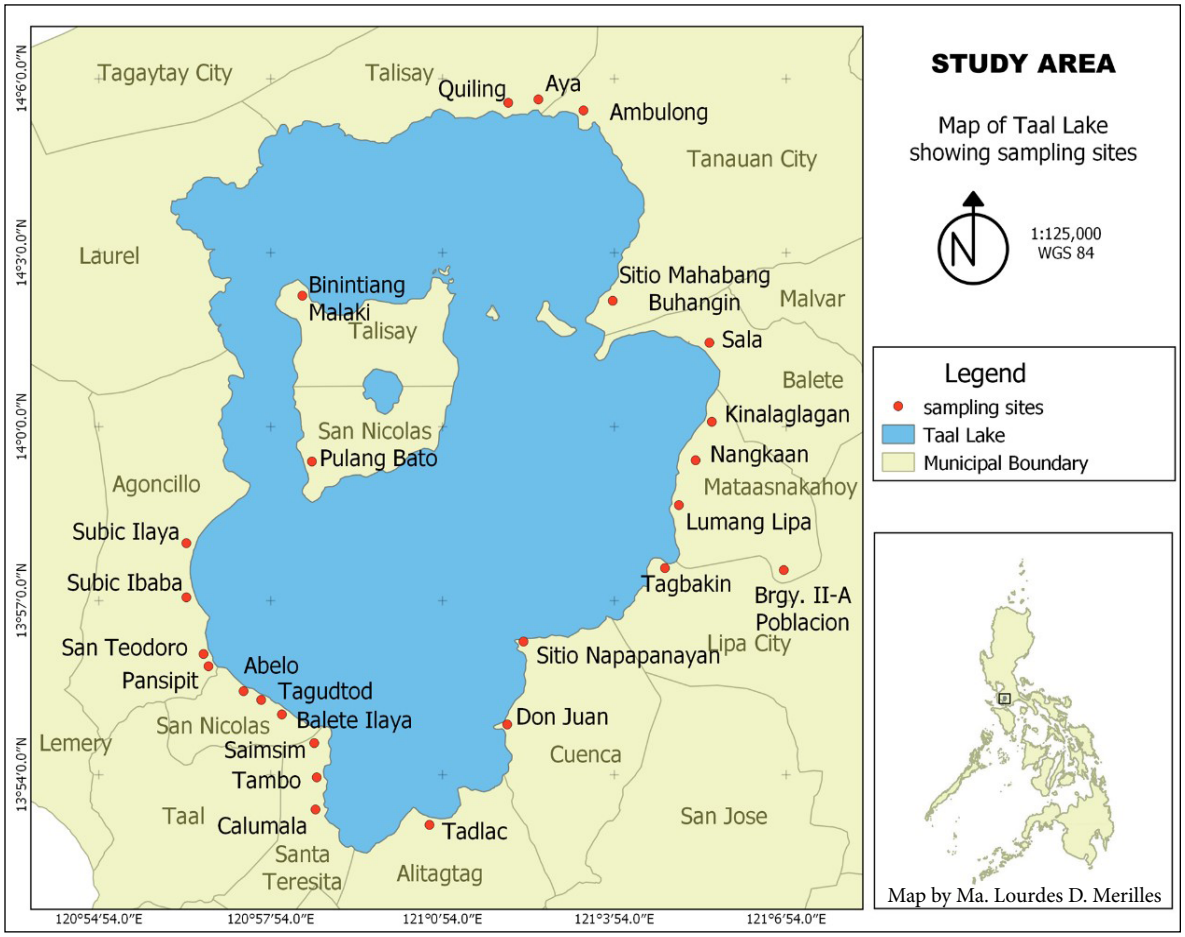

Figure 2. Map showing the 25 study areas in Taal Lake

2.3 Data Collection

2.3.a Secondary Data Gathering

Secondary data collection was conducted through a desktop review of related printed materials, websites relating to supply and value chain, published reports, and peer-reviewed journal articles. The number of *tawilis* fishers and production data were retrieved from the NSAP database.

2.3.b Primary Data Gathering

2.3.b.1 Key Informant Interview

Information on the existing *tawilis* market industry was gathered through the Key Informant Interview (KII) with the different local government officials around Taal Lake. The number of *tawilis* fishers was established, and the list of *tawilis* fish buyers and processors was traced after interviewing the different stakeholders.

2.3.b.2 Survey Interview

Tracer survey interview was conducted to target respondents to build the detailed value chain map and determine the following: (1) key customers, (2) actors in the chain and their respective roles, (3) activities and processes along the chain, (4) value additions of each actor in the chain, (5) roles of men and women along the chain, and (6) constraints and opportunities or areas that need to be developed for value chain upgrading. The key actors were interviewed using semi-structured questionnaires, which were pre-tested before the actual survey. The questionnaires provide information on respondents' socio-demographic profiles, roles, activities, and processes, issues, and concerns in the value chain.

2.3.b.3 Focus Group Discussion

A Focus Group Discussion (FGD) was conducted with the key chain actors and the Municipal Agriculture Officers (MAOs) of each study area to validate the analyzed results based on the interview. The FGD also conducted a SWOT analysis to identify the strengths, weaknesses, opportunities, and threats that can lead to the actors' awareness and successful participation in the chain and reveal prospective starting points for possible interventions.

2.3.b.4 Roles of Men and Women in the Chain

Information on the roles, activities, and responsibilities of men and women in fishing, trading, and processing were gathered from the survey interview using the semi-structured survey questionnaire.

2.4 Data Analysis

All primary data gathered from the interview were encoded and tabulated using MS Excel 2007. Mapping and analyzing the chain uses both qualitative and quantitative tools. The qualitative part involved identifying actors and their respective roles, relationships between them, activities and processes along the chain, and the issues and concerns. The quantitative part involved the creation of costs and income covering the entire components of the chain. Exploratory factor analysis and descriptive statistics such as measures of central tendency and frequency were performed. The cost of catching the fish among fishers, the cost of product transformation among buyers, sellers, and processors, gross value-added, and value-added net of value-adding cost were computed. The value-added refers to the increment in the value of the original product arising from further utilization of capital, labor, and entrepreneurship to transform the products sold to the next actor in the value chain.

3. RESULTS AND DISCUSSION

3.1 Overview of *tawilis* fish industry in the Philippines

Tawilis is the major fish species caught in Taal Lake, accounting for 57% of the total fish production (Mutia et al. 2018a). *Tawilis* harvest was 1,120 MT in 1998 and declined to 71 MT in 2011. Recent data showed a slight increase of 378 MT in 2016 (NFRDI 2016). *Tawilis* is mainly caught by gillnet, motorized push net, and beach seine. Gillnet is a passive gear and has the lowest catch per unit effort (CPUE) of 4.4 kg/day in 2011 (Mutia et al. 2018a). Motorized push net and beach seine are active gears that are prohibited in the lake. These gears have the highest CPUE in 2011, with 222 kg/day and 73 kg/day for motorized push net and beach seine, respectively. The excessive fishing of these two active gears contributed to the high exploitation indicating overfishing. The use of gillnet and the right mesh size of nets are recommended for a sustainable *tawilis* fishery in the lake (Alba et al. 2018).

Tawilis is traded fresh and processed (braised or *sinaing*, fried, dried or *tuyo*, and bottled). At present, there are small-scale and large-scale processors. Most small-scale processors are located in Balete, Batangas who process *sinaing na tawilis* with a volume of 5 to 10 kilograms three times a week, while large-scale processors are situated in Balete and Malvar, Batangas. On the other hand, restaurants in Talisay, Batangas and Tagaytay City, Cavite serve fried *tawilis* on their menu.

Currently, there is no global market for these *tawilis*. The major destinations of *tawilis* products are the local markets, restaurants, resorts, and supermarkets within Batangas, Tagaytay, Cavite, and Manila.

3.2 Mapping the Value Chain

3.2.a Key Customers and Product Requirements

Based on the KII and available literature, *tawilis* is a commodity traded in the Philippines, mainly in the CALABARZON and National Capital Region, where the locals and tourists are the key customers. *Tawilis* is marketed as fresh, braised or *sinaing*, fried, dried or *tuyo*, and bottled. The products are available in the local market, restaurants, resorts, and supermarkets. Since *tawilis* is an endemic species and a delicacy, it commands a high price, especially when processed.

The size and quality of *tawilis* are the most essential product requirements. Prices vary depending on the size, season, fishing gear used, and volume of harvest. Bigger size *tawilis* command higher price. The prices are also increased during the lean season as compared to the peak season.

3.2.b. Key Actors and their Respective Roles

A total of 189 respondents categorized into 159 fishers, 25 fish buyers, and five processors were interviewed who are involved in collecting or harvesting, trading, and processing of *tawilis* in Taal Lake (Figure 3; Table 1). Out of these, seven key actors were identified to be involved in the *tawilis* value chain. These are the fishers, fish buyers (wholesaler, retailer, peddler or maglalako, and contracted fish buyers), processors, and consumers.

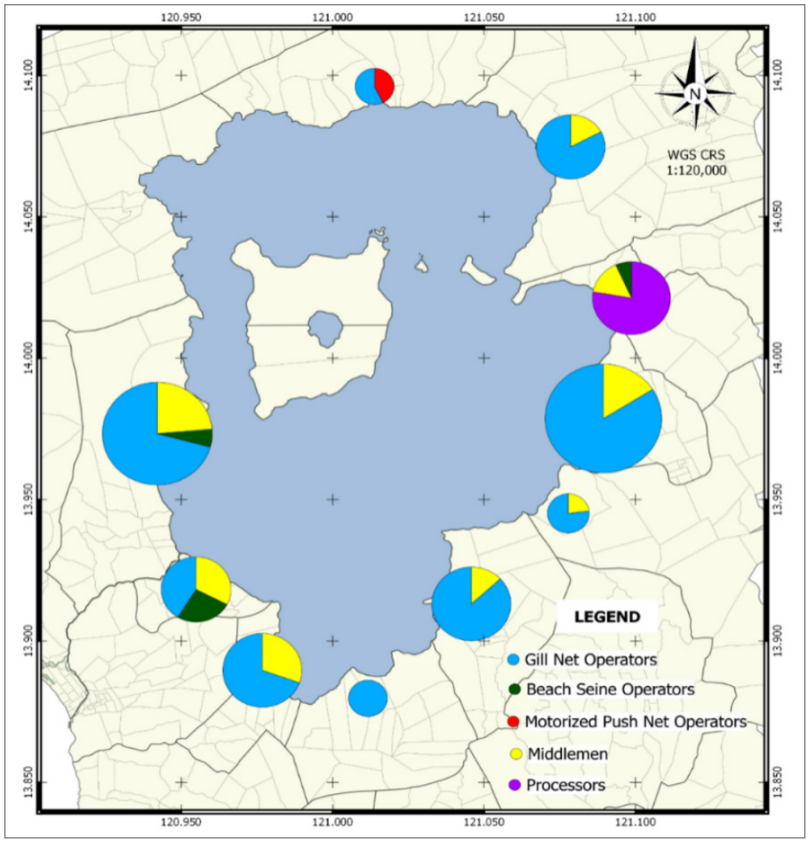

Figure 3. Distribution of *tawilis* value chain stakeholders in Taal Lake

Table 1. Categories and distribution of interviewed stakeholders in Taal Lake

Municipality	Fisher	Fish Buyer	Processor	TOTAL	%
Agoncillo	35	6		**41**	**22**
San Nicolas	21	8		**29**	**15**
Sta. Teresita	23	2		**25**	**13**
Cuenca	16	2		**18**	**9.5**
Lipa	5			**5**	**3**
MataasnaKahoy	34			**34**	**18**
Balete	3	2	5	**10**	**5**
Tanauan	22	4		**26**	**14**
Talisay		1		**1**	**0.5**
TOTAL	**159**	**25**	**5**	**189**	**100**

Fishers: The fisher is the first link of the chain. *Tawilis* is caught in the open waters of the lake. Gillnet and beach seine operators were included in the tracer study. Out of the 159 fishers interviewed, 79% were male and 21% female (Table 2). Youngest fisher aged less than 20 years old while eldest fisher aged over 70 years old. The majority of the fishers are married and have secondary education. A few of the fishers have no formal education. Fishing experience ranged from one to over 40 years with an average of 21 to 40 years. Sixty-eight percent (68%) of the respondents do not have other sources of income except fishing. Peak fishing season is during March, April, and May, which coincides with the spawning season of *tawilis* (Mutia et al. 2018b). The majority of the head of the family (father) are the respondents. Most fishers have 4-6 family members, and few have more than 10 family members (Table 3). Their household income ranged from PHP 1,000.00 to 5,000.00 per month.

Fish buyers: They are the intermediaries that place the second link in the chain. They play a significant role in supplying raw materials and processed products to processors and consumers. There were four kinds of fish buyers: wholesalers, retailers, peddlers or maglalako, and contracted fish buyers (contracts with processors and wholesalers). The study of Almazan et al. (2011) identified only three fish buyers in Taal Lake, and these are the peddlers, primary fish buyers, and contracted fish buyers (contract with processors). Wholesalers are the ones who purchase *tawilis* in larger quantities and sell to the retailers for resale. Retailers are the ones who sell fresh or processed tawilis to the public in smaller quantities for consumption and not for resale. In contrast, peddlers are the ones who sell the newly landed catch to their neighbors by walking. Some of these fish buyers trade among themselves. Twenty-five (25) fish buyers were interviewed, and most of them were female peddlers or maglalako and wives of fishers (Table 2). The youngest fish buyer aged between 20 to 29 years old, while the eldest fish buyer was over 70 years old. Most are married and have secondary education. The highest educational attainment was tertiary level, and no respondents have no schooling at all. Most of the respondents are female, and most of them are the head of the family (Table 3). Mostly have 4-6 family members. Their household income ranged from PHP 2,000.00 to PHP 6,000.00 per month. In terms of marketing, they dominate the chain.

Processors: There were only five processors identified and interviewed (Table 2). In Taal Lake, there is limited access to processing plants and facilities. The processing activities include braising or *sinaing*, bottling, and drying. There is only one commercial-scale processing plant in Balete, Batangas, and the rest of the four are small-scale or home-based processors. All interviewed processors were female, all are married and reached the college level of education. Their household income ranged from PHP 1,500.00 to PHP 2,500.00 per month (Table 3).

Consumers: They are the person or group who buy the product for consumption and the chain's last actors. The consumers are the local people and tourists in the community and nearby municipalities and cities.

Table 2. Socio-economic profile of *Sardinella tawilis* stakeholders

	Characteristics	Percentage (%)		
		Fisher (n=159)	Fish Buyer (n=25)	Processor (n=5)
Sex	M	79	13	0
	F	21	88	100
Age	<20	1		
	20-29	9	4	
	30-39	21	13	
	40-49	30	29	20
	50-59	25	29	40
	60-69	11	21	40
	≥70	3	4	
Marital Status	Single	9		
	Married	86	88	80
	Separated	1		
	Widowed	4	13	20
Educational Attainment	Elementary Level	38	46	80
	High School	50	50	
	College Level (Undergraduate)	4		20
	College Level	5	4	
	Others (No formal education)	3		

Table 3. Household profile of *Sardinella tawilis* stakeholders

Characteristics		Percentage (%)		
		Fisher (n=159)	Fish Buyer (n=25)	Processor (n=5)
Head of Household	Self/Respondents	69	33	20
	Mother	2	0	
	Father	16	13	
	Son	0	0	
	Daughter	0	0	
	Grandson	1	0	
	Granddaughter	0	0	
	Other relatives (Husband, wife, brother)	13	54	80
Household Size	1-3	16	21	
	4-6	53	54	60
	7-9	24	25	20
	≥10	7	0	20
Ave. Household Income (per month)		1,000-5,000	2,000-6,000	1,500-2,500

Figure 4 shows the flow of *tawilis* supply from the collection up to the final consumption. The first chain starts from the fishers to buyers to processors and lastly to the consumers. The longest supply chain identified was from the fishers to fish buyers (wholesalers) to processors and then again to fish buyers (retailers) and finally to the end-users who are the consumers. The shortest supply chain was from the fishers directly to the consumers.

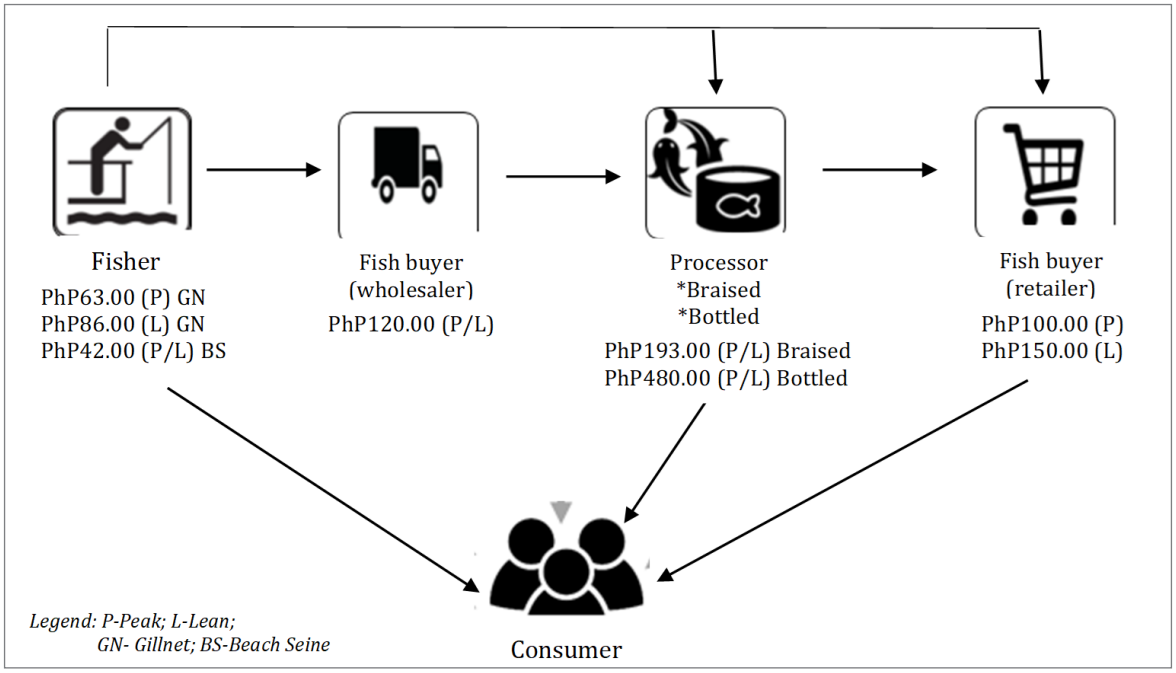

Figure 4. Supply and value chain map of *S. tawilis* in Taal Lake

3.2.c. Activities, Processes, and Cost Along the Chain

Processes and cost distribution per actor per operation are presented in Table 4. Harvesting of *tawilis* involves the use of gillnet and beach seine fishing gears. The size of *tawilis* being caught using gillnet is larger compared to the catch of beach seine. Costs are separated during peak and lean seasons for both fishing gears. It is further categorized into fixed, intermediate, labor, and transportation costs. Fixed costs involve boat, net, engine, and containers (polystyrene box, cooler, and basin), and the rest are for the intermediate, labor, and transportation costs. A boat with engine, fishing gear, container, labor, food, and fuel are the major cost items needed. The average cost spent by the gillnetters was PHP 390.00, including the labor cost, fuel, maintenance of boat engine, and nets. The fishers and their family members' labor cost in fishing was PHP 150.00 per operation since the gillnetters only spend 2-3 hours fishing. This is to set the gillnet in the lake in the afternoon and retrieve the net at dawn. For beach seine, there are 15 crew members on average per hauling process. Each crew member has a labor cost of PHP 150.00. Aside from labor cost, fuel, boat, and engine, weighing scale and fish containers are the cost incurred by the beach seine operators with a total cost of PHP 3,225.00. There is no transportation cost for beach seine fishers since fish buyers are already waiting at the fish landing site to purchase fresh *tawilis* for trading. Beach seine fishers do not operate during lean season. For gillnet operators, *tawilis* are sorted upon arrival to the lakeshore. Others opt to sort *tawilis* inside the boat right after the hauling process and placed them in a container with the addition of lake water, salt, and crushed ice. Sorting is done by removing the entangled fish from the net and removing the grasses. After that, the fish are ready to be traded.

The average value-adding cost per kilogram of *tawilis* gillnet operators is higher during the lean season at PHP 97.50 per kg compared to peak season at PHP 20.53 per kg because of the same amount of labor cost, fuel, ice, and food spent and the lower volume of catch obtained. In comparison, beach seine operators have an average value-adding cost of PHP 16.13 per kg, lower than the gillnet operators. This is because of the higher volume of *tawilis* being caught every operation (Table 5).

Table 4. Processes and cost incurred per actor (CY 2016)

	Process	Materials/ Equipment Needed	QTY.	Price per Unit (PhP)	Variable Cost per operation*	Economic Life (Years)	Annual Depreciation Cost
Fishers (gillnetters)	Collecting	Boat & Engine	1	32,000.00		20	1,600.00
		Gill net	20	700.00		6	2,333.33
		Gasoline	1	45.00	45.00		
		Lubricant	1	75.00	75.00		
		Labor	1	150.00	150.00		
		Food	2	50.00	100.00		
	Sorting	Weighing Scale	1	850.00		2	425.00
	Transportation	Fare	1	20.00	20.00		
TOTAL					**390.00**		**4,358.33**
Fishers (beach seiners)	Collecting	Boat & Engine	1	32,000.00		20	1,600.00
		Non Motorized Boat	1	10,000.00		10	1,000.00
		Gasoline	5	45.00	225.00		
		Labor	15	150.00	2,250.00		
	Sorting	Fish container	5	600.00		3	1,000.00
		Weighing Scale	1	850.00		2	425.00
		Food	15	50.00	750.00		
TOTAL					**3,225.00**		**4,025.00**
Fish Buyers (small-scale)	Purchasing	Cooler	1	800.00		2	400.00
		Weighing scale	1	900.00		2	450.00
		Ice	1	100.00	100.00		
		Fresh Tawilis (Peak)	46	70.00			
		Fresh Tawilis (Lean)	25	113.00			
		Plastic	1	65.00	65.00		
	Transportation	Tricycle	2	50.00	100.00		
		Gasoline	1	45.00	45.00		
		Labor	2	200.00	400.00		
		Food	2	50.00	100.00		
TOTAL					810.00		850.00
Fish Buyers (large-scale)	Purchasing	Weighing scale	1	900.00		2	450.00
		Cooler	1	800.00		2	400.00
		Ice	1	100.00	100.00		
		Labor	1	200.00	200.00		
		Food	1	100.00	100.00		
		Fresh Tawilis (Peak)	200	103.00			
		Fresh Tawilis (Lean)	100	103.00			
	Stocking	Plastic	1	65.00	65.00		
		Ticket	1	30.00	30.00		
		Water	1	30.00	30.00		
	Transportation	Gasoline	1	45.00	45.00		
		Labor	2	200.00	400.00		
TOTAL					**970.00**		**850.00**

Continuation… Table 4. Processes and cost incurred per actor (CY 2016)

Actors	Process	Materials/ Equipment Needed	QTY.	Price per Unit (PhP)	Variable Cost per operation*	Economic Life (Years)	Annual Depreciation Cost
Processor (Braised tawilis)	Purchasing	Fresh Tawilis	10	50.00			
	Processing	LPG	1	500.00		10	50.00
		Stove	1	800.00		3	266.67
		Casserole	1	200.00		2	100.00
		Ingredients	1	30.00	30.00		
		Banana Leaves	1	10.00	10.00		
		Microwavable plastic	35	9.00	315.00		
		Labor	2	200.00	400.00		
		Food	2	100.00	200.00		
	Transportation	Fare	1	20.00	20.00		
TOTAL					**975.00**		**416.67**
Processor (Bottled tawilis)	Purchasing	Fresh Tawilis	50	70.00			
	Processing	LPG	1	500.00		5	100.00
		Pressure cooker	1	29,000.00		10	2,900.00
		Burner	1	750.00		5	150.00
		Sealer	1	650.00		2	325.00
		Charcoal	10	5.00	50.00		
		Seasonings	1	100.00	100.00		
		Plastic	1	10.00	10.00		
		Bottle	100	12.00	1,200.00		
		Ingredients	1	500.00	500.00		
		Labor	2	200.00	400.00		
TOTAL					**2,260.00**		**3,475.00**

**Cost of fresh tawilis or raw materials not included to compute for change in value due to transformation that uses these other variable cost items.*

Table 5. Cost of raw materials, cost of value-adding, and estimates of the value-added net of cost among various actors in the *tawilis* value chain, Taal Lake, Philippines, 2016

Cost Item	Fisher			Fish Buyer				Processor	
	Gillnetter		Beach Seiner	Small-scale		Large Scale		Braised	Bottled
	Peak	Lean	Peak	Peak	Lean	Peak	Lean	Peak/ Lean	Peak/ Lean
Value of tawilis materials (PhP/kg)				70.00	113.00	103.00	103.00	50.00	70.00
Quantity of tawilis materials (kg)				46	25	200	100	10	50
Total value of tawilis materials (PhP)				3,220.00	2,825.00	20,600.00	10,300.00	500.00	3,500.00
Quantity of end-product traded (kg)	19.00	4.00	200.00	46.00	25.00	200.00	100.00	10.00	50.00
Average value of product traded (PhP/kg)	63.00	86.00	42.00	100.00	150.00	120.00	120.00	193.00	480.00

Continuation… Table 5. Cost of raw materials, cost of value-adding, and estimates of the value-added net of cost among various actors in the *tawilis* value chain, Taal Lake, Philippines, 2016

Cost Item	Fisher			Fish Buyer				Processor	
	Gillnetter		Beach Seiner	Small-scale		Large Scale		Braised	Bottled
	Peak	Lean	Peak	Peak	Lean	Peak	Lean	Peak/ Lean	Peak/ Lean
Total value of product traded (PhP)	1,197.00	344.00	8,400.00	4,600.00	3,750.00	24,000.00	12,000.00	1,930.00	24,000.00
Value-adding cost (PhP)*	390.00	390.00	3,225.00	810.00	810.00	970.00	970.00	975.00	2,260.00
Average value-adding cost (PhP/kg of product)	20.53	97.50	16.13	17.61	32.40	4.85	9.70	97.50	45.20
Total gross value-added (PhP)	1,197.00	344.00	8,400.00	1,380.00	925.00	3,400.00	1,700.00	1,430.00	20,500.00
Gross value-added (PhP/ kg)	63.00	86.00	42.00	30.00	37.00	17.00	17.00	143.00	410.00
Total value-added net of cost (PhP)	807.00	-46.00	5,175.00	570.00	115.00	2,430.00	730.00	455.00	18,240.00
Value-added net of cost (PhP/kg)	42.47	-11.50	25.88	12.39	4.60	12.15	7.30	45.50	364.80

**Only including the cost of materials or variable cost items listed in Table 4, but not including depreciation cost of equipment, other investment items, and other fixed costs proportionate to the volume harvested, sold, or processed described.*

Fishers sell their catch either directly to the consumers or small-scale and commercial fish buyers. The majority of the fishers sell their catch to small-scale and commercial fish buyers, who usually dictate the price based on the fishers' volume of catch. On the other hand, the price of *tawilis* can be dictated by the fishers when they are sold directly to the consumers, which is relatively at a higher price than the fish buyers. The average value-adding cost per kilogram incurred by small-scale fish buyers is PHP 17.61 per kg during the peak season and PHP 32.40 per kg during the lean season (Table 5). Commercial fish buyers incurred an average value-adding cost per kilogram of PHP 4.85 per kg during the peak season and PHP 9.70 per kg during the lean season, significantly lower than the small-scale fish buyers during the lean season. This is due to the volume of fish purchased from the supplier and the procurement cost of *tawilis*. The cost of *tawilis* varies during peak and lean seasons. The price of *tawilis* per kilogram is higher during the lean season, which results in the higher average cost per kilogram of fish buyers. Primary resources needed by the small-scale fish buyers are fish, fare, labor, and gasoline, while fish, ice, labor, container, and ticket for commercial fish buyers. Small-sized *tawilis* are sorted from the larger-sized *tawilis* because they are sold at a lower price.

Processors are classified into small-scale for the *sinaing na tawilis* and commercial for the bottled *tawilis*. All bottled *tawilis* processors purchase *tawilis* from the fish buyers regardless of size. They don't get the fish directly from the fishers since they have loyal or kinship relationships with their suppliers. Both processors came from the same municipality, which is in Balete, Batangas. The average value-adding cost incurred per kg for the small-scale processors during the peak and lean seasons is PHP 97.50 (Table 5). On the other hand, commercial processors incurred an average value-adding cost per kg of PHP 45.20 per kg during the peak and lean seasons. It can be noticed that each processor's cost is the same throughout the year because of the fixed volume and price of *tawilis* purchased.

3.2.d. Production

Harvest from the beach seine operators is greater during peak season (March, April, and May) and lower during bad weather conditions and when the catch of marine fish is high. Operations are done when the school of fish is observed at the water surface, locally termed as *litaw*. Otherwise, beach seine operators shift to other economic activities. In contrast, the gillnet operators operate for several

months in a year. The gillnet operators' average selling price is PHP 63.00 per kg during peak season and PHP 86.00 per kg during the lean season. On the other hand, for beach seine operators, fresh *tawilis* is being sold at an average price of PHP 42.00 per kg during peak season because of the higher volume of their catch (Table 5).

Commercial and small-scale fish buyers bought fresh fish from the fishers. The small-scale fish buyers' average selling price is PHP 100.00 per kg and PHP 150.00 per kg during peak and lean seasons, respectively. In contrast, commercial fish buyers sell fresh *tawilis* at an average price of PHP 120.00 per kg, both during peak and lean seasons.

Production of small-scale processors (*sinaing na tawilis*) is lower than the production of bottled *tawilis*. Unlike the fishers and fish buyers, the production of processors is the same during peak and lean seasons. This is because the price from the processors does not vary. One kilogram of fresh *tawilis* can be processed into five braised *tawilis* packed in banana leaves with 12 pcs of *tawilis* per pack and sold at PHP 193 per kg (Table 5). On the other hand, 1 kg of fresh *tawilis* is equivalent to four bottled *tawilis* sold at PHP 480 per kg.

Due to the seasonality of *tawilis*, price is mainly controlled by supply and demand. *Tawilis* have to compete with other marine species. The marketing trend of *tawilis* shows the best price only when sold during holidays (especially during Holy Week and Christmas) and when the supply of marine catch is less during days with extreme weather.

3.2.e. Value Addition

Table 5 shows the cost distribution and value addition per actor per operation. Value addition is the increment in the value of *tawilis* before fishers sell them to the consumers. It is the process associated from the time *tawilis* are being caught up to the selling to the consumer. Value-added net of cost at the fisher level is estimated to be PHP 42.47 per kg for gillnet operators during peak season. It is PHP -11.50 per kg during the lean season due to lower volume of catch and higher total cost than the product sales. For beach seine operators, the value-added net of cost is PHP 25.88 per kg during peak season.

Value-added net of cost at the small-scale fish buyer level is estimated at PHP 12.39 per kg during peak season and PHP 4.60 per kg during the lean season while PHP 12.15 per kg during peak season and PHP 7.30 per kg during the lean season for the commercial fish buyers. Transportation costs, market fees, labor, and capital are among the cost components to add value to the product at various value chain levels.

For small-scale processors (braised), the value-added net of cost, which represents payment for labor and capital, is estimated to be PHP 45.50 per kg during peak and lean seasons while PHP 364.80 per kg for commercial processors (bottled) during peak and lean seasons. The value-added represents the wealth created by using the different production factors (Brown et al. 2010).

It can be observed that the total value-added net of cost was highest at the level of commercial processors (bottled) for PHP 18,240.00 due to the place, form, and time transformation of the product. Simultaneously, the fishers have the lowest value-added net of cost of PHP -46.00 during lean season but not during peak season when small-scale fish buyers have the lowest total value-added net of cost at PHP 570.00.

3.3. Roles of Men and Women in the Chain

Both men and women are involved in the collection or harvesting of *tawilis*; however, men dominate the actual fishing activity while women dominate the pre-fishing activities such as the preparation of fishing gear and paraphernalia and net mending (Table 6). Also, men dominate the chain when it comes to purchasing *tawilis* in large volume or quantity. In comparison, women dominate in purchasing and retailing *tawilis* in smaller volumes or quantities and in processing. There was a high percentage of men than women in the fishing aspect because, as stated in the study of Arenas and Lentisco (2011), women are stereotyped as weak and cannot meet the physical demands of fishing. When it comes to children and other immediate family members, boys are somehow involved in fishing activities while girls are not engaged in any fishing activities. Sometimes fishers hire laborers, particularly during fishing operations, because their wives or sons are not available. Wives have other duties to do, and their sons were at school. In addition to male responsibilities, they have more access to trading with fish buyers in large volume or quantity.

Both men and women transport *tawilis*, and they act as fish buyers. Due to lack of transportation means, women are forced to sell the newly-landed catch *tawilis* to their neighbors, nearby markets, and neighboring barangays in small quantities by means of walking. This is true in the study of Medard et al. (2002) that women sell fresh in small quantities near

the beach communities because they have no alternative ways to transport the fish quickly. The number of women involved in marketing and trading is high because they lack alternative sources of economic activities and need to contribute to the household income.

Women are also engaged in processing *tawilis* in Taal Lake. In the study of Adebo and Alfred (2008), he said that men are involved in the tedious aspect of tilapia fish farming while women are primarily engaged in activities related to their home duties which are also true in *tawilis* fishing.

Table 6. Roles of men and women in fisheries

Activity	Roles of Men and Women in Fisheries		
	Men	Women	Both
Harvesting/Collecting			- preparation of fishing gear and paraphernalia - net mending - actual fishing activity
Trading	- purchasing *tawilis* in large volume or quantity		- purchasing and retailing *tawilis* in smaller volume or quantity - transport *tawilis*
Post-harvest			- processing
Reproductive activities		- home duties such as child and elderly care, budget-related and food related	

3.4. Issues and Concerns in the Value Chain

The fishers' two major issues are 1) seasonality and declining catch of *tawilis* and 2) post-harvest losses during the peak season (Table 7). For the past years, production of *tawilis* has declined, and the volume of catch depends on the season. The peak season is from March to May, while the lean season is from November to December. There are times that fishers have a minimal volume of catch or no catch at all. *Tawilis* fishers cannot catch other fish species because their gear is specific only for catching *tawilis*. They lack the capital to acquire adequate fishing gear and paraphernalia to catch different fish species. The declining catch of *tawilis* is due to the illegal operation of active gears and small mesh size nets (Mutia et al. 2018a). While there is an overall declining catch of *tawilis*, there is also an oversupply harvest during peak season only. During this time, passive and active gear operations are non-stop and without restrictions on the size limit of fish. This brings about problems of oversupply and post-harvest losses. Since the fish is highly perishable and most fishers lack storage facilities, they need to sell immediately or transport directly to buyers and processors. Fishers usually land their catch in their respective lakeshore barangays, where they sell to buyers. Sometimes buyers also dictate the price forcing the fishers' wives to market their catch, especially during the peak season where there is an abundant supply of fish. They sell to their neighbors, nearby markets, neighboring barangays, and municipalities in small quantities, even in the absence of transportation means. They walk for a long distance to reach the marketplace, and this causes fish spoilage. Buyers in the area are limited and cannot buy all the fisher's catch. The absence of knowledge on proper handling and preservation and the difficulty of selling the fish led to post-harvest losses, which affected the fishers' livelihood.

Fish buyers and processors also lack knowledge on the proper handling, processing, and marketing of *tawilis*. They have inadequate fish processing equipment and facilities and the capital to upgrade these. Lastly, there are no restrictions on the

size of *tawilis* being traded. The small sizes are often rejected in the market and affected the income of the buyers and processors.

Based on the SWOT analysis conducted (Table 8), the *tawilis* market's strengths show that there is a demand for *tawilis* because of its popularity being an endemic fish only found in Taal Lake. It is a favorite delicacy of tourists in restaurants in Tagaytay City. It commands a high price and can be prepared as cooked (fried, stew or *sinigang*, and braised or *sinaing*) or processed (bottled or canned). There is an ample opportunity for *tawilis* processing to be upgraded and become more competitive in the market. Although *tawilis* is the most commercially important endemic species from the capture fisheries in Taal Lake, it is linked with constraints that hinder the growth of its market, which include the poor handling of the fish during harvest and marketing, lack of knowledge on proper fish handling, processing, and marketing, mislabeling of *tawilis* with marine sardine (*salinyasi*) and lack of capital to upgrade the fishing gear used and other paraphernalia. The identified threats include bad weather conditions, especially typhoons and southwest monsoon, and alien fish species introduced in the lake.

Table 7. Issues, concerns, and intervention or management options of the *tawilis* fishery in Taal Lake

Issues and Concerns per Key Actor	Interventions/Management options
Fishers	
1. Seasonality and declining catch of *tawilis*	1. Provision of alternative source of income/ livelihood training on other fisheries technologies
2. Oversupply of *tawilis* during peak season	2. Provision of other fishing gears to catch other species and post-harvest equipment and facilities
3. Post-harvest losses	3. Training on post-harvest technologies (proper handling and processing)
4. Inadequate fishing gear and paraphernalia	4. Provision of gear with appropriate mesh size
5. Illegal fishing	5. Strict monitoring and implementation of the law (URRF)
6. No restriction on size of *tawilis* catch	6. Provision of honoraria to Bantay Lawa
7. No capital to upgrade fishing gear and other paraphernalia	7. Access to credit/loans/grants, loan assistance, outsourcing of funds
Fish Buyers	
1. Poor handling of fish during marketing	1. Training on proper handling of fish products
2. Lack of training on fish handling, processing and marketing	2. Provision of training on post-harvest technologies
3. No restriction on size of *tawilis* by traded and small sizes are often rejected in the market	3. Regulation of fish sizes to be traded
Processors	
1. Poor handling of fish during processing	1. Provision of training on post-harvest technologies such as processing, value adding and product development
2. Inadequate processing equipment and facilities	2. Provision of equipment
3. Lack of training on fish handling, processing and marketing	3. Provision of trainings on marketing
4. No restriction of size and small sizes are often rejected on processing	4. Strict monitoring and implementation of the law (URRF)
5. Lack of capital to upgrade processing equipment and facilities	5. Access to credit/loans/grants, loan assistance, outsourcing of funds

Table 8. "Strengths, Weaknesses, Opportunities and Threats" of *tawilis* market

Strengths	Weaknesses
- *Tawilis* an endemic species in Taal Lake is a popular delicacy of tourists especially in Tagaytay City	- *Tawilis* catch is seasonal - Limited market outlet
- It commands good price depending on the season	- Fishers practice poor handling of fish during harvest and marketing
- *Tawilis* can be cooked (fried, stew or "*sinigang*", or braised or "*sinaing*") and processed (bottled or canned)	- Lack of knowledge on fish handling, processing and marketing
- *Tawilis* fishery is the main livelihood in the capture fisheries in the lake	- Mis-labelling of "*tawilis*" with marine sardine ("*salinyasis*") in the market - Lack capital to upgrade fishing gear and paraphernalia

Opportunities	Threats
- *Tawilis* is a unique and rare species	- Bad weather condition (typhoon, southwest monsoon)
- Fish processing can upgrade the product to be more competitive in the market	- Presence of alien fish species introduced in the lake

4. CONCLUSION AND RECOMMENDATIONS

The value chain of *tawilis* caught in Taal Lake starts with capturing the fish by the small-scale gill-netters and beach seiners. The fresh catch's value ranged from PHP 42.00 per kg during the peak season to PHP 86.00 per kg during the lean season. Small-scale and commercial fish buyers buy fresh fish. Then sold and valued at prices ranging from PHP 100.00 to PHP 150.00 per kg in markets. The value added is due to the convenience and access brought about by the product's movement from the place of catch in the lake to the marketplace as performed by the fish buyers or traders. The small-scale processors of braised *tawilis* then bought fresh fish to the fish buyers or sometimes bought it directly to the fishers for PHP 50.00 per kg, and processed (braised) *tawilis* were sold and valued at PHP 193.00 per kg. Finally, some fresh *tawilis* are then purchased by commercial processors at PHP 70.00/kg. These commercial processors invest in the direct cost of materials and equipment to process or transform the fresh *tawilis* into cooked *tawilis* in oil packed in bottles. These processed products are finally valued at PHP 480.00 per kg. Therefore, the gross value-added through various forms of product transformation increased the value of *tawilis* as it moves along the value chain. The value-added net of the cost was estimated at PHP 42.47 per kg among small-scale gill-netters; PHP 25.88 per kg among beach seiners; PHP 12.39 per kg among buyers; PHP 45.50 per kg among processors of braised *tawilis*; and PHP 364.80 per kg among processors of bottled cooked *tawilis*.

The outcome of the value chain analysis showed that commercial processing provided the highest value-added due to the place, form, and time transformation of the product. The fishers showed the lowest value-added during the lean season, but the small-scale buyers showed the lowest during the peak season. Since the product is seasonal, the value differs depending on the time of collection of the fish. There is an ample opportunity to improve the product by upgrading and becoming more competitive in the market. *Tawilis* industry in the lake provides livelihood to the marginal fisherfolk, which is the first link of the supply chain.

The chain must undergo upgrading strategies to boost the *tawilis* industry, maximize its potential, ensure sustainability, and ultimately uplift the living conditions of all the actors. The following upgrading strategies are recommended in the form of process, product, function, and overall chain upgrading.

Process upgrading. The fishers' activity must be improved by lessening the hours of hauling in fishing operations to prevent spoilage of fish catch. The product will command a higher selling price. The fishing gear and paraphernalia must be upgraded to catch bigger sizes of *tawilis*, which are the preference of the buyers and processors. Provision of proper training on post-harvest techniques such as proper handling and preservation for all actors in the chain will improve the business process and efficiency.

Function upgrading. Market matching strategies should be initiated thru an efficient linkage system from fishers to consumers to improve the product quality so that each actor achieves the most benefit. Moreover, farm-to-market roads should be developed to improve transportation for a faster and more efficient fish catch.

Product upgrading. Processors need to acquire new skills in value-adding and product development through training. The establishment of more processing centers will address the issue of post-harvest losses during peak season. Product improvement can be achieved when actors in the chain have access to credits, loans, and grants, among others, to be able to upgrade processing equipment and facilities.

Overall chain upgrading. Transformation into new and higher value products will be achieved through assistance from the national government or the local government by establishing infrastructure facilities such as fish processing plants to improve the overall chain's effectiveness and efficiency.

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AUTHOR CONTRIBUTION

Mutia MTM: Conceptualization, Methodology, Formal analysis, Writing—Review and Editing, Supervision, Funding acquisition, Project administration. **Muyot MC:** Methodology, Investigation, Formal analysis, Writing—Review and Analysis. **Balunan RL:** Writing—Original Draft, Investigation, Formal analysis.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

ETHICS STATEMENT

No animal studies were carried out by the authors.

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