Trends in the Major Aquaculture Food Fish Production in the Philippines

Roy C. Ortega
Bureau of Fisheries and Aquatic Resources -
National Brackishwater Fisheries Technology Center
Pagbilao,Quezon, Philippines
kaulayao@yahoo.com

Abstract

Predictability of food fish derived from the aquaculture sector is a pragmatic concern for the society at large. In this paper, the trend in aquaculture production is presented, with emphasis on the two major food fish species, milkfish and tilapia. Particular interest is on the assessment of observed over-all decline on the rate of output generation in the recent years and its major cause. Accordingly, the impacts on supplies and estimates on the needed catch-up growth rates for the milkfish and tilapia sub-sectors (excluding municipal inland fisheries) are explained. Adjustments currently being implemented by the milkfish and tilapia farming sub-sectors are discussed. Finally, selected prospects related to farming site expansion, emerging farmer-oriented information needs and quality of critical inputs are discussed. In the context of this important occasion, the International Workshop on the Promotion of Sustainable Aquaculture, Aquatic Animal Health and Resource Enhancement in Southeast Asia (SARSEA), interventions offered herein are deemed relevant to the greater Southeast Asian region as well.

Introduction

Macro production trends in the fisheries sector

The increasing contribution of aquaculture in the overall fisheries production in the Philippines reflects the global trend. The local aquaculture contribution to the total fisheries output has grown from 36 % to 53 % over the last 20 years (**Figure 1**).

The UN-FAO 2018 SOFIA Report (State of the World Fisheries and Aquaculture) mentioned that the share of aquaculture output to the world fisheries production is at 46.8 %.

According to the UN FAO 2018 SOFIA, the Philippines is ranked in the world aquaculture as follows (based on 2016 data):

a. 3rd in seaweeds, next to China and Indonesia;

b. 5th in fish production from marine and coastal, after Norway, Indonesia and Chile;

c. 9th in marine crustacean production, after Mexico, Thailand and Bangladesh

d. 11th in total aquaculture output, excluding seaweeds, next to Chile and Myanmar

According to PSA (2018), the Philippine aquaculture output was 2,304,122 tons, valued at Php 110.329 billion or approximately US$ 2.099 billion (Php 52.554: 1 US$ June 01, 2019; **Figure 2**). The total value of output indicates food aquaculture items such as fish, and crustaceans represents more than 80% of the total value. A summary graph and table below (**Figure 3**) indicate the relative economic significance of each commodity based on its raw form or ex-farm valuation. It is important to note that while tilapia and milkfish are relatively cheaper products (US $ 1.96 and 1.48 per kilo ex-farm), their combine massive output comprises almost 60% (approx. US $ 1.185 billion) of the total value of outputs in 2018 (**Figure 4**).

Species, farming systems and output

The species of farmed fish in Philippine aquaculture is fairly diverse (**Table 1**). Meanwhile, the relative contribution of these species to the total output over the years (e.g. 2008 versus 2018) has not dramatically changed, albeit substantial enough in response to externalities and pursuit production efficiencies.

There is a distinct dominance of species relative to farming environment based on historical 2008 and 2018 PSA datasets. Tilapia, milkfish and seaweeds remain the primary species in the freshwater, brackishwater and marine environments, respectively. The 2018 data indicates increase in the total output in the brackishwater sub-sector by 21,726 tons, brought by milkfish, oysters, mud crab (or mangrove crab) and notably tilapia. The marine sub-sector meanwhile contracted by 150,041 tons mainly due to seaweeds, however, milkfish farming in cages has increased by 37,729 tons (PSA, 2008 and 2018 data sets).

Growth in oyster, mangrove crab and white shrimp are expected to increase in the coming years. Technology transfer efforts by SEAFDEC/AQD and DA-BFAR on mangrove crab farming in key provinces such as Catanduanes, Quezon, Iloilo are in full-swing. Two new private oyster hatcheries (i.e. Arton Farms and ASIN Inc.) which benefited from SEAFDEC/AQD training are now poised to go on commercial scale operations. Furthermore, investments on intensive white shrimp farming in Pangasinan, Southern Luzon and Southern Mindanao are progressing.

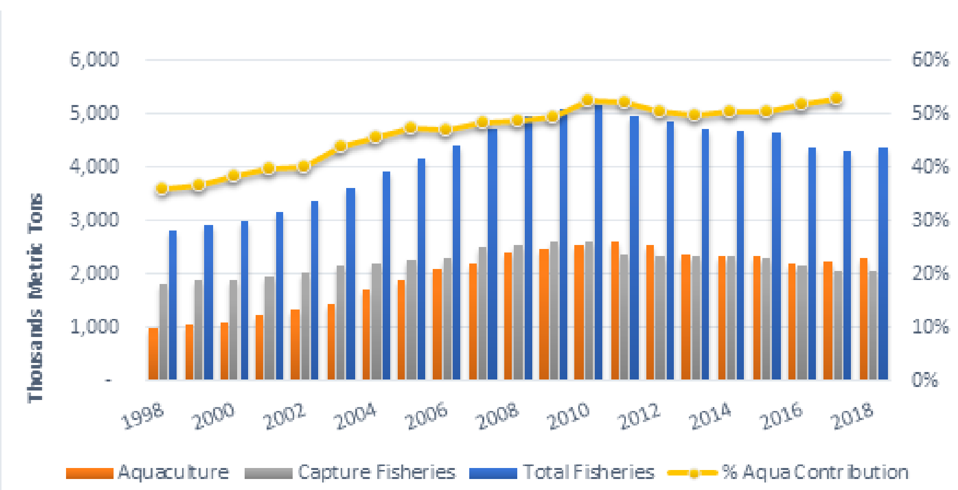

Figure 1. Fisheries production and aquaculture contribution from 1998-2018

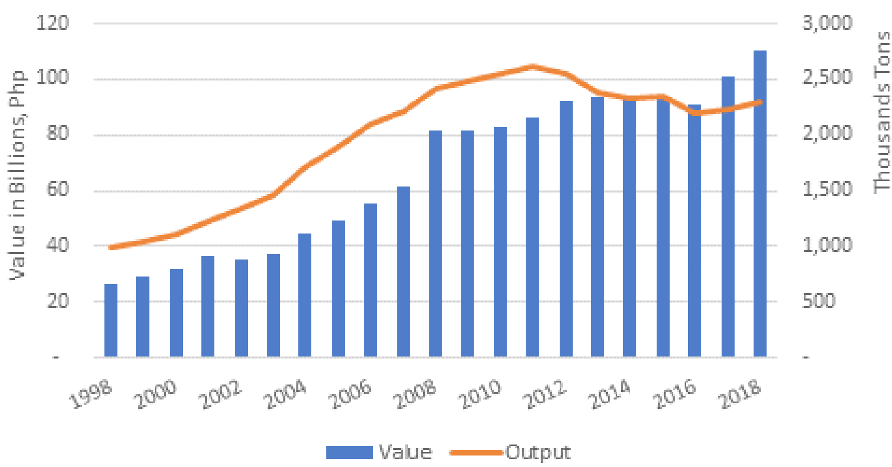

Figure 2. Value and output of total Philippine aquaculture

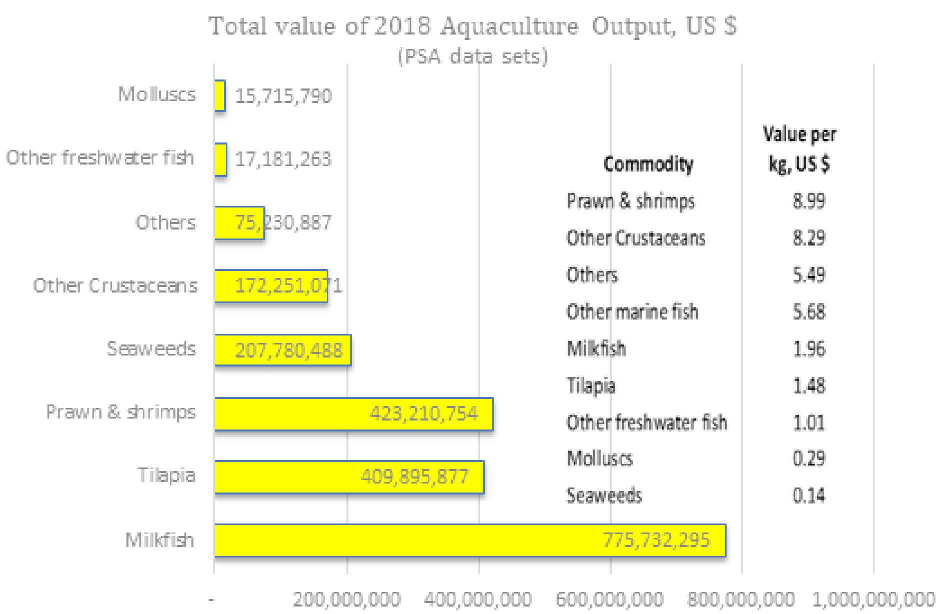

Figure 3. Total value of 2018 Aquaculture output.

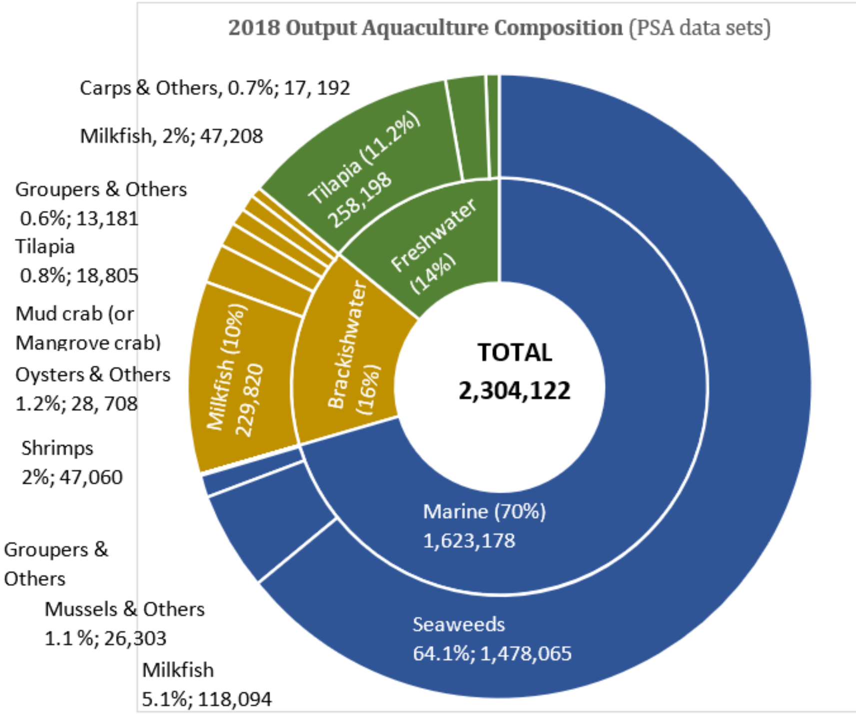

Figure 4. 2018 Output Aquaculture Composition (PSA dataset)

Table 1. Farmed fish species in the Philippines

Group	Species
Freshwater	Tilapia: *Oreochromis niloticus*, *O. mossambicus*, and its hybrids
	Carps: *Cyprinus carpio*, and *Aristichthys nobilis*
	Catfish: *Clarias gariepinus* and its hybrids
	Others: Mudfish *Chana* spp., Gourami species (Giant and Common)
Diadromous	Milkfish: *Chanos chanos*
	Eels: *Anguilla marmorata* and *A. bicolor pacifica*
Marine	Grouper: *Epinephelus coioides*, *E. fuscoguttatus*
	Others: Sea bass *Lates calcarifer*, Pompano *Trachinotus blochii*,
	Siganid: *Siganus guttatus*, *S. vermiculatus*,
	Snapper: *Lutjanus* spp.

Group	Species
Crustaceans	Tiger shrimp: *Penaeus monodon*
	Endeavor prawn: *Metapenaeus ensis*
	Whiteleg shrimp: *Litopenaeus vannamei*
	Mangrove crab: *Scylla serrata* and *S. olivacea*
	Giant freshwater prawn: *Macrobrachium rosenbergii*
	Spiny lobster: *Panulirus* spp.
Mollusks	Green mussel: *Perna viridis*
	Oyster: *Crassostrea iredalei* and *Saccostrea cucullata*
	Others: Pearl oyster *Pinctada* spp. and Abalone *Haliotis* spp.
Seaweeds	*Eucheuma/Kappaphycus*
	Gracilaria spp.
	Sea grapes *Caulerpa racemosa* and *C. lentillifera*

On the other output of marine (e.g. grouper and pompano) and other diadromous (e.g. seabass, siganid) species are expected to remain low due to limited investments on hatchery.

Trends in the major farmed fish production

Nowadays, more than half of fishery products served on tables worldwide are farm-raised (51 % in 2015), according to the UN FAO 2018 SOFIA. The country data meanwhile shows a steady increase to that effect growing at 1.1 % per year on the average for the last 10 years. In PSA2018 data, the local aquaculture provided food fish in the tune of 826,064 tons or 27.9 % of the total fisheries (F**igure 5**). The explanation on what drives local consumption of farm-raised fish is sensitive to the culinary culture of the population. Per observation, Filipinos prefer live tilapia and would not likely buy its frozen counterpart. This apparently simple issue on product presentation has a strong influence on production in general, as the market for (stock-piled) frozen tilapia is almost zero at this point. Nevertheless, with the global trend as the benchmark and participation in the seafood world trade are being considered, the Philippine food aquaculture will have to significantly increase its output in a sustainable manner.

The graph (**Figure 6**) depicting two decades (1998-2018) of food fish aquaculture production clearly shows that milkfish and tilapia are the primary output generators (PSA datasets). In 2018, milkfish and tilapia contributed 48 % (395,130 tons) and 34 % (277,006 tons), respectively in that particular year. On the other hand, long-term local data shows a steep decline in the rate of growth in the entire food aquaculture (**Figure 7**). From a high of 7.98 % average increase between 2000 and 2005, it contracted to 1.19 % between 2012 and 2017 (PSA datasets). This observation should be taken seriously and demands pragmatic interventions from the entire stakeholder base.

Evaluation of datasets on milkfish and tilapia farm outputs pertaining to years 2000–up to the present affords us perspectives on the trends (**Table 2**).

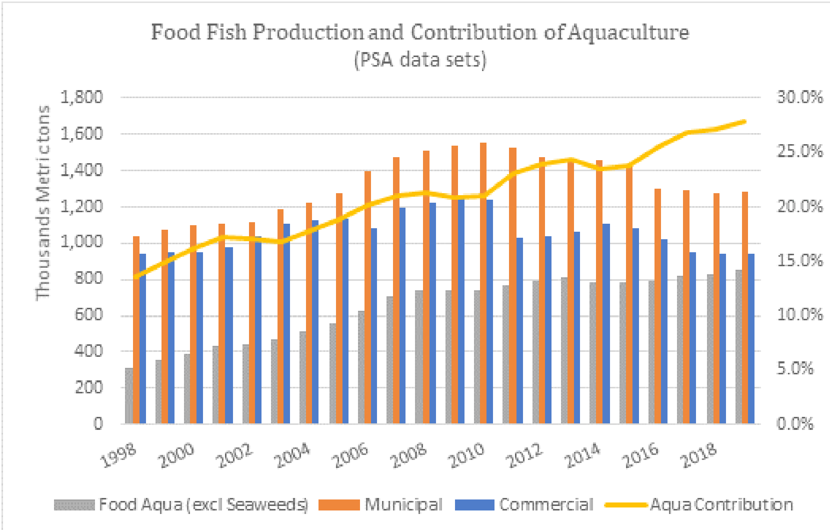

Figure 5. Food fish production and contribution of aquaculture from 1998-2018

Primarily we are concerned about the rate of growth in tilapia and milkfish outputs as a sound metric of farmed fish sufficiency. Surprisingly, the average annual output growth in the years 2012–2017 is only 31 % (8,938 tons) of the years 2000–2005 (28,021 tons). Furthermore, the percentage increase of the average annual output from 2006–2011 (539,581 tons) to 2012–2017 (609,566 tons) was barely 13.0 %. These pieces of information corroborate the downward trend of the growth of output which can easily slipped unnoticed by merely looking at the increasing absolute value of tons of farmed fish produced year by year.

The apparently diminished averages of growth in all major farming systems beyond 2000–2005, for both species lends many important insights. Brackishwater ponds generate 57 to 60 % (227,000 to 243,000 tons) of the total milkfish outputs (PSA 2015 to 2018 datasets). The narrow rate of increase is primarily inherent to the available areas. Conversion of mangroves for fishpond use are no longer allowed as a consequence of ban in cutting mangrove vegetation (RA 7161 of 1991). Vast areas of traditional brackishwater fishponds are leased/bought by marine cage farm operations to ensure production of cage-appropriate size milkfish fingerlings (>10 cm TL). Loading of one (1) unit 15 m diameter, HDPE floating milkfish fish cage (40,000 to 50,000 pcs) per cycle, would require fingerling output from two (2) hectares brackishwater fishpond. This development is expanding in Davao and Northern Mindanao provinces. Freshwater fishponds generate 46 to 48 % (142,00–155,000 tons) of the total tilapia output in the years 2015-2018 (PSA datasets). It is reasonable to surmise that new expansive tilapia fishpond development is very limited. Instead, what is observed is that real-estate/housing development projects are fast converting flat agricultural lands otherwise used for tilapia or rice/vegetable farming. According to tilapia sector leaders, consolidation of fishponds holdings is the current trend particularly in Pampanga in Central Luzon region. Consolidation of up to 50 hectares and above is motivated by the intent to achieve economically competitive scale of operation.

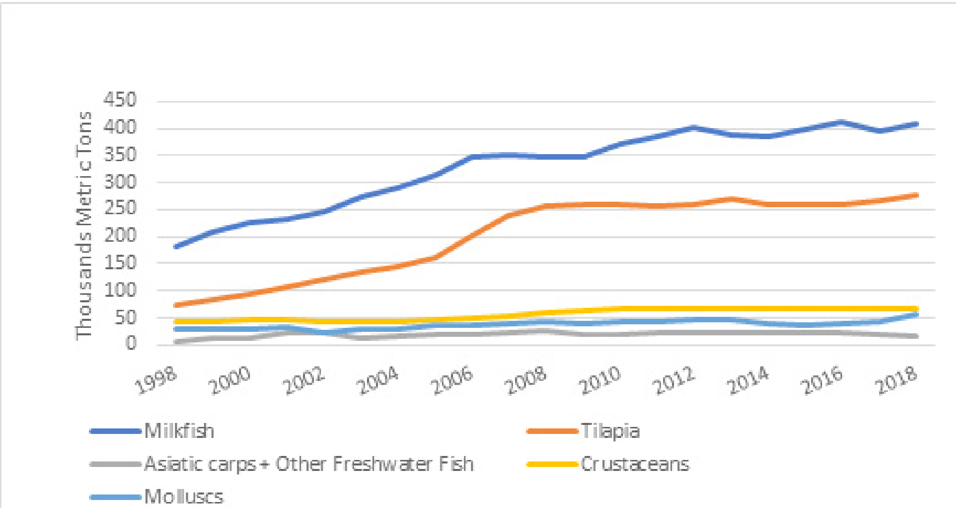

Figure 6. Philippine Aquaculture Production Trend, excl. Seaweeds (PSA data sets)

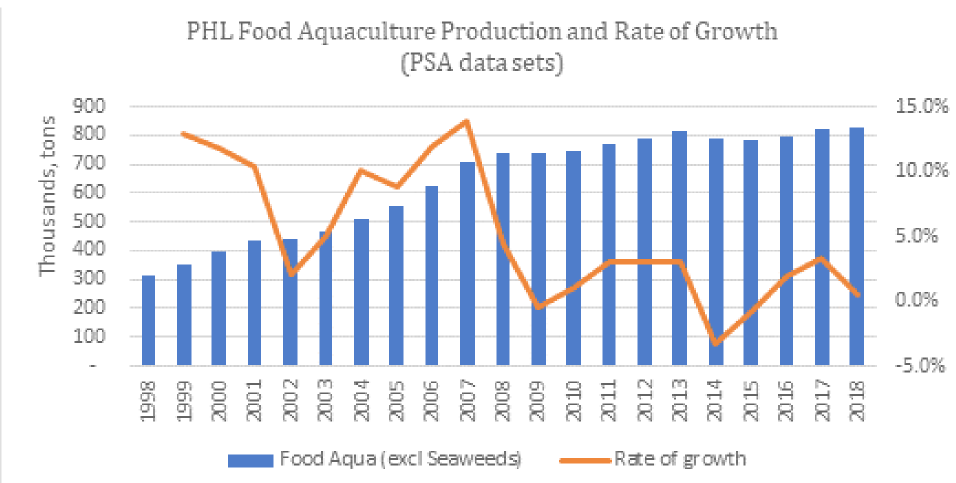

Figure 7. Philippine food aquaculture production and growth rate from 1998–2018 (PSA data sets)

Table 2. Growth and Output Generation in Milkfish and Tilapia Farming Systems, Philippines, 2000–2017 (PSA dataset)

Commodity	Indicator Farming systems	Average Growth%		
		2000–2005	**2006–2011**	**2012–2017**
Milkfish	Brackishwater ponds	5.4	1.1	1.4
	Marine cages	53.9	19.8	4.5
	Freshwater pens	43.4	2.7	3.0
		Average Annual Total Output, tons		
		2000–2005	**2006–2011**	**2012–2017**
	Brackishwater ponds	197,765	219,166	234,397
	Marine cages	13,502	61,079	102,737
	Fresh water pens	15,729	2,116	27,024
		Average Change in Annual Output, tons		
		2000–2005	**2006–2011**	**2012–2017**
	Brackishwater ponds	9,177	2,380	3,239
	Marine cages	4,651	8,631	3,989
	Fresh water pens	1,411	608	657
		Average Growth %		
		2000–2005	**2006–2011**	**2012–2017**
	Freshwater ponds	14.2	10.4	1.5
	Freshwater cages	9.0	6.3	-0.2
	Freshwater pens	60.7	9.3	-3.4
Tilapia		**Average Annual Output, Tons**		
		2000–2005	**2006–2011**	**2012–2017**
	Freshwater ponds	63,944	133,361	143,184
	Freshwater cages	47,824	78,647	81,981
	Freshwater pens	6,804	20,211	20,243
		Average Change in Annual Output, tons		
		2000–2005	**2006–2011**	**2012–2017**
	Freshwater ponds	7,274	9,610	2,153
	Freshwater cages	3,969	3,918	-347
	Freshwater pens	1,540	1,495	-752
Summary: Milkfish and Tilapia outputs		**2000–2005**	**2006–2011**	**2012–2017**
Ave. annual output, tons		345,560	539,581	609,566
Ave. annual change, tons		28,021	26,643	8,938

To date, official statistics on brackishwater fishponds (134,739 ha) and freshwater fishponds (16,603 ha) were based on survey conducted between 2005 and 2010 by the Philippine Statistics Authority (PSA). The said agency is about to release the results of "Updating of List of Aquaculture Farms (ULAF)" project. It is important to note that while the area of freshwater fishponds is only 12 % that of brackishwater ponds, the output of the latter approximates up to 60 % of the former. The tilapia farming community attributed significant increase in farm productivity with the introduction of high-yielding Nile tilapia strains such as the Genetically Improved Farmed Tilapia (GIFT) strain which was launched in 1993, after almost a decade-long research in the Philippines (ADB, 2005). Meanwhile, introduction of genetically improved milkfish is yet to be realized. Per hectare output for each crop of pond-raised tilapia in Pampanga is between 5.61 to 6.04 tons (PSA datasets), while the national average for milkfish pond farming is in the range of 0.72 to 1.05 tons (PSA datasets), or 1:5-6 in favor of tilapia ponds.

Stagnation of milkfish outputs from freshwater fish pens were glaring in the years 2006 to 2017, while the reverse is true for tilapia. This can be explained by, first, the significant shift to marine fish cage farming, which now generating 3.8 times more milkfish than from freshwater pens (PSA datasets, 2012–2017). Second, data suggests probable shift in favor of tilapia over milkfish in freshwater pens as shown in the ratio of milkfish to tilapia output: 2.3:1 in 2000–2005 declined to 1.35 in 2012–2017. This is perhaps a spill-over effect of the above-mentioned first cause, as poly-culture of milkfish, tilapia and Asian carps is the norm in freshwater pen systems (Ortega, 2013).

Please note that resource use restrictions are being implemented by concerned government (national and local) agencies to balance the utilization of mixed-used inland bodies of water. A precautionary blanket ceiling of not more than 10 % of the lake or river surface area can be utilized for aquaculture is clearly specified in the amended Fisheries Code (Sec. 51, RA 10654). Furthermore, environmental laws, (e.g. RA 7586 and its expanded edition RA 11038), designed to protect areas of national interest also regulates the expansion of aquaculture in many lakes covered under these legislations. Taken together, these put a cap on expansion of freshwater fish pen and cages, however, not necessarily intend to limit sustainable intensification.

The rise of fish cage operations in marine environments for milkfish and in freshwater for tilapia is remarkable. PSA 2018 data indicated that fish cage grown milkfish (108,237 tons) and tilapia (85,440 tons) provided 27 % of the total output for these commodities. The increase is attributable to economic and technological efficiencies. Modern circular (15 to 18 m. dia.) HDPE-made cages is becoming common, phasing out the bamboo or galvanized iron (GI)-framed square cages (5 m × 5 m up to 18 m × 18 m) in milkfish farming. Output using circular HDPE cages ranges from 22 to 30 tons per crop realized in 5 to 6 months. This output is 1.6 to 1.9 times more than a typical 18 m x 18 m x 10 m GI framed milkfish marine cage in Pangasinan. In tilapia, either GI or bamboo framed cages remains the norm in areas such as Taal Lake and Magat Dam. A typical 10 m × 10 m × 10 m GI-framed tilapia cage in Taal Lake generates at least 10 tons every 6 months cycle.

Accordingly, fishpond development is more expensive, estimated at US$ 19,028 to 27,700 per hectare of raw land versus procurement and deployment of a 15 m diameter HDPE cage, at US$ 7,600 (direct importation and own assemble) to US$ 11,790 (local vendor package). Cost of tilapia fishpond development is relatively less expensive (20-30%) by some estimates than brackishwater ponds, while cost to fabricate GI-framed cages ranged between US$ 1,300 and US$ 1,600 per unit (DA-BFAR-300 Fish cage Project, 2018).

Growth trajectory shows intensification, measured by the average annual output of marine fish cages, continued to expand compared to its tilapia counterpart in lakes. Comparing year 2000 and 2017 PSA data indicates marine fish cage output grew 39.5 times while barely 2.1 times for tilapia cages. In fact, tilapia cage annual contribution contracted by 347 tons on the average, while milkfish marine cages added 3,989 tons between 2012 and 2017. This is an indication that upper limits of major lakes (e.g. Taal Lake in Batangas, Lake Sebu in South Cotabato, Lutayan Lake and Buluan Lake in Maguindanao) that are currently utilized in tilapia cage and pen operations has been reached. Nevertheless, while coastal and nearshore farm sites generally have a higher carrying capacity due to "cleansing" effects of tides and currents and vast surface area, this system is also vulnerable in exceeding its carrying capacity, as evidenced by recurring and relatively new fish kill incidents in Pangasinan and Misamis Oriental marine farm sites.

Finally, the combined average of added milkfish and tilapia biomass annually contracted by 30.8 %, down to 8,938 tons from 28,021 tons between 2000–2005 versus 2012–2017. Discussions on the impact of this downtrend, underlying contributing factors and some investments/interventions needed are discussed in the following sections.

Impacts on farmed fish supplies

Estimates of demand and supply gap presented in **Tables 3** and **4** are based on the following key assumptions:

a) Fish-eating population is based on the PSA population projection (high assumption) for the specified years then subtracting 30% and 50 % of the 0 to 4 and above 80-year old groups, respectively;

b) Demand per commodity is the product of fish-eating population multiplied by the per capita consumption (Consumption of Selected Agricultural Commodities in the Philippines Vol. 2, PSA, 2017). Furthermore, it is assumed that half of the fish-eating population are urban dwellers.

It is clear that significant amount of supply gap will have to be filled-up by 2025 and onwards should the current dismal rate of growth persist. Based from the offered growth estimates, milkfish and tilapia should increase by 40.7 % (555,988 tons) and 65.9 % (459,560 tons) by 2025, from their respective 2018 base amount. This straight forward assessment reflects the estimates provided in other rather more elaborate available benchmarking documents over the same time horizons (**Table 5**).

A perspective on the probable causes of decline

The author perceives that a pervasive factor, that is the occurrence of natural calamities, is the primary caused and exacerbated the rapid decline across the aquaculture production systems in the

Philippines. Data on natural calamity incidents that impacted the Philippines from the International Disasters Database (www.emdat.be) was filtered based on the following criteria and shown in **Table 6** and **Figure 8**. More than 20,000 total affected persons;

a) Impacted multiple provinces, particularly areas with high aquaculture output;

b) Climatological, meteorological and hydrological incidents only.

Table 3. Estimated aquaculture food fish demand, Philippines 2018 and projections

Indicator Commodity	Per capita, Comsumption, kg		Base 2018 production, tons	Fish Eating population	
				2025	2030
	All Group	Urban Group		110,327,391	117,324,563
				Commodity specific demand, tons	
Milkfish	4.193	5.291	395,130	523,205	556,388
Tilapia	3.950	3.905	277,006	433,340	460,823

Table 4. Estimated aquaculture food fish supply gap and required catch-up growth rates, Philippines, 2017 and projections

Indicator Commodity	Commodity Average annual growth, % 2012-2017 (PSA datasets)	Estimated commodity supply gap, tons		Fish Eating population	
		2025	2030	2019–2025	2026–2030
Milkfish	1.69 %	78,893	73,241	5.0 %	1.5 %
				32, 783 tons	42, 569
Tilapia	0.69 %	142,675	159,991	7.5 %	2.0 %
				26,226 tons	46,575 tons

Table 5. Key industry scenario planning references, Philippines, 2021-2035 projections

Years	Aquaculture Futures DOST/PCAARRD-WorldFish, 2016		Comprehensive National Fisheries Industry Development Plan, (DA-BFAR 2008)	
	2021–2025	2026–2035	2021–2025	2026–2035
Milkfish	2.6-5.0 %	1.4-5.0 %	5.0 %	No data
Tilapia	4.2-8.1 %	2.3-8.1 %	5.0 %	No data

Table 6. Summary of natural calamities that impacted the Philippines, 1998-2017

Natural calamities	Number of incidents over time periods		
	1998-2005	2006-2011	2012-2017
Storms	23	35	26
Flooding	4	15	9
Drought	2 (1998 & 2002)	1 (2007)	1 (2015)

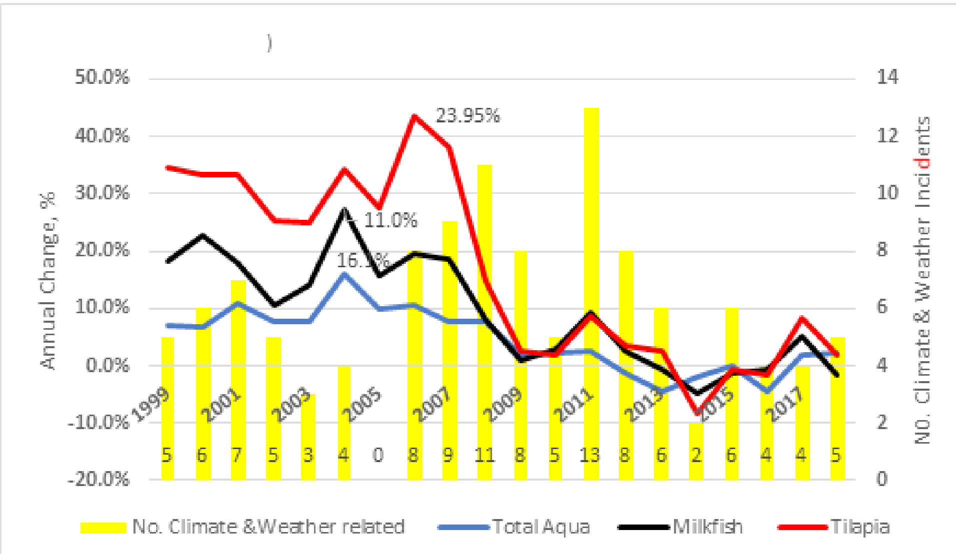

Figure 8. Twenty- year Rate of Change (%) in Aquaculture and Occurrences of Selected Natural Calamities (PSA datasets and www.emdat.be U.C. Louvain Belgium)

It is clear from the graph below that aquaculture output tends to regain in the years immediately after zero or low occurrences of natural calamities (e.g. 2004, 2006, 2011, 2015 and 2017). Conversely, contraction in outputs are evident in years following the highest number of natural calamity incidents. Furthermore, it appears that the years 2006 and 2007 were the tipping point, wherein the high growth rates previous to this reference points have yet to be surpassed to date.

One can easily imagine the financial devastation to farm operators and its crippling effect on investments supposedly for farm expansion. Data on the economic value of damages on fisheries or aquaculture must be collated from multiple sources and consequently analyzed. Needless to say, an in-depth multi-perspective study will definitely add to our understanding particularly on sectoral investment planning, disaster risk adaptation, and impact mitigation, among others.

Selected prospects

Expansion and alternative areas

Private investments are the primary engines that drives the Philippine aquaculture and the entire fisheries sector at large. It is remarkable that despite the impact of pervasive and cyclical natural calamities, local and foreign investments in aquaculture remains in the country. Based on the data shown in the previous section (D. Impacts on farmed-fish supplies), the future value of the 2025 demand for milkfish (523,205 tons) and tilapia (433,340 tons) is estimated at US$ 1,180 billion and US$ 765 million, respectively. As such, there is a compelling reason to invest in the Philippine aquaculture from business and social obligations perspective despite the risks imposed by natural forces.

From the previous section (C. Trends in the major farmed-fish production), the integration of marine fish cage and traditional brackishwater fishponds into a consolidated, modern and highly productive production chain is the future. Similar trend has been observed in the case of tilapia farming in freshwater environment, however, the over-all scale is smaller than the former. These developments are sensible from the standpoint of productivity, economic efficiencies and response to perennial bouts with natural calamities. It was also raised that both marine and freshwater environments are vulnerable to pollution-induced or naturally-caused fish kills. In the context of disaster risk impact reduction, it is imperative that exposure of food aquaculture sub-sector to hazards must be minimized, if not addressed as in the case of pollution related fish kills.

Sometime in June, 2019, DA-BFAR tasked the author to conduct a desk assessment in coordination with DA-BFAR Regional counterparts, on the potential milkfish mariculture expansion areas in the country. The said exercise shows that the Philippines has approximately 3,224 hectares of potential marine farm-sites, with a 25,643 cage capacity with a potential output of at least 1,0225,720 tons per year, based on the assumptions below, and a map was prepared accordingly:

a) One (1) cage unit is 15-18 m diameter HDPE cage, 8 m, net depth;

b) One (1) cage unit can produce 40-60 tons per year;

c) One (1) hectares surface area can accommodate eight (8) units of HDPE cage;

d) Only 20-50% surface of identified potential area will be utilized;

e) Not included are mariculture areas/ zones that are:

- Subject to environmental assessment/review;
- Areas already operating in full capacity (i.e. existing sites);
- Areas within NIPAS protected seascapes; and
- Previously identified areas deemed not productive.

The above-information clearly shows that the Philippines has sufficient marine areas to fill-in the immediate and long-term milkfish demand and alternative/ relocation sites to allow recovery of heavily utilized areas. The above estimated potential is almost 10 times of the current capacity, based on 2012-2017 average annual total output of milkfish marine cages (102,737 tons). Furthermore, this is by no means an exhaustive assessment of available expansion areas, considering the country has 184.6 million hectares of continental shelf (<200 m depth) (Philippine Fisheries Profile, 2016 DA-BFAR). The above assessment remains to be rigorously analyzed particularly from the so-called "climate-lens", value-chain perspectives and carrying capacity modeling. Nevertheless, it can be claimed that there is a sufficient expansion area for consideration of private investors and accordingly mobilize in coordination with the concerned local government units having jurisdictions over the areas and DA-BFAR for technical assistance.

Alternative sites for tilapia cage farming is warranted to augment outputs generated from freshwater fishponds and to afford down-scaling of operations on heavily utilized lakes. Particular interest is on Lake Mainit (14,000 hectares) in Agusan del Norte and Lake Naujan (11,000 hectares) in Mindoro Oriental. These lakes are currently not extensively used for aquaculture operations. Based on the Asian Development Bank documents, approximately 2,500 tons per year can be produced in a modest scale integrated tilapia project in Lake Mainit (ADB ADTA 4807, 2007). In addition, utilizing at least 5 % of the surface area of Lake Naujan could potentially yield 44,000 tons per year (i.e. 550 hectares, with 4 cages per hectare each producing 20 tons per year). Meanwhile, a maximum of 10 % of the surface area of a lake or river can be utilized for aquaculture is clearly specified in the amended Fisheries Code (Sec. 51, RA 10654). The combined rough estimates of production capacities of Lake Naujan and Lake Mainit represents 10.7 % (46,500 tons) of the projected demand for tilapia in 2025 (433,340 tons).

Research and development to build and disseminate user-friendly environmental modelling packages to estimate carrying capacity, determine best fish cage sites and other functionalities is needed in aide of sustainable aquaculture intensification both in marine and freshwater environments. The complementary use of geographic information systems for marine/lake spatial planning would also prove to be very useful. In addition, GIS-based technologies have been used for multi-parametric site suitability analytics in crop farming which can be extended to aquaculture.

Knowledge dissemination

Dissemination of better practices that have been proven by farmers and technologists borne out of the so-called "new normal" of aberrant weather/climate conditions is important. DA-BFAR in partnership with innovative farmers, DOST-Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) and UN FAO Philippines developed a new set of knowledge products with a series title "Impact Management of Weather Systems on Aquaculture" (IMWS). Invited SEAFDEC/AQD experts also provided inputs during its development. This publication is eleven (11) part series which covers all farmed species and corresponding farming systems across all four (4) climatic conditions in the country. The IMWS series provides details on farmer-proven and scientifically-validated practical techniques to mitigate impacts of climate/weather disturbances and response to emergencies. Documentation and validation of such knowledge must continue and popularized.

Sustainable intensification in essence is producing more with less inputs. Along this line, UN FAO tapped the expertise of SEAFDEC/AQD and DA-BFAR on projects for efficient use of aquaculture feeds. Developed knowledge products namely, FAO Fisheries and Aquaculture Technical Paper 614 (2018) "Better management practices for feed production and management of Nile tilapia and milkfish in the Philippines" and FAO Fisheries and Aquaculture Technical Paper 583 (2013) "On-farm feeding and feed management in aquaculture", are highly recommended for dissemination.

Access and quality of inputs

The realized gains of the successful introduction of genetically improved tilapia strains must be sustained. DA-BFAR's GET-EXCEL tilapia strain, is one of the so-called GIFT-derived strain, is the one of the most utilized tilapia genetic material in the country today (DA-BFAR Tilapia Commodity Program, 2018). DA-BFAR on the average produces 6.8 million pieces of GET-EXCEL broodstock for distribution to both private (e.g. Central Luzon Registered Tilapia Hatchery Operators) and government hatcheries. According to DA-BFAR Tilapia Commodity Program, approximately 30 % of the entire demand for genetically tilapia fingerlings (i.e. 1.352 billion pieces total national requirement) are being supplied through its broodstock distribution program alone. Recently, DA-BFAR National Freshwater Fisheries Technology Center and other DA-BFAR Technology Outreach Stations have been investing on improved design of tilapia artificial incubation systems and broodstock conditioning ponds to increase the production of high-quality fingerling. Recently, in 2017–2018, farmers in Pampanga complained about the so-called "Tagalog" others called it "Bulugan" strain, which is basically a mongrel. This "Tagalog" or "Bulugan" strain was described as hardy to poor water conditions and can out-compete normal tilapias in feeding but very thin-long body. Per information, this mongrel strain came from tilapia hatcheries in Laguna de Bay and bought by farmers despite their knowledge of its unknown pedigree. This underscores the need for DA-BFAR, SEAFDEC/AQD, tilapia farmers and other partner institutions to address the need for genetically improved tilapia strains.

One of the known limiting factors in local milkfish production is the low hatchery capacity for milkfish fry production. Demand for milkfish fry estimates varies from a low 2.5 to a high of 3.6 billion pieces annually (DA-BFAR Bangus Development Plan, 2020–2024). Long-term investments have been drawn by the Philippine government to build central and smaller satellite hatcheries in partnership with local government units and existing hatchery operators. SEAFDEC/AQD have been working with DA-BFAR in conducting technical assessment on proposed sites for central hatcheries and development of detailed engineering design and production plans.

References

Websites

International Disasters Database UC Louvain, Belgium www.emdat.be

Philippine Statistics Authority (PSA) OpenStat http://openstat.psa.gov.ph/

DA-BFAR internal and institutional documents

Bangus Development Plan 2020-2024, RD. Wilfredo Cruz, National Focal Person

Tilapia Commodity Program, 2018, Ma. Judecel Danting, National Focal Person

300 Fish cage Project, 2018. Roy C. Ortega, DA-BFAR Aquaculture Division

Philippine Fisheries Profile, 2016

Comprehensive National Fisheries Industry Development Plan (CNFIDP), 2008.

Potential Areas for Milkfish Marine Cage Operations, 2019.

Other references

Asian Development Bank. 2005. An Impact Evaluation of Genetically Improved Farmed Tilapia and Their Dissemination in Selected Countries. ADB, Pasig City, Philippines

Asian Development Bank. 2007. Strategy for Sustainable Aquaculture Development for Poverty Reduction (ADTA: PHI 4708), Philippines., Pasig City,

DA-BFAR and DOST-PAGASA. 2017. Impact Management of Weather Systems in Aquaculture. DA-Bureau of Fisheries and Aquatic Resources and DOST- Philippine Atmospheric, Geophysical and Astronomical Services Administration. PDF versions available upon request. Roy C. Ortega, National Project Coordinator (kaulayao@yahoo.com)

DOST-WorldFish. 2016. Aquaculture Futures: Fish Supply and Demand Scenarios and the Sustainable Growth of Aquaculture in the Philippines. DOST-Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development Council and WorldFish-Philippine Country Office, 2016, Los Banos, Laguna

FAO. 2018. The State of World Fisheries and Aquaculture 2018 - Meeting the sustainable development goals. Rome. Licence: CC BY-NC-SA 3.0 IGO

FAO Fisheries and Aquaculture Technical Paper 614 (2018) “Better management practices for feed production and management of Nile tilapia and milkfish in the Philippines”;

FAO Fisheries and Aquaculture Technical Paper 583 (2013). “On-farm feeding and feed management in aquaculture”

Ortega, R.C. 2013. The emergence of the cheapest farmed freshwater food fish in the Philippines”. International Symposium on Small-scale Aquaculture Extension. Dec. 2-6, 2013. UN FAO Regional Office and Network of Aquaculture Centers in Asia and Pacific, Bangkok, Thailand.

PSA. 2017. Consumption of Selected Agricultural Commodities in the Philippines Vol. 2, Philippine Statistics Office, Quezon City, Philippines

R.A. 7161 Of 1991 “An Act Incorporating Certain Sections of the National Internal Revenue Code Of 1977, As Amended, to Presidential Decree No. 705, As Amended, Otherwise Known as “The Revised Forestry Code of The Philippines,” and Providing Amendments Thereto by Increasing the Forest Charges on Timber and other Forest Products”

R.A. 10654. An Act to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing, Amending Republic Act No. 8550, Otherwise Known as "The Philippine Fisheries Code of 1998," and For Other Purposes

R.A. 7586. An Act Providing for the Establishment and Management of National Integrated Protected Areas System, Defining Its Scope and Coverage, and for Other Purposes

REPUBLIC ACT No. 11038. An Act Declaring Protected Areas and Providing for Their Management, Amending for This Purpose Republic Act No. 7586, Otherwise Known as the "National Integrated Protected Areas System (NIPAS) Act of 1992" and for Other Purposes

Personal communications (various dates)

Mr. Jaime Sale, JIKARS Aqua farm, Candaba, Pampanga

Mr. Jon Juico, President, Philippine Tilapia Association

Mr. Rodrigo Basallo, President, Philippine Milkfish Industry Group

Mr. Jothon Lanzar, Fish cage operator, Malalag Bay, Davao del Sur

Mr. Norbert Chingcuanco, Vice. Pres. for Corp. Planning., Feedmix Specialist

Ms. Marivic V. Maglaqui, Regional Sales Manager, Santeh Feeds

Ms. Ma. Judecel Danting, Focal Person, DA-BFAR Tilapia Commodity Program

Mr. Wilfredo Cruz, Reg. Director, Focal Person, DA-BFAR Bangus Program

Mr. Hoseas Montevilla, Farm owner, Laguna Lake, Binangonan, Rizal

Ms. Reinelda Adriano, Division Chief, PSA-Fisheries Statistics Division