

Current status of shrimp fishery in Pakistan: economic role, challenges, opportunities and strategies for aquaculture development

¹Syed Babar Hussain Shah, ¹Yongtong Mu *, ²Tushar Ramesh Pavase, ³Ghulam Abbas, ⁴Maqsood Ahmed Soomro, ¹Muhammad Talib Kalhoro, ¹Muhammad Mohsin, ¹Muhammad Noman, ¹Mumtaz Ali, & ³Abdul Malik

¹College of Fisheries, Ocean University of China, Qingdao, 266003, China

²College of Food Science & Engineering, Seafood Safety Lab, Ocean University of China,

³Centre of Excellence in Marine Biology, University of Karachi, Karachi

⁴College of Marine life Science, Ocean University of China, Qingdao, 266003, China

*[E-mail: ytmu@ouc.edu.cn]

Received 02 May 2018; revised 06 June 2018

The Shrimp fishery has an important role in society to meet current and future food, livelihood, employment, business and other economic needs. The capture fishery is one of the largest food-providing sector, whereas aquaculture has emerged as the fastest food-contributing sector globally. This research determines the socio-economic structure of shrimp fishery with a prime objective to expose an overview of shrimp fishery with economic perspective in Pakistan. In addition, further specifying the shrimp capture production, export earnings, farming and socio-impact in coastal region. Indus delta is the most favourable breeding ground for many fish and shrimp species, exhibiting highly rich in natural resources. There is a huge non-agricultural land available along the coast, which can be utilized for aquaculture. This study elucidates that the Shrimp fisheries is 'Drowning' in Pakistan. Hence, in order to sustainably develop shrimp aquaculture in Pakistan, this study aims to propose developmental strategies for authorities to establish an extension aquaculture in fisheries department all over the country. In addition, promoting shrimp farming initially at coastal regions to benefit and generate numerous opportunities for sustainable development in country's livelihood.

[Keywords: Aquaculture; Economic role; Pakistan; Shrimp; Strategies]

Introduction

Fisheries perform subservient role to produce food and employment worldwide. Fish and fishery products are the major source of food, and income, and it contributes in the nation's economy over the world. Catch from wild (marine and freshwater) and aquaculture are origin for fish and fishery products. Fisheries is one of the best supporting sectors after agriculture for coastal societies and for those inhabiting near inland water bodies, therefore domestic people are directly or indirectly dependent on the fisheries sector for their livelihood¹. Majority of people inhabiting near coastal, rivers, dams, lakes and reservoirs areas are carrying out varied occupations for instance, capturing fish, fish netting, gear preparation and repairing, small-scale fish business, diesel provisions, loading or unloading fishing boats, processing, packaging, marketing, trading, aquaculture related industries and others services².

World fisheries scenario

According to recently published The State of World Fisheries and Agriculture (FAO), the capture fisheries reported as 92.6 Million Tons (MT) in 2015 worldwide, including 81.2 MT by marine and other remained 11.6 MT captured from inland waters³. Besides that in the same time aquaculture produced 106 MT, which has earned US\$ 163 billion, including 76.6 MT food fish of US\$ 157.9 billion, 29.4 MT aquatic plants worth US\$ 4.8 billion and 41.1 thousand tons of non-food product worth US\$ 208.2 million. However, 76.6 MT fish food consisting 51.90 MT Finfish, 7.35 MT Crustacean, 16.43 MT Molluscs, and 0.90 MT other aquatic animal were produced from aquaculture⁴. The world aquaculture production of main species group was calculated as 76.6 MT (live weight), in which 48.75 MT were from inland aquaculture and remaining 27.84 MT were produced from marine and coastal aquaculture. In addition, the production of crustaceans by aquaculture

was 7.35 MT by live weight including 2.85 MT from inland aquaculture and 4.49 MT from marine and coastal aquaculture⁴.

In 2014, 73.8 MT fish was harvested from aquaculture worth US\$ 160.2 billion including US\$ 99.2 billion from 49.8 MT of finfish, US\$ 19 billion from 16.1 MT of mollusks, US\$ 36.2 billion 6.9 MT of crustaceans, and US\$ 3.7 billion from 7.3 MT other aquatic animals including frogs. The difference in these figures of 2014 and 2015 demonstrates that in 2015, 2.8 MT extra were produced than 2014. In the last 15 years from 2001 to 2015 the average growth rate of world aquaculture production was computed as 5.9 % per-year (year⁻¹). The continent's progress of aquaculture year⁻¹ interned of average growth rate computed for Africa as 10.4 %, for Asia 6 %, 5.7 % America, 2.9 % Oceania and 2.5 % for Europe⁴.

The global Shrimp catch have been standing at around 3.5 MT since 2012⁵, owing to the jump in the production of (*Crustaceans*) shrimp, prawn and mollusk through aquaculture and the proportional decline in their price, annual per-capita of crustaceans grew substantially. During 1961, it was 0.4 kg and it consistently increased up to 1.8 kg in 2013⁵. Globally, in 2013, the value share of the trade of shrimp and prawns was about 15.3 %, 16.6 % instigated from Salmon, Trouts and Smelts, 18.1 % trade value originated from other marine fish species by catch as well as aquaculture and so on (Figure 1)⁶.

Shrimps are commercially categorized into three major groups such as Jaira (white shrimp), Kalri (pink-brown shrimp) and kiddi shrimps. The kiddi shrimps belong to marine *Crustaceans* family *Penaeidae*, which has 48 genera worldwide⁷. Shrimp and other types of bottom trawling have main role in

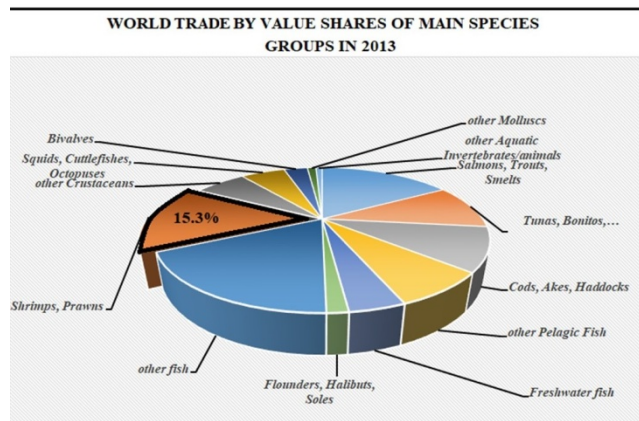


Fig. 1 — World trade by value share of main species groups in 2013.

providing employment, income and livelihoods for hundreds of thousands of people in tropical and subtropical countries^{5,8}.

Status of fisheries in Pakistan

Pakistan, has 1,120 km long area of coastline along the Sindh and Baluchistan provinces with approximately 50,270 square kilometres (Km²) of continental shelf and 350 nautical miles virtually (2,900,00 km²) of exclusive economic zone (EEZ). On the other hand, thus it almost 3,102,408 hectare area of inland water reserves (Figure 2)⁹. It is blessed with plenty of potential fishery resources. The significance of commercial marine fish fauna consist of 250 demersal fish species, 15 different kinds of shrimp, 20 large, 15 medium and 50 small pelagic fish species, 5 lobsters and 12 cuttlefish/squid/octopus species. Thus, the addition of fresh water fauna particularly comprises as more than 235 species, which consist 200 fish species (admitted 20 commercially valuable) and 35 types of shellfish included prawn and crab¹⁰.

The fisheries sector in Pakistan plays a substantial role in alleviation of poverty and accomplishment of food security. However, considering of county's economy, it has not very effective role yet, nonetheless, fisheries support various sub-branches of livelihood to relevant folks along the coastal range and inland areas of country. In the year 2016-17, the country's Gross Domestic Product (GDP) was 5.3 %, as compared to previous years additional 0.8 %, by the year 2015-16, economic expansion was 4.5 %^{11,12}. In 2017, 19.53 % of share in GDP was contributed by agriculture sector with the support of is four major sub-sectors viz. crops, livestock, fisheries and forestry. Share of fisheries in agriculture was 2.12 % and its share in GDP accounted to 0.41 %, respectively¹³. Moreover, employment in fisheries sector was around 400,000 directly and 600,000 indirectly¹⁴ [12]. It made about 1 % of the labor force of the country¹⁵. In 2013, Pakistani fisheries sector contributed 62.30 thousand Metric Tons (mt)



Fig. 2 — Coastal belt of Pakistan.

including 14.81 thousand mt from aquaculture and 47.49 thousand mt from capture. Although, export and import were remained at 11.08 thousand mt and 0.16 thousand mt, respectively, except that value of export earnings was 2.27 million USD and import expenditure 4,313 USD. The export of seafood from Pakistan was enhanced to 16,991 tons and value was 49.82 million USD in 2014¹⁶. Furthermore, it is reported, that in the year of 2015 Pakistan fisheries had produced 643164 mt, including 491990 mt from capture fishery and the rest 151174 mt contributed through aquaculture^{17,18}. The progress of total fisheries production was more prominent with an increase to 19707 mt, including 16914 mt increase in capture and 2793 mt from aquaculture as compared to previous year 2014 (Figure 3)^{17,18}. The exports of fish and fish preparations in the first half of Fiscal Year (FY) (Dec 2016-July 2017), fishery exports and preparations had earned as US\$ 183.5 million, which depicts an increase of more than 10 % as compared to the US\$ 166 million for the FY 2015-2016¹⁹.

Status of Shrimp fishery in Pakistan

The shrimp fishery is considered as one of the major landing resource on the dock stations at the coast of Pakistan. The Indus delta estuary is particularly rich in the shrimp diversity, which consists of an area of around 140 land miles wide,

extending about 40 miles²⁰. Throughout the monsoon seasons, sediments and organic matters are usually carried in to the delta by the flow of fresh water through the Indus River²¹⁻²³. Moreover, the sediment deposition is driven into the plankton blooms following the track of mangrove creek network²⁴ in terms of providing most favourable habitats for marine food chain^{25,26}. Since, this kind of environment is very appropriate for natural breeding grounds. The Indus River estuary specifically contribute towards nurseries for above 30 species of shrimp in the mangrove creeks around delta^{20,25,27}. Currently, almost 75 shrimp species have been reported in the coastal and inland water bodies of Pakistan²⁸. The commercial species comprise mainly of the *Penaeidae* and *Solenoceridae*, apropos 27 *penaeid* shrimp species were reported from marine waters^{29,30}. Among these, 15 shrimp species are commercially important with higher trade market values¹⁰. The commonly captured shrimp species from this region are categorized into three major groups i.e. Jaira (white shrimp) *Penaeus* species, Kalri (pink-brown shrimp) *Metapenaeus* species and Kiddi *Parapenaeopsis* species⁷. Foremost, many of the previous studies from different surveys and landing centers data had reported that the most captures of shrimp species included Jaira, Kalri and Kiddi (Table 1)³¹⁻³⁵.

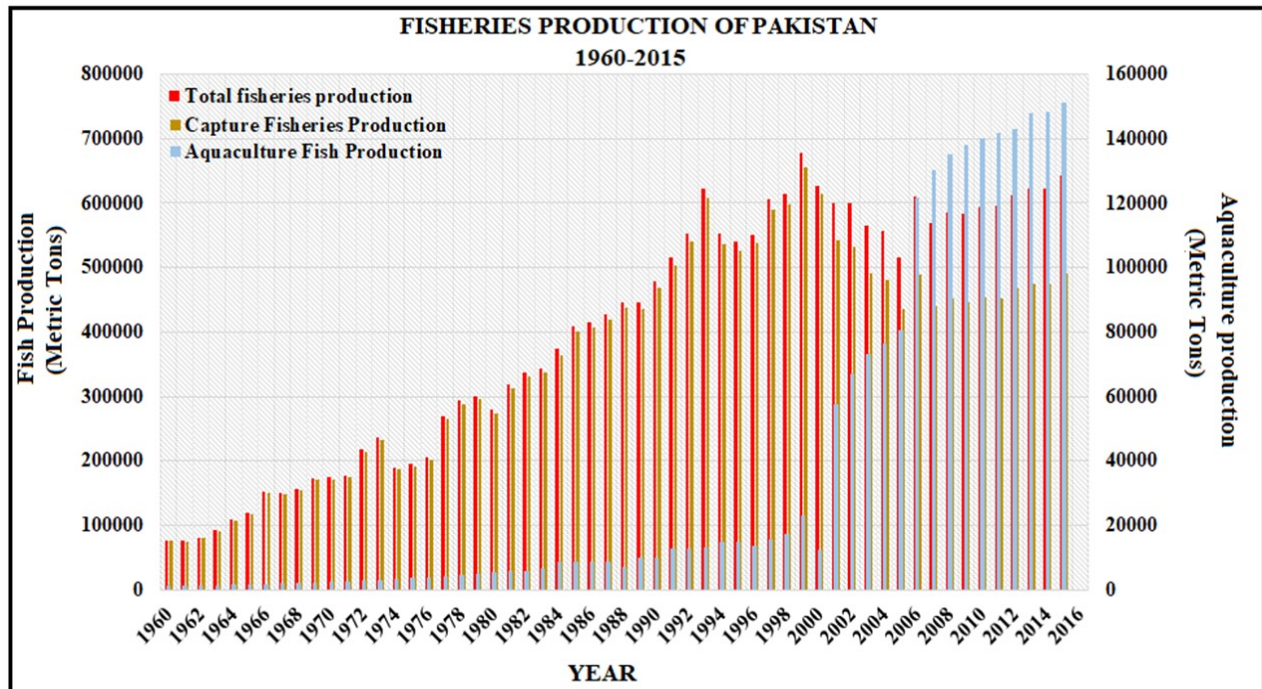


Fig. 3 — Fisheries production of Pakistan from 1960-2015.

Table 1 — Commercial shrimp species at Pakistan

Sr.No	Species Name: Common/Scientific	Local Name	Size (BL) cm	Reference
1	Deep-sea mud shrimp <i>Solenocera hextii</i>	(S) Lal kiddi, Bare sar ka kiddi; (B) Sore kiddi	M= 12.7 cm F= 13.8 cm	(Wood-Mason and Alcock, 1891)
2	Coastal mud shrimp <i>Solenocera crassicornis</i>	(S) Lal kiddi, Bare sar ka kiddi; (B) Sore kiddi	M= 9 cm F= 14 cm	(Edwards, 1837)
3	Ridgeback shrimp <i>Solenocera choprai</i>	(S) Lal kiddi; (B) Sore kiddi	M= 9.5 cm F= 13 cm	(Nataraj, 1945)
4	Indian rough shrimp <i>Trachysalambria aspera</i>	(S) Kalri, Saana, Lal kiddi; (B) Kalri, Madak	M= 8.1 cm F= 10.5 cm	(Alcock, 1905)
5	Flamingo shrimp <i>Parapenaeus longipes</i>	(S) Kalri, Saana, Lal kiddi; (B) Kalri, Madak	M= 7.6 cm F= 7.9 cm	(Alcock, 1905)
6	Kiddi shrimp <i>Parapenaeopsis stylifera</i>	(S) Kalri, Saana, Kiddi; (B) Kalri, Madak	M= 11.7 cm F= 14.5 cm	(Edwards, 1837)
7	Rainbow shrimp <i>Parapenaeopsis (Mierspenaeopsis) culptilis</i>	(S) Kalri, Saana, Kiddi; (B) Kalri, Madak	M= 13 cm F= 17 cm	(Heller, 1862)
8	Jawla paste shrimp <i>(Acetes indicus)</i>	(S) Saana, Bhusa	M= 1.5–2.5 cm F= 2.3–4 cm	(Milne-Edwards, 1830)
9	Spear shrimp <i>Parapenaeopsis (Mierspenaeopsis) hardwickii</i>	(S) Kalri, Saana, Kiddi; (B) Kalri, Madak	M= 11.1 cm F= 13.5 cm	(Miers, 1878)
10	Peregrine shrimp <i>Metapenaeus stebbingi</i>	(S) Kalri, Saana; (B) Kalri, Madak	M= 11 cm F= 14 cm	(Nobili, 1904)
11	Speckled shrimp § <i>Metapenaeus monoceros</i>	(S) Kalri, Saana, Giddani kalri; (B) Kalri, Madak	M= 15 cm F= 20 cm	(Fabricius, 1793)
12	Arabian red shrimp <i>Aristeus alcocki</i>	(S) Sana; (B) Madak	M= 15 cm F= 13-15 cm	(Ramadan, 1938)
13	Jinga shrimp § <i>Metapenaeus affinis</i>	(S) Kalri, Saana, Karachi kalri; (B) Kalri, Madak	M= 14.6 cm F= 18.6 cm	(Edwards, 1840)
14	Yellow shrimp <i>Metapenaeus brevicornis</i>	(S) Kalri, Saana; (B) Kalri, Madak	M= 15 cm F= 20 cm	(Edwards, 1840)
15	Fiddler shrimp <i>Metapenaeopsis stridulans</i>	(S) Kalri, Saana, Lal kiddi; (B) Kalri, Madak	M= 8.9 cm F= 10.6 cm	(Alcock, 1905)

*BL = Body length, *S=Sindhi, *B= Balochi, *M= Male, *F=Female. Source (Psomadakis, 2015)

History of shrimp farming in Pakistan

An initial step of shrimp culture in Pakistan was taken up by Department of Livestock & Fisheries, Government of Sindh (GOS) in 1982. The pilot project of shrimp farming was initiated at Dabhu Creek (Gharo), and it was the part of Asian Development Bank (ADB), ADB-financed Aquaculture Development Project. Other Private sector investor's viz. Lipton Farm, Mansour Sherif farm and Baloch farm also became partners and invested in the project to get achievement. In addition, projects had demonstrated the commercial feasibility of shrimp farming in Pakistan. However, none of them were succeeded in continuing any operations³⁰. Furthermore, in the same year of 1982, and experimental farm of Penaeoid shrimp was established in Sindh Province, along with this, elite

private enterprisers notably had imported feed and seed from Malaysia and launched some shrimp farms (only cultivate to grow out), due to unavailability of local feed, seed and infrastructural facilities, on account of which it had to stop shrimp farming activities almost for 15 years. However, presently efforts of Sindh Fisheries towards revitalization of aquaculture industry are underway; A shrimp hatchery and shrimp farms have also been established³⁶. On the other hand public-private partnership between Fisheries Development Board (FDB) and Sinora Prime, established shrimp farm in Sindh besides Dhabeji town³⁷.

Material and Methods

The intentions of this review study is to attain to the revision of the comprehensive literature review

related to value chain of shrimp fisheries, production, farming, trade, future potential and social impact, and other perspectives of sector development in Pakistan. In addition, this review has accumulated selective information by large spatial extent, revision of reports, published research articles, opinion articles, newspaper and communications. In addition, departmental officials and private stakeholders were also communicated for the collection recent information to be included in the present study. Furthermore, the published and online time series data of fisheries sector such as shrimp production, export and trawlers were collected from various sources viz. Handbook of Fisheries Statistics of Pakistan published by Marine Fisheries Department Karachi (MFD), Development Statistics of Sindh printed by Bureau of Statistics, Government of Sindh, Karachi, The world Bank and Food and Agriculture Organization of the United Nations (FAO) individually. Along with this, to get full insight in the project objectives, Microsoft Word Excel 2010 was applied to represent statistical graphs and some analytical equations to determine percentage and growth rate.

Results

Shrimp fishery Production in Pakistan

Overall, there are 15 species of marine shrimp reported in Pakistani waters, with most of the commercially important species belonging to Kiddi

shrimp³³. However, from the period of 1971 to 2009, catch production of Kiddi shrimp accounted for nearly 45 % percent of the total shrimp production, other 29 % catch production was registered for Kalri and rest 26 % was produced by Jaira catch. Nevertheless, the 39 years date of catch of Shrimp from 1971-2009 totalled to 966,409 tons. In addition, 247,265 tons from species of Jiara, 279,941 tons by Kalri, and Kiddi shrimp production were accounted at 439,203 tons, all together average rate was calculated as 8,260 tons year⁻¹. The total catch contribution of Jaira at the same duration of 1971-2009 was 247,265 tons along with 6,340 tons year⁻¹ on an average however, 279,941 tons were contributed from the catch of Kalri, which considered 7,178 tons year⁻¹ and most rich catch of Kiddi shrimp was totalled to as 279,941 tons along with 11,262 tons average year⁻¹. Furthermore, in the primary decade of 1971-1980 total production of shrimp was 211,079 tons with an average of 7,036 tons year⁻¹. The next decade of 1981-1990 showed progress of catch to 276,721 tons with the year⁻¹ average at 9,224 tons; Further, 1991-2000 catch of shrimp was 283,291 tons which was little higher than last two decades and year⁻¹ average was also little more at 9443 tons and the remaining duration of nine years from 2001-2009 saw quite low in production, as it accounted a total catch of 195,318 tons with on an average 7,234 tons year⁻¹ (Figure 4). On the other hand, in 1971 total 668 trawlers were registered which increased to 3044 in 2009. The

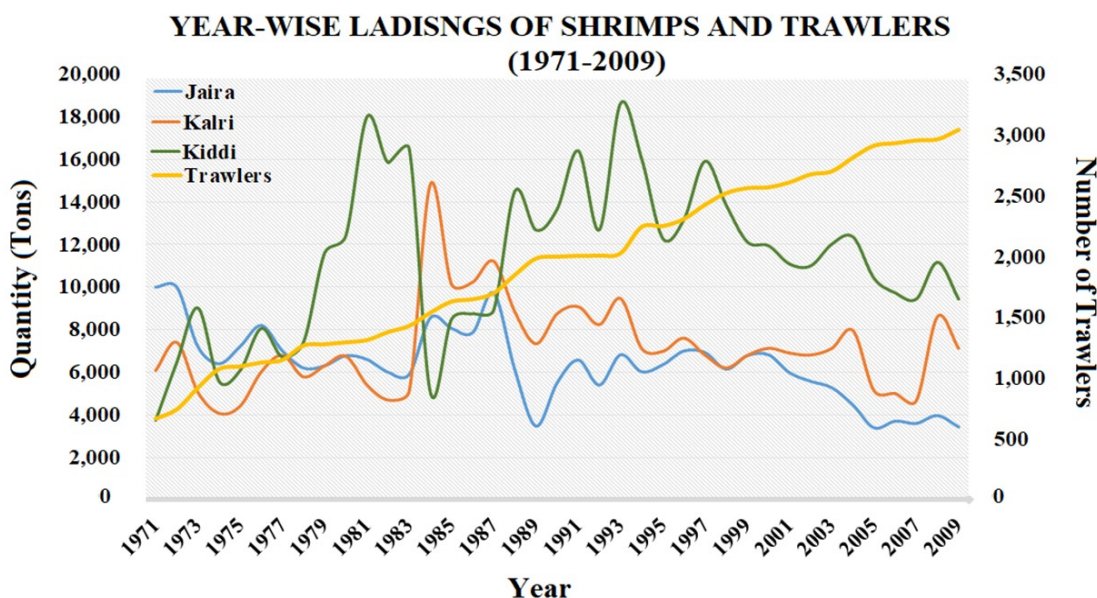


Fig. 4 — Year-Wise landings of shrimps and trawlers from (1971-2009).

increasing rate of trawlers was calculated as 17 year⁻¹. In 1993 trawlers were 2028 which became 2245 in 1994, therefore, an addition of 217 tram was in a year was highest in timeline and lowest was registered with only two addition in 1992 (Figure 4).

Figure 5 shows the month-wise landings of all there shrimp species categories i.e. Kiddi, Jaira and Kalari. The highest landings of Kiddi shrimp was recorded in the September, October and November. The production has decreased in the last years in the

Month of November. Moreover, production of Jaira shrimp increased in month of April, October and November from 1971-2004. Additionally, catch production of Kalari year-wise increase was recorded in the month of October, November and December, respectively.

Shrimp sale and Local Market prices

The Figure 6 represented the whole-sale estimated avarage prices of shrimp varieties at Karachi fish

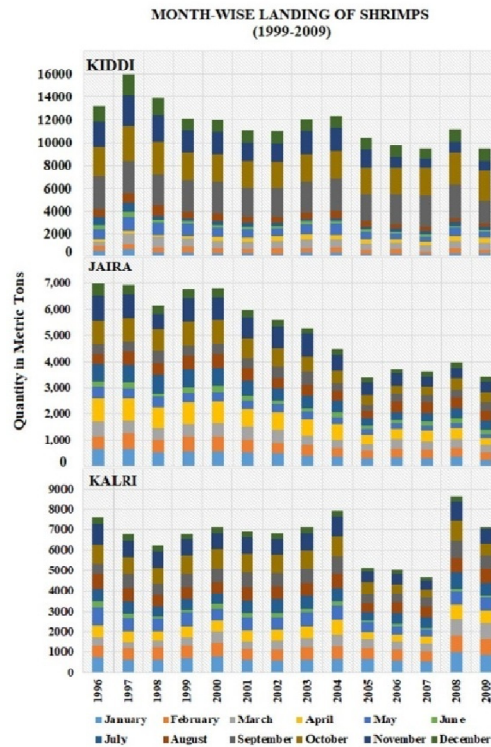


Fig. 5 — Month-Wise landing of shrimp from (1999-2009).

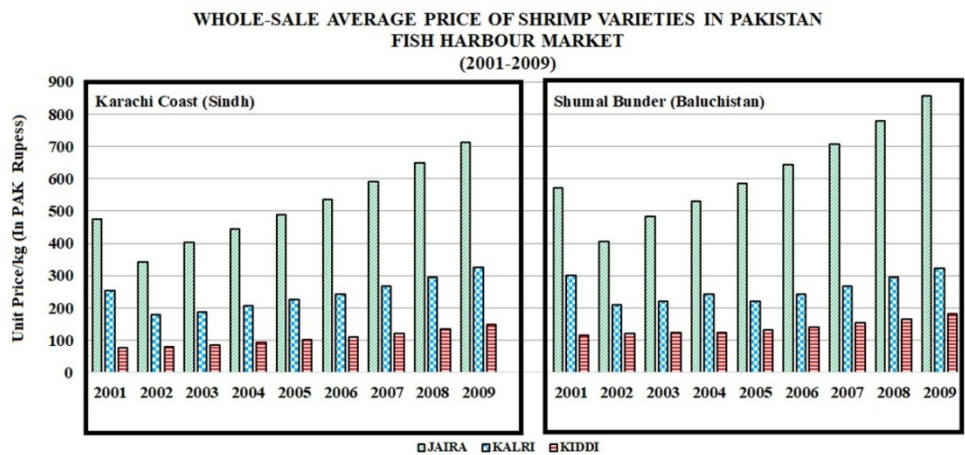


Fig. 6 — Whole-Sale average price of shrimp varieties in Pakistan fish harbour market (2001-2009).

harbor market (Sindh and Baluchistan coast) from the period 2001-2009. In each season, month and year did not have the same market prices. Even different provinces had different values. The Jaira variety have good price in market because of big size and market demand. In addition, year⁻¹ estimated growth rate of Shrimp price at Sindh coast was calculated at PKR 54 Jiara, 28 Kalri and 9 Kiddi, However, at same time in Baluchistan coast prices were considered as PKR 63 Jaira, 33 Kalri and 10 kiddi, respectively.

International trade of shrimp in Pakistan

The export of cumulative frozen fishery products from 1970 to 2009 (40 years) was computed as

1,399,003 t, the average was calculated as 34975 t year⁻¹, including 29.6 % share of frozen Shrimp in numbers 414,325 t, with average at 10358 t year⁻¹, respectively. In addition, earning amount was 128,215 million Pakistani Rupee (PKR), including, 45.3% (58,193 million) PKR share from frozen shrimp export (Figure 7). Moreover, the export of cumulative frozen fishery products in the decade 1970-1979 was totalled as 46,401 t, with 43,265 t of frozen shrimp, the average were 4640 t year⁻¹, however, the share of frozen shrimp was 93.2 % year⁻¹ in numbers 43,265 t and average was 4,327 t year⁻¹.

Figure 7 and 8 represented the statistical representation of growth, higher and lower export

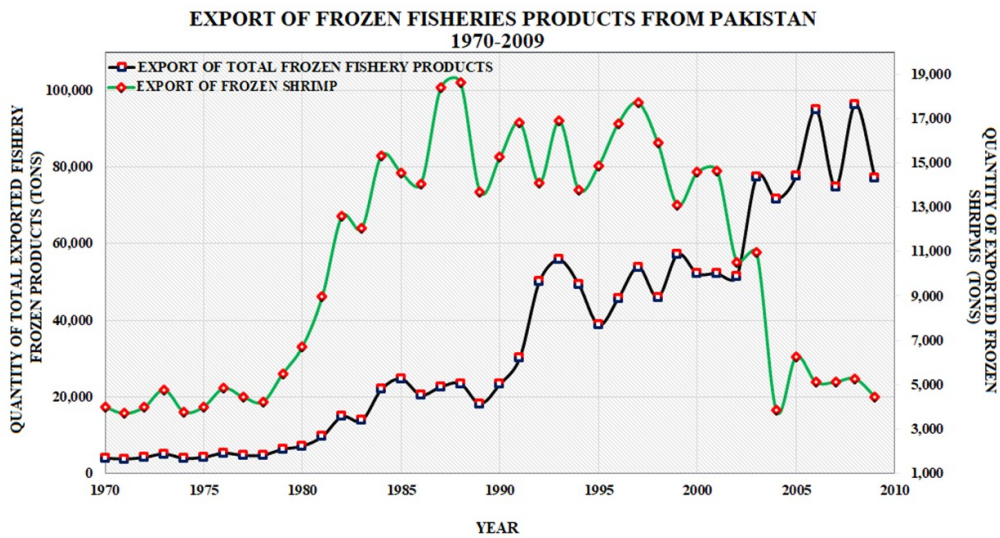


Fig. 7 — Export of frozen fisheries products in Pakistan from (1970-2009).

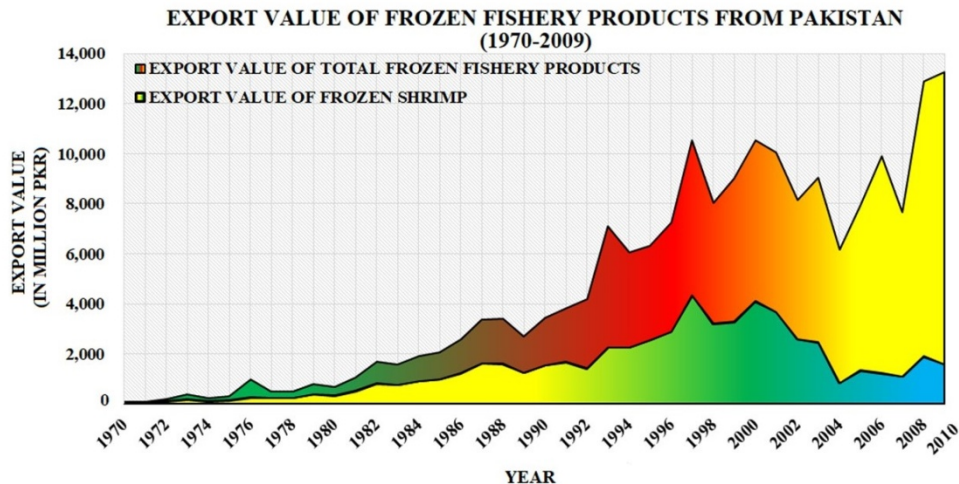


Fig. 8 — Export value of frozen fisheries products in Pakistan from (1970-2009).

trade rate of frozen shrimp and other frozen fishery products. As per the date of the primary decade of study (1970-1978), almost 93.2% of frozen shrimp products were exported (43,265 t), however, the export of all frozen fishery products was 46,401 t. In the same decade, export value of frozen shrimp totalled at 1,798 million PKR and the total frozen fish products earned 2,270 million PKR. In value, 79.2 % was the share of frozen shrimp. In this decade, estimation of frozen shrimp were calculated as 4,327 t year⁻¹ and the value was estimated as 180 million PKR year⁻¹ including frozen shrimp production. The frozen fishery were 4,640 t year⁻¹ with a total value of 252 million PKR year⁻¹. The share of frozen shrimp products was 71.4 % year⁻¹ in value it was 79.2% year⁻¹.

However, 1980-1989, total of which 135,018 t, frozen shrimp were exported, the frozen fishery products were 176,784 t. Export value of the frozen shrimp was 10,047 million PKR and the total frozen fish products earned 10,968 million PKR. The contribution of frozen shrimp was 76.3 % and in this value was 91.6 % in decade. The estimation of frozen shrimp was calculated as 13,502 t year⁻¹ worth 1,005 million PKR and total frozen fishery production was 17,678 t year⁻¹ worth 1,097 million PKR; in total 76.3 % year⁻¹ was the share of frozen shrimp products and value was 91.6 % year⁻¹. Furthermore, during 1990-1999 frozen fish products exported amounted to 450,143 t including frozen shrimp 155,243 t. The value of frozen fish products were 40,244 million PKR including 25,479 million PKR of frozen shrimp. The contribution of frozen shrimp was 34.4 % and in value it was calculated as 63.3 % in the decade. Meanwhile, approximate export of frozen fishery products was 45,014 t year⁻¹ worth 4,024 million PKR year⁻¹ including 15,524 t year⁻¹ of frozen shrimp products with a total value of 2,580 million PKR year⁻¹. The share of exported frozen shrimp products was calculated to be 62 % year⁻¹ was a value 64.1 % year⁻¹. Analysis of the last decade i.e. 2000-2009 showed that (80,799 t) 11.1 % frozen shrimp was exported as compared to frozen fishery products at 725,675 t. In this decade, export value of the frozen shrimp totalled to 20,869 million (27.9 % share) PKR, and the total frozen fish products gained 74,688 million PKR. The estimation of frozen shrimp was calculated as 8,080 t year⁻¹ worth 2,087 million PKR year⁻¹ and total frozen fishery was 72,568 t year⁻¹ worth 7,469 million PKR year⁻¹. In this decade, the value share of frozen shrimp computed as 27.9% year⁻¹.

Discussion

Fish consumption is usually associated with health benefits, particularly the consumption of marine-fish that has abundant quantity of polyunsaturated fatty acids, iodine and selenium³⁸. Moreover, the fish consumption can relieve nutritional deficiencies by providing calcium, vitamin A, iron, and zinc³⁹ and can help to cure various diseases⁴⁰. It is therefore recommended to consume one-two fish per week⁴¹. Previously, the natural fisheries resources and fish stocks were adversely affected in order to meet the global fish demand^{42, 43}. For example, natural fish stocks continuously declined since 1950s due to technological advancement and improvement in global fisheries⁴⁴. Since the 1990s, aquaculture has been developed as an alternative way to enhance fish production without decreasing wild fish stocks in order to meet the worlds' fish demand^{44,45}. Recently, aquaculture has rapidly grown to a major industry in Asia and especially in China, which is the world's largest producer, processor, consumer and exporter of seafood⁴⁶. China is not only the major fish producer all over the world but also the largest exporter of fish and fishery products since 2002. In 2014, China accounted for 45.4 million tons (more than 60 %) of global fish production from aquaculture (FAO, 2016).

Shrimp aquaculture is the fastest growing sector since last two decades. The shrimp industry provides immediate economic benefits, contributes to poverty reduction and food security, as well as generates employment from seed collectors to exporters. Moreover, in Bangladesh after garments, shrimps are considered the second largest export commodity and contribute about 4 % of national GDP. Some other Asian countries such as India, Thailand, Indonesia, Malaysia, and Vietnam recently have become very strong in culturing brackish water shrimp⁴⁷⁻⁴⁹. Similarly, shrimps are one of the major fishery resources landed on the dock stations along the coast of Pakistan. The environment along the coast of Pakistan is very suitable as it provides breeding grounds for shrimps. In addition to this, the estuary of Indus River is playing a significant role in providing nurseries and also in providing basic natural nourishments to aquatic biota. The exports of shrimps from Pakistan is continuously increasing due to increase in demand of large sized shrimps from global markets such as USA, Japan and other West European countries. Therefore, the number of commercial mechanized fleets was increased and still increasing

with the passage of time in order to meet this rising demand. For instance, the number of motorized crafts increased from 3 (1958) to 1631 (1985), and the number has now grow roughly to about 2400^{50,51}. Nevertheless, several factors viz. overfishing, usage of high-tech gear, improper licensing, issuing of fishing vessels, improper awareness of fishing spots, improper abiding of fishing rules and absence of shrimp aquaculture are responsible for decrement of shrimp production from Pakistan. It is therefore, needed to initiate marine and inland shrimp aquaculture to enhance the shrimp production in Pakistan in order to meet increased global shrimps demand. Therefore, it can be expected that aquaculture shrimp production will rescue the country's sinking seafood exports demand.

Issues in Shrimp fishery

Several factors which are responsible for decrement in fish and shrimp production in Pakistan are as follows.

- Environmental problems.
- Coastal erosion.
- Overexploitation of fisheries resources stock.
- Improper awareness of fishing spots.
- Improper licensing and issuing of fishing vessels to control natural fishery stock.
- Improper abiding of fishing rules and regulation to control illegal gears and fishing methods.
- Improper structural framework management of fisheries.
- Lack of governmental and non-governmental institutions joint efforts management.
- Absence of research institutions.
- Lack of MPAs to rehabilitate natural biota.
- Nonappearance of mega plan infrastructure for community development.
- Inaccessibility of commercial shrimp producing hatcheries to facilitate local farmers.
- Nonattendance of marine aquaculture on local basis to give rise to seafood.
- Lack of local feed making industries to deliver low-cost feed for farming.
- Unavailability of aquaculture extension to transformation of awareness and technology adaptation.

Conclusion

The shrimp fishery in Pakistan play a significant role, in terms of economic development, contribution

in employment, nutrition, income generation and foreign exchange earnings. However, the industry of shrimp production in Pakistan showed a decrease in our study. Leading to further damage to socio-economic condition as well as affecting fisheries resources, international market and economy, so it is necessitate to overcome schism order to promote sustainable shrimp aquaculture. As Pakistan needs to emphasize on busting shrimp production, which will be very beneficial for promoting socioeconomic condition in Pakistan. Sufficient production will also boost shrimp export potential. There is no doubt that federal and provincial government are tackling number of opening move themselves along with the support of international organizations and nongovernment agencies for sustainable development of fisheries sector in the country, however, yet there's still numerous serious steps are necessary to be taken for betterment of fisheries sector. Our study addresses some major directions to establish authorities with following strategies.

Strategies for shrimp farming development in Pakistan

The discussion section clearly indicates that Pakistan coastal region is reliable for the shrimp farming. Previously, many influential steps have been taken for the best use of this great opportunity. For most, the wild fisheries resources are currently decreasing worldwide due to many environmental and anthropogenic factors. Regarding shrimps, landings have been steadily increasing and per caput, world availability has increased as well⁵²⁻⁵⁷. Moreover, in the last decade, the shrimp farming had played a "production-led" role to increase global shrimp production. Globally, in the next decades there might be greater demand for farmed shrimp and seafood. Evidently, during the 2nd part of 20th century farmers became fascinated with new technologies and increased production abilities, there are many success stories⁵⁸⁻⁶³. Similarly, food demand, export market, technical innovated equipment market and employment ratio were significantly increased in past. However, in PAK, the wild shrimp landings are continually decreasing from last decade, for next, it will not sustain any more in PAK waters, which will affect the accommodations of society. The coastal fisheries are providing extensive benefits to local communities, including employment, livelihood and nutrition. It will directly contribute of coastal community, commercial and subsistence fishing into

GDP and collection proper landing data will be beneficial for further research and implementations. The most important strategies as applicable, to secure farming success for the future concerns to establish dependable zoning patterns and fair arrangements with substitute users of the river and coastal borderlines. Shortly thereafter, shrimp industry will stand up...year, after year, after year.... with application of modern production methods, the cost savings will eventually let down in farming expenses, enhancing strength shrimp farming at PAK will turn to reasonably profitable for next it will be more competitive.

The primary aims: enhancement of aquaculture; the better development and important commodity actions can partially enhance to the shrimp and other fish production. In addition, the enhancement of aquaculture, law enforcement, governmental collaborations and establish new platforms can effectual to generate employment, produce quantitative and qualitative seafood, export and it can reduce the pressure upon natural resources. Here, it would be appropriate to commencing propose at coastal region of country (Sindh & Baluchistan), the shrimp farming might become an important commodity that further action should be taken to:

1. Establish, wherever applicable, the 'extension aquaculture' (wing) in Department of fisheries with overall jointly in other directorates in each province of PAK, to develop aquaculture in a sustainable manner. The essential need is to convey extension awareness about problems, prevalent conditions, requirements, circumstances and detailed information about scientific techniques to encourage and motivate the practicing farmers, landowners and further intending people to adopt and initiate aquaculture business with integrated management practices. It would be very supportive to initialize and grow the shrimp farming at coastal areas as well.
2. Establish the coastal fisheries department (Sindh), to maintain the coastal ecosystem and balance natural biodiversity of the Indus delta. According to many studies, the fisheries resources are decreasing form the last decade due to overfishing and anthropogenic activities leading to the mangrove deforestation. It is needed to focus a wide range of benefits like social and recreational values, which are difficult to quantify. Some major actions are required to deal with overexploitation

and poor coastal management with the proper involvement of NGOs, consolidating services and legislation actions for the development of sustainable fishery and shrimp aquaculture.

3. PAK responsible authorities need to establish Integrated Coastal Zone Management (ICZM) with the engagement of local community, resource utilizers and technical experts. ICZM platform's responsibility is to provide exclusively coordination mechanism with Govt. & NGOs stakeholders to streamline coastal and marine affairs. The counter measures of ICZM to tackle environmental issues, unplanned management activities, enforcement law and regulation, communication gap among departments and will reduce conflicts between user's groups. Alternatively, it will deliver different economic, social, recreational and conservational facilities.
 4. Extension, Shrimp farming, In order to increase the production of shrimp at the coastal belt of Sindh and Baluchistan, the fisheries department (FD) should be constructed small hatcheries of commodity at the beginning scale, which can easily provide shrimp seed to local farmers. In addition, FD should make model shrimp farms to increase the interest of local farmers.
 5. FD hatcheries and trainings (H&T), needs to spread department towards commercializing fish farming. The commercial fish farming system will play ideal role in the society and generate various job opportunities in FD, and will increase fish/shellfish production. Eventually, the earned money from farming could be used into H&T and R&D for foster latest research & technology and can be used to shape compensation funds that accumulate portions of the production/export.
- The actions should also be taken to enhance aquaculture especially shrimp aquaculture, also should not ignorable relates following factors, which can create other unnegotiable problems to environment and investment risks.
- To avoid of land, that could otherwise to be used for agricultural operations;
 - To avoid destruction of fragile habitats such as mangrove forests;
 - To avoid such places where seasonal flow of water can occur, like Indus River seasonal streams;
 - To control of the diseases and their dissemination;
 - To avoid the chemical usage and its negative effect on environment;

In fact, these actions in these salutations should not problematic to be taken, as most developing countries have previously recognized that whenever appropriate the objectionable side effects or exceptionable to rehabilitate demands and development, associated to establishment of this industry have to be adjust to step forward. It is also acknowledged that significant ranges related to future strategic actions for development, support and balancing, evaluates are applicable to small, medium and big size producers. While, formers and their employment are the important factor for assuring development at poor rural areas, the big industry have to lead the way for maintain it sustainable consumption in local and exports markets. Both producers are enormously important for each country and their particularities and basic necessitates have to be taken into account for their better livelihood services and as well country's economic contribution.

Acknowledgement

This work was supported by China Scholarship Council (CSC), earmarked fund for Modern Agro-industry Technology Research System (Project No CARS-49) for funding of this project of China and special research fund of Ocean University of China. We are very grateful to the reviewer for comments and suggestions which greatly improved the manuscript.

References

- Darryl, F., Indigenous peoples of the world's coastlines are losing their fisheries-and their way of life. *The Washington Post, USA.*, Retrieved from: https://www.washingtonpost.com/news/energy-environment/wp/2016/12/02/coastal-native-people-who-need-fish-the-most-are-losing-them/?utm_term=.afea0fd4d6f3 (2016).
- Jentoft, S., The community: a missing link of fisheries management, *Marine. Policy.*, (2000) 53-60.
- FAO., Food and Agriculture Organization Global Capture Production database updated to 2015 in Summary information, *Food and Agriculture Organization of the United Nations, Rome*, Retrieved from: <http://www.fao.org/3/a-br186e.pdf> (2017).
- FAO., An Overview of Recently Published Global Aquaculture Statistics, in global aquaculture updates, *Food and Agriculture Organization of the United Nations, Rome*, Retrieved from: <http://www.fao.org/3/a-bs235e.pdf> (2017).
- FAO., National Aquaculture Sector Overview, Pakistan, National Aquaculture Sector Overview Fact Sheets, *Food and Agriculture Organization of the United Nations, Rome*, Retrieved from: http://www.fao.org/fishery/countrysector/naso_pakistan/en (2017).
- FAO., The state of world fisheries and aquaculture, in shares of main groups of species in world trade 2013, *Food and Agriculture Organization of the United Nations, Rome*, Retrieved from: <http://www.fao.org/3/a-i5555e.pdf> (2013).
- Sammy, D.G.N., Dean P., & Shane T.A., A classification of living and fossil genera of decapod crustaceans, *Raffles Bull. Zool.*, (2009) 1-109.
- FAO., International Guidelines on Bycatch Management and Reduction of Discards, The state of world fisheries and aquaculture, *Food and Agriculture Organization of the United Nations, Rome*, Retrieved from: www.fao.org/3/a-ba0022t.pdf (2011).
- Siddiqi, A.H., Fishery resources and development policy in Pakistan, *Geo Journal*, (1992) 26(3): p. 395-411.
- Jarwar, A.A., A status overview of fisheries and aquaculture development in Pakistan with context to other Asian countries, *Aquacult. Asia*, (2008) 13(2):13-18.
- Govt, P., Highlights of Pakistan Economic Survey 2014-2015. Economic Adviser's Wing, Finance Division, *Government of Pakistan, Islamabad*, (2015).
- Sherani, S., Economic survey 2016-2017: Sizing up growth, *DAWN News*. (2017).
- Govt, P., Pakistan Economic Survey 2016-17 in Overview of the Economy, *Government of Pakistan, Islamabad*, Retrieved from: http://www.finance.gov.pk/survey/chapters_17/overview_2016-17.pdf (2017).
- Ebrahim, Z., Inside Pakistan's Untapped Fishing Industry, *Inter Press Service News Agency*, Retrieved from: <http://www.ipsnews.net/2014/11/inside-pakistans-untapped-fishing-industry/> (2015).
- Irshad, A., Over exploitation of marine fisheries resource, in *DAWN News*, (2017).
- Anwar, K., Exporters Still Disappointed: Record Fisheries Worth \$ 367.472 million Exported in Fiscal year 2014, Retrieved from: <http://www.pakissan.com/english/news/newsDetail.php?newsid=26826> (2014).
- FAO., Sector performance, National Aquaculture Sector Overview Pakistan, *Food and Agriculture Organization of the United Nations, Rome*, Retrieved from: http://www.fao.org/fishery/countrysector/naso_pakistan/en (2017).
- World-Bank., World Bank Data, *World Bank Group, Pakistan*, Retrieved from: <https://data.worldbank.org/country/pakistan> (2017).
- Business, M., Pakistan's seafood industry, *Business Mirror*, (2017).
- Sami, M.A., Wild shrimps and shrimping in Pakistan territorial water, *Economic Review*, (1994).
- Milliman, J.D., & Meade, R.H., World-Wide Delivery of River Sediment to the Oceans. *J. Geol.* (1983) 91(1): p. 1-21.
- Holeman, J.N., The sediment yield of major rivers of the world, *Water Resources Research*, (1968) 4(4): p. 737-747.
- Milliman, J. D., Quraishee, G., & Beg, M., Sediment discharge from the Indus River to the ocean: past, present and future, *Mar. Geol. Oceanograp. Arabian Sea Coast. Pakistan*, (1984) p. 65-70.
- Spilling, K., & Magnus, L., Phytoplankton life cycle transformations lead to species-specific effects on sediment processes in the Baltic Sea, *Continental Shelf Res.* 28, no. 17 (2008): 2488-2495.
- Loneragan, N.R., Bunn, S.E., & Kellaway, D.M., Are mangroves and seagrasses sources of organic carbon for *penaeid* prawns in a tropical Australian estuary? *A*

- multiple stable-isotope study, *Mar. Biol.* 130, no. 2 (1997) 289-300.
- 26 Nagelkerken, I.S.J.M., Blaber, S.J.M., Steven, B., Green, P., Haywood, M., Kirton, L.G., Meynecke, J.O., Pawlik, J., Penrose, H.M., Sasekumar, A. & Somerfield, P.J., The habitat function of mangroves for terrestrial and marine fauna: a review, *Aquat. bot.* 89, no. 2 (2008) 155-185.
- 27 Hayat, M., Fishing capacity and Fisheries in Pakistan, (2003).
- 28 Kazmi, Q.B., & Kazmi, M.A., Biodiversity and Biogeography of *caridean* shrimps of Pakistan, *Higher Education Commission*, (2012).
- 29 Tirmizi, N.M., & Bashir, Q., Shore and offshore *penaeid* prawns of northern Arabian Sea, *University of Karachi, Department of Publications*, (1973).
- 30 SMEDA., Marine Fisheries Sector in Pakistan Development Strategy, *Small and Medium Enterprise Development Authority Government of Pakistan*, (2000).
- 31 AYUB, Z., & MIUZAMIMIL, A., Species Composition of the *Jaira, Kalri and Kiddi* Groups of Shrimps Landing at the Karachi Fish Harbor, *Pakistan J. Zool.* 33(3) (2001) 179-187.
- 32 Ayub, Z., & Ahmed, M., Maturation and spawning of four commercially important *penaeid* shrimps of Pakistan, *Indian J. Geo. Mar. Sci.*, 31(2) (2002) 119-124.
- 33 Mohsin, M., Yongtong, M., Aamir, M.M., Muhammad, T.K., & Syed, B.H.S., Fishery stock assessment of Kiddi shrimp (*Parapenaeopsis stylifera*) in the Northern Arabian Sea Coast of Pakistan by using surplus production models, *Chinese Journal of Oceanology and Limnology* 35, no. 4 (2017) 936-946.
- 34 HEC., 12 Miles Territorial Waters of Pakistan Reported shrimp species, Retrieved from: <http://pr.hec.gov.pk/Chapters/899-1.pdf> (1994).
- 35 Psomadakis, P.N., Field identification guide to the living marine resources of Pakistan. The state of world fisheries and aquaculture, *Food and Agriculture Organization of the United Nations, Rome*, (2015).
- 36 Kazmi, Q.B., & Sultana, R., Economics of Shrimps & Prawns of Pakistan, *Proceedings of Fifth World Fisheries Congress, Japan*, (2008).
- 37 The, N., Cultivating shrimp culture, *The International News*, Retrieved from: <https://www.thenews.com.pk/magazine/you/77534-cultivating-shrimp-culture> (2015).
- 38 DGE., Ten guidelines for a wholesome diet, *German Nutrition Society*, Retrieved from: <https://www.dge.de/fileadmin/public/doc/fm/10-guidelines-for-a-wholesome-diet.pdf> (2015).
- 39 World, F.C., Nutrition and Health, *World Fish Centre*, Retrieved from: <http://www.worldfishcenter.org/content/nutrition-health> (2015).
- 40 Harris, W.S., Fish oil supplementation: evidence for health benefits, *Cleveland Clinic Journal of Medicine*, 71(3): (2004) 208-221.
- 41 FAO., & WHO., Joint FAO/WHO expert consultation on the risks and benefits of fish consumption, Food and Agriculture Organization of the United Nations, *Fisheries Aquacul. Rome*, (2010).
- 42 Jacquet, J.L., & Daniel, P., The rise of seafood awareness campaigns in an era of collapsing fisheries, *Marine Policy*, 31, (3) (2007) 308-313.
- 43 NRC., A framework for assessing effects of the food system, National Research Council, *National Academies Press*, (2015).
- 44 Sumaila, R.U., Christophe, B., & Alice, T., Fishing for the future: An overview of challenges and opportunities, *Marine Policy* 69 (2016) 173-180.
- 45 Little, D.C., Newton, R.W., & Beveridge, M.C.M., Aquaculture: a rapidly growing and significant source of sustainable food? Status, transitions and potential. *Proceed. Nutri. Soci.* 75, (3) (2016) 274-286.
- 46 Biao, X., & Kaijin, Y., Shrimp farming in China: operating characteristics, environmental impact and perspectives. *Ocean Coast. Manage.*, 50(7) (2007) 538-550.
- 47 Paul, B.G., & Vogl, C.R., Impacts of shrimp farming in Bangladesh: challenges and alternatives. *Ocean & Coastal Management*, 54(3) (2011) 201-211.
- 48 Hensler, L., A sustainable future for shrimp production in Bangladesh? *Sustaining ethical aquaculture trade*, (2013).
- 49 FAO., Fisheries Statistics in Bangladesh: Issues, Challenges and Plans, in Asia and pacific commission on agricultural statistics, *Food and Agriculture Organization of the United Nations, Rome*, Retrieved from: http://www.fao.org/fileadmin/templates/ess/documents/apcas26/presentations/APCAS-16-6.3.2_-_Bangladesh_-_Fisheries_Statistics_in_Bangladesh.pdf (2016).
- 50 FAO., Fisheries and shared resources of Pakistan, Food and Agriculture Organization of the United Nations, *Fisheries Department, Rome*, (2011) 1-58.
- 51 MFD., Hand Book of Fisheries Statistics of Pakistan, *Marine Fisheries Department, (Government of Pakistan)* 2012, Vol. 20.
- 52 Páez-Osuna, F., The environmental impact of shrimp aquaculture: a global perspective, *Environmental pollution*, 112(2) (2001) 229-231.
- 53 Naylor, R.L., Goldburg, R.J., Mooney, H., Beveridge, M., Clay, J., Folke, C., Kautsky, N., Lubchenco, J., Primavera, J., & Williams, M., Nature's subsidies to shrimp and salmon farming. *Science*, 282(5390) (1998) 883-884.
- 54 Primavera, J.H., Socio-economic impacts of shrimp culture. *Aquaculture research*, 28(10) (1997) 815-827.
- 55 Goss, J., Burch, D., & Rickson, R.E., Agri-food restructuring and third world transnationals: Thailand, the CP Group and the global shrimp industry, *World Development* 28(3) (2000) 513-530.
- 56 Wang, Q., Cheng, L., Liu, J., Li, Z., Xie, S., & De, S.S., Freshwater aquaculture in PR China: trends and prospects, *Reviews in Aquaculture*, 1;7 (4) (2015) 283-302.
- 57 Bondad-Reantaso, M.G., Subasinghe, R.P., Josupeit, H., Cai, J., & Zhou, X., The role of crustacean fisheries and aquaculture in global food security: past, present and future. *J. Inverteb. Pathol.*, 1;110 (2) (2012)158-65.
- 58 Gordon, H.S., The economic theory of a common-property resource: the fishery, *Journal of political economy*, 62(2) (1954) 124-142.
- 59 Coche, A., Fish culture in rice fields a world-wide synthesis, *Hydrobiologia*, 30(1) (1967) 1-44.
- 60 Iversen, E.S., Farming the edge of the sea: *Fishing News Books Ltd*, (1976).
- 61 Shepherd, C.J., & Bromage, N.R., Intensive fish farming, *Blackwell Science*, (1988).
- 62 Lovshin, L., Tilapia farming: a growing worldwide aquaculture industry, *Simpósio Sobre Manejo e Nutrição de Peixes*, 1: (1997) 137-164.
- 63 FAO., The future of food and agriculture in (Trends and challenges), *Food and Agriculture Organization of the United Nations, Rome*, Retrieved from: <http://www.fao.org/3/a-i6583e.pdf> (2017).