FISHERIES AND AQUACULTURE PRODUCTION AND POTENTIALS

Background Study to support the development of Pakistan's Agriculture Vision 2050 Paper

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&

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This study is part of the 18 studies conducted for providing background information for preparing Pakistan's Agriculture Vision 2050 Paper. The report is based on the review of literature, consultation and discussion with experts involved in different background studies along with technical input from the subject specialists by the technical experts responsible for team.

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EXECUTIVE SUMMARY:

- Pakistan is endowed with considerable quantity of resources i.e. 0.29 million sq km of marine with 1120 km long coastline and approximately 8.6 million ha of inland waters.
- Pakistan possesses seafood industry of worth about $1.2 billion of which exports alone are worth nearly $315 million per annum. About one million people are associated with the industry for their livelihood directly or indirectly.
- With the exception of trout culture in KPK and the northern region, virtually all aquaculture currently carried out in Pakistan is pond culture of various carp species. Carp are cultured in earthen ponds, using mostly extensive farming practices with very little inputs.
- Marine fisheries exclusively depend upon capture fisheries.
- About 50 % of the total production is consumed locally, 22% is exported whereas 28% is converted into fish meal for poultry industry.
- Human resource is single most critical area of concern in the fisheries sector of Pakistan. Only research program of PARC exists for aquaculture sector and that too is limited by human resources. The worst part of the scenario is that there is almost no research system either at the institutional level or at the enterprise level which could cater the needs of the fisheries industry.
- Global fish production was around 184 million tons of which 49% comes from Aquaculture (2012).
- Unrestricted access to fisheries resources has resulted in over exploitation of natural stocks. Fishermen are using destructive fishing gears in greed of more fish and they have contributed in stock depletion.
- Pakistan has more than 50 fish processing plants, which mostly clean and freeze fish for international buyers, out of these only 2 plants have permission to export their fish to EU countries.
- The maintenance of quality system in Pakistan has been found to have flaws and contamination levels are high on board the fishing vessels, landing docks and auction halls. On-shore handling also falls below the basic sanitary and health standards, the auction halls are equally unsanitary. Storages constructed near the auction halls for storing unsold fish exhibit similar unsanitary conditions.

- Technological advances that improve information and management methods are now required. Satellite remote sensing and other information technologies can help provide better information about wild fish stocks as well as help monitor fishing activity and improve consumer information about the condition and origin of fish products. Technology is also crucial to avoiding the environmental damage and waste caused by certain fishing practices.

- Genetic modification and biotechnology also hold tremendous potential to improve the quality and quantity of fish reared in aquaculture.

- Most of the culture practices in Pakistan are still based on extensive culture, but with the establishment of few feed mills, the semi intensive farming practices have been started on limited scale, to boosts this process substantial investment is required in raising awareness and extending financing to fish farmers.

- The main issues of the Fisheries sector includes Weak institutional management and capacities for strategic planning and implementation, unknown fisheries stock carrying capacity, high post-harvest losses, low quality of fish/fisheries products etc.

- The main issues of the aquaculture sector includes lack of diversification in species and systems, high input cost, low technology adoption, weak institutional support etc.

- Strategy to develop fisheries sector includes development of responsible fishing systems for inland and marine capture fisheries incorporating principles of bycatch reduction, protection of biodiversity, minimization of environmental impacts and energy conservation. Developing food safety standards for the domestic market along the value chain and standards for processes and products. Development of 'green fishing vessels' with built-in energy saving design features, fuel saving technologies and practices for existing fleet and alternate sources of energy for propulsion of fishing vessels and onboard fish processing. There shall be need for capacity building of stakeholders in public and private sector.

- Strategy to develop aquaculture sector includes environment friendly and cost effective technologies, ddiversification of species and systems, utilization of brackish-water resources. Increase awareness of farmers and aquaculture industry about environment, food safety and social equity issues and at the same time educate public about the positive aspects of aquaculture and fish as health food.

1) INTRODUCTION

a) Status of fisheries and aquaculture in Pakistan

Pakistan is endowed with considerable quantity of resources i.e. 0.29 million sq km of marine with 1120 km long coastline and approximately 8.6 million ha of inland waters (Jarwar 2008). Pakistan possesses seafood industry of worth about $1.2 billion of which exports alone are worth nearly $315 million per annum (Nasim 2010). About one million people are associated with the industry for their livelihood directly or indirectly. The seafood industry is under threat from two sides, one is over-fishing, which may reduce the resource base and hence the yields. The other is from poor quality control, which means that the value of the catch is not being maximized and much is going to waste. It is evident through export conditions that poor quality is a main issue of Pakistan's competitiveness in the world markets, since the standards demanded by the importing countries (notably EU and US) at large are not being maintained on vessels, at landing sites and auction centers and in the processing units. Pakistan is one of the beneficiary coastal states of the most important international initiative contributing to the transition of the fisheries sector worldwide by adoption in 1982 of the United Nations Convention on the Law of the Sea (UNCLOS) granting the legal rights to regulate and manage fish resources up to 200 nautical miles from the coast and during 2015 another 50000 sq. km is added into the Exclusive Economic Zone (EEZ) of Pakistan (MFD ppt. 2015). This extension of jurisdiction has redistributed fisheries resources away from distant industrialized fishing states to the coastal states, enabling them to extract benefits from developed nations through license fees and joint ventures and it also encouraged the development of the coastal states‟ own industrial fishing fleets, thereby increasing the contribution to the country's economic, social, and nutritional objectives. Second, it allowed coastal states to exercise greater management control over their fishery resources. Ironically Pakistan is one of those few countries which have yet to develop the capacity and knowledge to manage the fishery resources sustainability. If we would have realized this potential, a clear outcome would have been that structural changes in the fishing particularly in the processing industry would have taken place which potentially could have changed the complexion of the fisheries in Pakistan altogether not only by transfer of boat titles; investments in new boats; but above all it would have tremendously increased the supply chain (Nasim 2010). Carp farming is the major aquaculture activity in Punjab, Sindh, Khyber Pakhtunkhwa and part of Balochistan. The northern mountains of Pakistan have good potential for trout culture, but production is still small (Bhatti 2012).

b) THE HISTORY OF PAKISTANI FISH INDUSTRY

It is felt that a brief history of the fisheries sector in Pakistan should be reviewed to create a proper context. The fishing industry in Pakistan is a direct descendant of the fishermen that have been fishing in these waters for hundreds of years. Similar situations can be found in the rest of the world as far as the fishing industry is concerned. Karachi began to emerge as a major center for fishing and fisheries in 1945 when the Fisherman's Cooperative Society (FCS) was formed to look after the welfare of the fishermen that were fishing in Sindh coastal waters and landing their catch in Karachi. This was largely due to the fact that, prior to the independence of Pakistan in 1947, the fishing industry had already begun to flourish under the patronage of the British rulers and Karachi had begun to emerge as a regional source of prime quality catch (Kumar 2006).

The history of fishing and fisheries in Pakistan is the history of its associated bodies. Since partition, the fishing and fisheries sector, as a potential source of export revenue, remained largely neglected by successive governments that were focused more on developing an industrial and economic base for the country and towards developing other agrarian sources like cotton, wheat and sugar cane as potential sources of export revenue. During this time fishermen in other parts of the country continued to land and sell fish along traditional trade routes leading to other parts of the country and into neighboring Iran. The Federal Government under US-Aid Program created the Karachi Fish Harbor Authority (KFHA) in 1959 and its control was then passed on to the Provincial Government in 1974. However, the FCS handled the day-to-day operations of the harbor (Kumar 2006).

The fishing and fisheries sector began to receive proper support and began to develop as a source of export revenue in 1984 when the prevailing regime at the time, recognized the potential in the sector and authorized the formation of the Karachi Fish Harbor Authority along with the development of other harbor authorities namely Korangi, Gawadar and Pasni Fish Harbors in due course of time. As a result of these activities, this sector was encouraged to grow and today fish exports generate US$ 138 million worth of export revenue. It is estimated that the sector has potential to around 1.0 billion US$ from existing natural resources and aquaculture in fisheries sector has the potential to yield even higher exports earnings from the fisheries sector in Pakistan (MFD ppt. 2015).

c) Resource Potential

i) Marine

The fisheries sector of Pakistan is divided into parts, the fisheries resources of coast along Balochistan and Sindh. With the declaration of an exclusive economic zone (EEZ) in 1976, Pakistan’s fishing limits were extended to 200 nautical miles from the shore, providing the country with a fishing area of approximately 196,600 square kilometers, with shoreline areas of less than 200 metres in depth estimated at around 50,000 square kilometers . The entire coastline, of about 1,100 kilometers (km) bordering the Arabian Sea, lies within the subtropical zone and is divided into the coasts of Sindh, and Makran in Balochistan. The continental shelf off the Makran coast is steep, rough and very narrow, i.e., between 12-32 km wide. The Sindh coast, on the other hand, has an extended 40-120 km shelf area. Mostly flat, it forms good trawlable ground. The coast protrudes into the sea in the form of capes and peninsulas and is, at a few sites, cut off into several small and large bays. There are only a few islands along the coast. The large estuarine delta of the river Indus provides good nurseries for fin-fish, shrimp and other marine life.

ii) Inland

Pakistan possesses an extensive lake, river and canal system. Natural lakes cover an area of 109,780 hectares. Some are high- altitude lakes suitable for cold water fish e.g., Saif-ulMulook in the Khyber Pakhtunkhwa (KPK), Satpara in the Gilgit Biltistan Areas and Hanna in Balochistan. Warm water lakes are mostly located in Sindh, and two such lakes are Manchar and Keenjhar. There are several small lakes also, mostly in the Thatta and Sanghar districts of Sindh. The Indus and its tributaries are the major freshwater fisheries of the country. The Indus flows from the GB Areas through the KPK and the Punjab, where it is joined by five large rivers; Kabul, Jhelum, Chenab, Ravi, and Sutlaj before passing through Sindh and finally draining into the Arabian Sea. Along the course of the Indus are a number of dams and reservoirs which provide water to an extensive irrigation network in the Punjab and upper Sindh regions, representing one of the world's largest canal systems. These running and still waters cover about 4.57 million hectares, while waterlogging covers about 2.225 million hectares. Of the reservoirs, six; Mangla, Tarbela, Chashma, Hab, Khanpur and Warsak cover an area of 80, 613 hectares and play an important role in freshwater fisheries. Besides these, more than a hundred small and minidams (in the baran (rain-fed) tract of the country, particularly in the Potwar Plateau) built for the storage of water, hold an immense potential for aquaculture. At present only a few of these water resources are being used to raise fish. Although aquaculture is a fairly new activity in the country, dug-out ponds for fish farming have been constructed in the private sector. There are approximately 120,000 hectare fish farming in the country. However, aquaculture is characterized by low production per unit area, mainly because of low inputs.

Table 1. Fish Production in Pakistan

ITEMS	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13
Marine Fish Production (in million M.Tons)	0.425	0.425	0.430	0.450	0.465	0.467
Inland Fish Production (in million M.Tons)	0.220	0.225	0.240	0.250	0.260	0.262
TOTAL (in million M.Tons)	0.645	0.650	0.670	0.700	0.725	0.729

Source: Marine Fisheries Department/GoP.

d) Existing status of Aquaculture

Aquaculture is a rather recent activity in Pakistan and is still in its infancy; nevertheless there is immense potential for development of the sector. Despite its vast fresh, brackish and marine water resources only carp culture is practiced in inland waters and only on a limited scale, carp are cultured in earthen ponds, using mostly extensive farming practices with very little inputs. In Pakistan, the fish fauna is rich but only following nine warm water species and two cold water species are cultivated on a commercial scale;Table-2 &3.

Table 2: List of Warm-Water Fish Species Being Used in Aquaculture of Pakistan

Carps	Labeo rohita (Rohu), Cirrhinus mrigala (Mori), Catla catla (Thaila) Cyprinus carpio (Gulfam), Hypophthalmichthys molitrix (Silver carp) Aristichthys nobilis (Bighead carp), Ctenopharyngodon idella (Grass carp)
Tilapia	Oreochromis niloticus
Catfish	Ictalurus punctatus Clarius spp.

Table 3: List of Cold-Water Fish Species Being Used in Aquaculture of Pakistan

Trout	Oncorhynchus mykiss (Rainbow trout) Salmo trutta morpha fario (Brown trout)

These fishes are cultured in earthen ponds utilizing extensive poly-culture farming systems with very little inputs; in some farms semi-intensive culture has also been adopted. Freshwater carp farming is the major aquaculture activity in three of the country's four provinces (Punjab, Sindh and KPK). The northern mountains of Pakistan have good potential for trout culture but production in these colder regions is still very small.

With the exception of trout culture in KPK and the northern region, virtually all aquaculture currently carried out in Pakistan is pond culture of various carp species. Pakistan has not yet begun any coastal aquaculture operations although there is good potential all along Pakistan's 1 100 km coastline. Efforts have been made in the past to start shrimp farming along Sindh coast, (Yaqoob, 1994.) which did not succeed, the main constraints being the non-availability of hatchery produced seed and lack of expertise. Freshwater fish culture in earthen ponds, both small and large reservoirs as well as community ponds was initiated in late 1960s by the provincial fisheries departments. From 1980 onwards the poly-culture of Indian major carps and Chinese carps has been carried out in Punjab, Sindh and to some extent in KPK and Balochistan. According to the old estimates, the total area covered by fish ponds across all provinces is about 60 470 ha, with Sindh having 49 170 ha, Punjab 10 500 ha, KPK 560 ha and the other provinces (Balochistan, Azad Jammu Kashmir [AJK] and Northern Area [Gilgit Biltistan or GB]) 240 ha (Akhter), current data of total number of fish farming is not available, however, a recent survey conducted by Fisheries Development Board reveals that in three Tehsil one each of Gujranwala, Hafizabad and Mandi Bahuddin, about 10000 hectare of area is under fish farming. Projecting based on this data, it could safely be said that total fish farming area of Pakistan is about 120,000 hectare.

Marine fisheries exclusively depend upon capture fisheries. Some development work for shrimp farming was initiated under two development projects namely Aquaculture1 and Aquaculture 2 during 1980s and 90s, which established among other a big coastal aquaculture farm at Gharro area district Thatha. The farm consists of about 28 hectare of pond area along with offices, labs and residential buildings. At the same time the Sindh government allocated 6800 hectare of land in the area to about 80 prospective shrimp farmers. However, because there was no local production of seed in Pakistan, all those involved had to import seed from Sri Lanka and Malaysia resulting to high mortalities experienced. Due to the lack of expertise, none of the pilot farms managed to continue in operation and all shrimp farming activities ceased by 1990. The government, however, took note of the potential importance of shrimp farming and again initiated efforts to establish a shrimp hatchery complex at Hawks Bay which started operation in 2001. Successful rearing of post-larvae (PL) was achieved at this hatchery in 2002. A privately run enterprise has successfully cultured the seed from this hatchery and subsequently produced about 3.0 tons of shrimp that were later exported. Fisheries Development Board has supported to enhance the capacity of the said hatchery upto 32 million PL/year (Personal communications). The federal government has also taken a number of additional steps aimed at supporting the development of commercial scale shrimp farming in Pakistan. In this context, the Marine Fisheries Department (MFD) conducted two stock assessment surveys of the coastal areas of Sindh and Balochistan provinces, established a hatchery for shrimp and fish species. Fisheries Development Board under aquaculture and shrimp farming project selected 11 potential sites along Balochistan Coast and established a shrimp hatchery at Jiwani. But all these efforts remained unsuccessful due to one reason or other (personal communications).

e) Contribution of fisheries to national economy

Fisheries and allied industrial activities are the most important economic activities along the coast of Sindh and Balochistan supporting livelihood of about 1.0 million fishermen and their families living in rural villages under difficult conditions (Nasim, 2010). A fishery also is an important sub sector of agriculture in Pakistan and its role in national economy cannot be underscored. The sector also contributes towards national food security. The GOP, has been working in past to promote fisheries, both marine and inland, but somehow the sector was unable to receive attention and matching resources thereof from the government side due to which the sector could not be developed on strong footings in Pakistan, although there has been increasing trend in total fish production (Nasim 2010).

About 50 % of the total production is consumed locally, 22% is exported whereas 28% is converted into fish meal for poultry industry. There are more than 50 fish processing plants in Pakistan with the capacity to process 586 metric tons of fish and shrimp daily. Out of these, 27 plants are involved in production of frozen products, 2 in canning, and 8 for fishmeal processing. The export of sea food products increased from US$ 213 in year 2007-08 to US$ 317 in year 2012-13 thus registered a marked increase in term of values (MFD, 2014).

f) Technology land scape in culture operations

The existing fish farming practices comprises of extensive to semi intensive system with low input and low output farms. Except trout farming which is practiced in concrete raceways, all farming practices are based on earthen ponds have shallow water depth of below 5 feet. Input consists of organic farm waste, cow-dung, poultry waste, farm made fish feed using locally available feed ingredients. Stocking density is very low from 1250 to 3000 fish babies per hectare. Use of aeration is very limited to cluster of Muzafargarh where semi intensive farming practices have become popular (NFS&R Yearbook 2013-14).

With the promotion of tilapia farming one tilapia hatchery has been established and two commercial feed plants. Tilapia farming has promoted the use of water aeration in some parts of Punjab. Cage farming is being conducted at experimental stages by Fisheries Development Board in Mangla dam and some other water bodies. The concept of hygienic methods of fish handling and marketing is yet to be popularized among various players of the sector (FDB, personal communication).

g) Human resources

Human resource is single most critical area of concern in the fisheries sector of Pakistan. This dearth of manpower is evident in at almost all levels of management at institute level and the situation is rather more alarming in the industries. Only research program of PARC exists for aquaculture sector and that too is limited by human resources. The worst part of the scenario is that there is almost no research system either at the institutional level or at the enterprise level which could cater the needs of the fisheries industry. This deficiency in research system reflects the level of low priority which has been given to the sector in the past. A viable Research system is considered as the back bone of a developing industry which supplies continuous support to the sector by providing information on new products, marketing strategies, biological profiles/basis for fisheries. Conflict resolutions and research based policy interventions. It is amazing how the whole system could not realize the need for research in this sector and so failed to develop the sector and its outlook on viable scientific lines. The role of academia in this regard is also very poor. None of the universities in the country thought to develop curricula to support the fisheries sector and its allied industrial development. Due to all this there has never been a rational planning on the today and future needs of manpower in the country to cater to the need of fisheries in the country. There is need to comprehensively look into the manpower requirements in the country, along with creation of matching opportunities for them and on top adoption of visible measures for providing a congenial working environment to the professional in fisheries where there are opportunities for them to excel in career on merit and merit alone . Unless done on these lines, all measures/ plan and actions related to HR development for both fisheries institutions and industry will prove ad hoc. A dire need, at this point in time is to immediately intervene and create, functional and purpose-built research institutions and for which a solid visionary strategic planning is required.

2) REGIONAL AND INTERNATIONAL STATUS OF FISHERIES AND AQUACULTURE

According to the FAO report, since the mid-1990s, production from global capture fisheries has stabilized around 90 million tons (with marine fisheries contributing around 80 million tons) precisely 93.7 million tons in 2011 while 93.8 million tons in 1996. This represents a substantial increase from 18.7 million tons in 1950, of which 16.8 million tons were from marine waters, but the expansion of marine capture fisheries was achieved in part at the cost of deteriorating regional fish stocks. Since the beginning of FAO stock assessments, the proportion of overexploited stocks has steadily increased from 10 percent in 1974 to 26 percent in 1989 and, with a slowing trend, to 30 percent in 2009. Furthermore, most of the stocks of the 10 key fish species (which represent 30 percent of marine capture production) are fully harvested, and there is little prospect for significant increase in the supply of these species from capture fisheries.

In contrast, the rapid expansion of global aquaculture production has continued with no sign of peaking. During the past three decades, global aquaculture production expanded at an average annual rate of more than 8 percent, from 5.2 million tons in 1981 to 90.4 million tons in 2012 (SOFIA 2014). Aquaculture's contribution to total food fish supply grew from 9 percent in 1980 to 49 percent in 2012 (FAO 2014). The estimated number of fish farmers also grew from 3.9 million in 1990 to 16.6 million in 2010. The rapid and massive growth of aquaculture production has contributed significantly to increased production of species whose supply would be otherwise constrained given the lack of growth in capture fisheries production. As a result, the prices of these species (for example, salmon and shrimp) declined, especially during the 1990s and in the early 2000s (FAO 2012).

3) LAPS AND GAPS OF LOCAL AND INTERNATIONAL FISHERIES AND AQUACULTURE PRACTICES

The commercialization of fisheries in Pakistan is fairly a recent phenomenon. On Fisheries side, Pakistan has opened up its deep-sea waters to commercial fishing relatively recently when compare to regional countries. This practice (with no scientific data in hand) has resulted in over exploitation of natural stocks and hence considered a main reason in depletion of fish stocks in Pakistani waters. The local fishermen are harvesting fisheries resources mostly in traditional manners but some fishermen are also using destructive fishing gears in greed of more fish and they also has contributed in stock depletion. The fish handling practices on boats and at harbors are so poor that it spoils fish during transportation and handling at harbors and in processing plants. The fish and its product produced under this supply chain are not at par with international standards and hence largely considered unhygienic for the export markets. The gaps identified in the supply chain are in respect to food safety standards, and sustainability standards.

i) In-plant processing

Pakistan has more than 50 fish processing plants, which mostly clean and freeze fish for international buyers out of these only 2 plants have permission to export their fish to EU countries. The certified Pakistani plants maintain HACCP standards, which are accepted by European countries. The certification process is thorough and the Société Générale de Surveillance (SGS) is the sole accredited certifying agency for marine products in Pakistan. The processing plants have made large investments in the requisite safety equipment and procedures, and have also installed in-house laboratories to check fish toxicity. The drivers of compliance at the processing stage are markets and the underlying unpredictability of the business. The first is self-evident; if exporters fail to comply with standards they lose export markets. Second, processing is both high-risk and costly. Contamination in a single container means the entire consignment has to be destroyed. Finally, catches fluctuate daily. The high risks, high capital and processing costs involve owners closely in plant management. The EU inspectors have noted high awareness levels with regard to HACCP among plant workers, comparing it with conditions in India and Thailand.

ii) Pre-processing

HACCP standards are both plant specific and apply to all stages of pre-processing. The three stages of pre-processing are: 1) on board fishing vessels; 2) docks/auction halls; and 3) transport to processing plants.

The EU requirements also include traceability which include first, fishing vessels are registered with a name and identification number. Second, the vessel owners are required to install radio systems so they can be monitored. Third, processors are required to test each batch and, if found contaminated, to backtrack through the vessel owners to the source of the catch. The processors are also required to prepare regular reports. The system in Pakistan has been found to have flaws and contamination levels on board the fishing vessels, landing docks and auction halls are high and have been pointed out by the EU inspectors. On-shore handling also falls below the basic sanitary and health standards, the auction halls are equally unsanitary. Storages constructed near the auction halls for storing unsold fish exhibit similar unsanitary conditions. The transportation of fish from the auction halls to the processing plants meets acceptable cleanliness criteria if the processors use their own mobile vans. Other forms of transport, including open mode, tend to be sub-standard.

Compliance failure has institutional roots. Three potential players in compliance are the Fishermen's Cooperative Society (FCS), the Marine Fisheries Department (MFD) and the Karachi Fish Harbor Authority (KFHA). Overlapping responsibilities are a source of tension among them and none of the three are technically, financially or administratively equipped to cope with the various aspects of compliance.

iii) New Technologies needed

a. Reducing pressure on wild fisheries

Nearly one-third of the world's wild-caught fish are not consumed directly by humans but rather are "reduced" to fishmeal and fish oil and consumed in feed by farm raised animals, such as chickens and other fish. This situation has raised concerns that demand for fishmeal and fish oil from the burgeoning aquaculture sector will raise prices for these commodities and place increasingly heavy pressure on wild fisheries to produce fish for feed. Technology can reduce the risks of higher prices and overfishing by providing alternatives to fishmeal and fish oil in aqua-feeds, such as protein-rich oilseed and grain byproduct meals. For a variety of reasons, vegetable meals are not ideal substitutes for fishmeal in aqua-feeds, so research is needed to help overcome this problem.

b. Improving management of wild fisheries

Technological advances that improve information and management methods are now needed more than advances to increase fishing capacity. Satellite remote sensing and other information technologies can help provide better information about wild fish stocks as well as help monitor fishing activity and improve consumer information about the condition and origin of fish products. But successful management of the world's wild-fishing operations will depend on the coordination of technology and policy. One example is a vessel monitoring system, which employs satellite tracking to allow onshore tracking of vessel movements, thereby enhancing the enforcement of regulations.

Technology is also crucial to avoiding the environmental damage and waste caused by certain fishing practices. Although some types of fishing gear may be banned altogether, others may be modified. Bycatch reduction devices, or BRDs, are increasingly used in fishing operations to lower the amount of unintended catch. But without policy incentives to encourage their use, along with training and extension, BRDs will remain unused or ineffectively used. Pakistan needs these technologies but strict enforcement is a key constraint for achieving desired goals.

c. Raising productivity in aquaculture

Breeding technology in aquaculture is in its relative infancy. Breeders have significantly raised productivity for a few commercial species such as salmon, trout, and tilapia, but the successful cultivation and breeding of other species such as cod and bluefin tuna would be a tremendous boost to high-value aquaculture. Genetic modification and biotechnology also hold tremendous potential to improve the quality and quantity of fish reared in aquaculture, although not without significant controversy and risk. Biotechnology has the potential to enhance reproduction and the early developmental success of cultured organisms. The possible environmental effects of genetically modified aquatic organisms are not well understood, however, and concerns exist over possible human health risks. The documented escapes of farmed salmon and their threat to native wild populations demonstrate that caution should be employed when considering the introduction of a new species into an ecosystem. Pakistan is successfully breeding freshwater carp and trout species, but for others investment and training is required.

d. Intensifying aquaculture sustainably

Although intensification of aquaculture can potentially generate high levels of environmental problems, capital-intensive production systems often give producers more control over problems like effluent pollution and the spread of disease. Technology may in fact present economies of scale in the control of environmental problems. Intensification can raise the risk of disease. Management techniques such as rotation of cultured species and lower-density stocking of organisms can partially address this risk, but antibiotics and water control technologies like aerators and water recirculation systems can also mitigate the stress caused by high concentrations of organisms. Technologies based on local knowledge systems and different political and cultural contexts can also help develop aquaculture in underexploited water bodies, such as rice paddies, irrigation canals, reservoirs, and seasonal or perennial ponds in developing countries. Some technologies long employed in traditional aquaculture systems can also be useful in addressing concerns raised by water management, effluent control, disease control, and land use in intensified aquaculture. Most of the culture practices in Pakistan are still based on extensive culture, but with the establishment of few feed mills, the semi intensive farming practices have been started on limited scale, to boosts this process substantial investment is required in raising awareness and extending financing to fish farmers.

4) DEMAND AND SUPPLY ANALYSIS

A. Global demand and supply

According to the FAO, fish accounted for almost 16 percent of the global human consumption of animal protein and just over 6 percent of all protein consumed by humans in 2007. Fish caught in the wild, whether in inland or marine waters, accounted for 54 percent of all fish consumed by humans in 2008. In economic terms, the 90 million tonnes of wild caught fish and marine life in 2008 had an estimated "first-sale value" of USD93.9 billion.

The global fish production from all sources was 184.2 million tons in 2012 of which fishery production in marine waters were 93.7 million tons in 2012 while global inland waters capture production reached 11.6 million tons in 2012. World aquaculture production continues to grow, albeit at a slowing rate. According to the latest available statistics collected globally by FAO, world aquaculture production attained another all-time high of 90.4 million tons (live weight equivalent) in 2012, including 66.6 million tons of food fish and 23.8 million tons of aquatic algae (mostly seaweeds).

B. Pakistan demand and supply

The fish production data of Pakistan is given in the table-1 which shows that production both marine and inland is increasing with a steady speed. This is not possible as per international scenario which shows that marine resources of fish have been fully exploited or over exploited. The same is the situation on ground in Pakistan where fishermen are complaining decline catches from marine waters. Therefore, the credibility of the official data is questionable.

Regarding fish consumption, for Pakistan, there was very little increase in per capita fish consumption (i.e. the estimate of the total supply available for human consumption divided by the population total) from 1.0 kg in 1961 to 2.03 kg in 2012, while the world average over the same period increased from 9.0 kg to 19.2 kg (FAO, 2012). If Pakistan wants to feed its masses the same amount of fish equal to world average it need to produce 6.9 million tons of fish while we are just producing only 10.5 % of that quantity. To meet the gap we need to increase out fish production upto 10 times more from the existing level. This is a very huge gap and hence presents an opportunity for local fish farmers too.

C. International demand of Pakistani fish

In 1986, Dr. Fridtjoy Nansen submitted the report (Kumar 2006) in which he compared the other regions of the world with Pakistan's shelf area and stated that the Pakistan's region is a richer region in terms of stock per unit. Unfortunately, in the last two decades there has not been any stock assessment that could provide us a figure for total stocks available or produced in our coastal areas. The data of very recent stock assessment is unavailable due to delay in the report compilation by the FAO consultant (MFD, 2014 presentation).

Fish and shrimp are processed in Pakistan as chilled, frozen, cured, and canned before they are exported. Fish was being exported in different forms such as dried, salted, brine, smoked, fresh, chilled, frozen and canned but export of some forms have been abandoned. In addition, fishmeal is also produced from small pelagic and also from by-catch.

Shrimp is the main export item both by weight and value. It is exported mostly fresh; frozen either as shell on tails or as peeled and divined. The USA, Japan, and the EU are the main importer. Also, Pakistan exports fish meal, fish maws and shark fins, as well as growing quantities of chilled fish, for which the main markets are Singapore and the Gulf. The export data is given in below Table-4.

Table 4: Fish Export Data 2007-13

ITEMS	**2007-08**	**2008-09**	**2009-10**	**2010-11**	**2011-12**	**2012-13**
Export Earnings (Quantity) (In M.tons)	135,112	127,246	113,212	133,926	131,624	144,148
Export Earnings (Value) In million US$	212	233	227	296	319	317

Source: Marine Fisheries Department/GoP.

D. Supply trends of fish industry

The importance of the fishing in the economy of Pakistan has by no means diminished despite the rapid pace industrialization. Pakistan is still predominately an agricultural country. About 70 percent of the population comprises agriculturists, farmers and fishermen, who toil in producing maximum quantity of food supply for the export and domestic consumption. The territorial seawater off the coast of Sindh and Balochistan has the potential to provide seafood to a population many times the present population of Pakistan. Aquaculture is gaining momentum in inland areas of Pakistan and many high value fish species are becoming popular in aquaculture system. Fishing is an important source of Foreign exchange earnings. The fish supply/production data as given in Table-1 shows an increasing trend and supply improved from 645000 ton in 2007 to 745,000 ton in 2014.

E. Shortcomings in demand and supply

The worldwide export in the fish and fisheries products was roughly US$129.2 billion during the year 2012. Despite having very rich natural resources, the share of Pakistan in the world export is very limited (Kumar 2006). The main reason behind this is that our exporters are exporting raw fish and are not focusing on value added products. In addition, lackluster marketing, untimely exports and variable export quality have all contributed to poor global market share, despite the richness of natural resource available.

Although shrimp has occupied a predominant position among the items of seafood exported from Pakistan, very little efforts have been made to harvest shrimp through aqua farming. Fresh/chilled fish exports from Pakistan have not recorded marked growth and expansion, despite the attractive markets with growing demand, available in the Gulf States. Internal demand for fresh fish and supply constraints are the main reasons for the decline in fresh/chilled fish exports from Pakistan. In addition, with global stocks of marine shrimp is declining, it is becoming more and more imperative to move towards aquaculture. The country has about 6.8 million hectares of freshwater bodies in the form of lakes, reservoirs, rivers and water logged areas, which is ideal for aquaculture, this resource is not utilized at present.

5) AGRO-ECOLOGICAL ZONES/ ZOOGEOGRAPHICAL DIVISIONS OF PAKISTAN

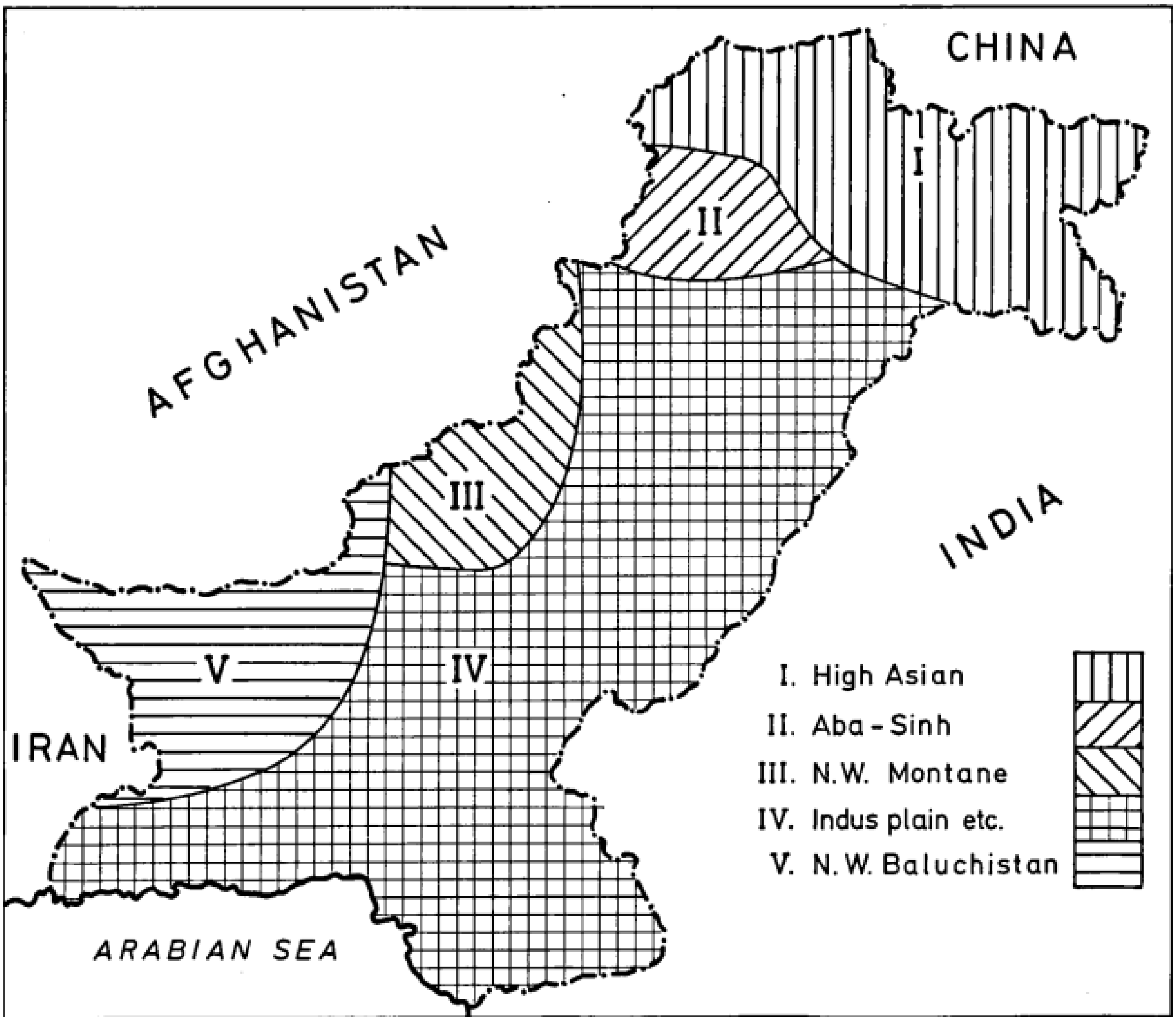

Figure 1: Map Showing the Zoogeographical Divisions of Pakistan

Agro-ecological zones are land areas representing unique combinations of homogenous agro-climate, ecology, soil units and agricultural activities (FAO, 1978). In Pakistan, the classification of Agro Ecological Zones is based upon an Asian Development Bank study on agricultural growth and rural poverty (ADB, 2005) that divides Pakistan into nine agro-ecological zones. However, this classification is not fit for ecological zonation for fisheries and aquaculture, mainly because many functions like precipitation, land cover, biodiversity etc. are not relevant for zoning of fisheries or aquaculture.

In Pakistan Zoogeographical divisions based on ecological zonation for fisheries and aquaculture has been given by M. R. Mirza -Freshwater fishes of Pakistan (1975). As per his classification, Pakistan is divided into following zones.

1. **High Asian Division**

This division comprises the northern montane areas of Pakistan above 1500 m including the Northern Areas and the upper parts of the Chitral, Swat and Kaghan valleys in the North West Frontier Province (fig. 1). The streams and rivers of this area are characterized by strong water currents and cool and dear water with rocky to pebbly beds. The temperature of the water rarely reaches 25°C, even in summer. The characteristic genera are Schizothorax, Diptychus, Ptychobarbus, Schizopygopsis, Noemacheilus (subgenus Triplophysa) and Glyptosternum. Most of the species are restricted to the Trans-Himalayan part of this division but a few species descend into the Himalayan part and sometimes even into the river Indus up to Attock, in winter.

2. **Aba-Sinh Division**

This division includes the southern parts of the Malakand Division (including the lower part of the Swat Valley and ai of the Buner Valley), the Valley of Peshawar and the submontane Hazara, north of the Safed Koh, Oheerat and Kala Chitta ranges (fig.1). The streams and rivers of this area are generally fast flowing with cool and clear waters and pebbly to sandy beds. Since there is a great range of elevation from 300 m to above 1000 m, the climatic conditions vary from place to place.

The fish fauna of this division is a mixture of South Asian and High Asian forms. No West Asian species has so far been reported from this area. It is interesting to note that the West Asian genus which is quite common South of the Safed Koh, Cheerat and Kala Chitta ranges in the Kohat Toi and the river Soan, is not represented in the rivers Kabul and Haro north of these ranges. The South Asian genera, such as Cyprinion, Notopterus, Salmostoma, Chela, Barilius, Danio, Brachydanio, Labeo, Crossocheilus, Garra, Aspidoparia, subgenus Tor, Puntius. Botia, Lepidocephalus, Glyptothorax. Schistura of Noemacheilus, Gagata, Mystus, Wallago, Ompok, Clupisoma, Heteropneustes, Channa, Mastacembelus and are represented in this division. The High Asian element is represented by the genus Colisa Schizothorax of the genus and the subgenus Tripl ophysa Noemacheilus

3. **Northwestern Mountain Division**

This division includes the northeastern part of Baluchistan (comprising the Zhob and Loralai districts and the northern parts of the Sibi and Kachhi districts) and the northwestern mountains along the Pak-Afghan border up to the Safed Koh Range in the north (fig. 1). The elevation of this area is more than 100 m above sea level. The summers are mild but the winters are quite cold. This division is demarcated from the rest of Pakistan by the Safed Koh Range in the north, the Sulaiman-Kohat hills in the east, the Marri-Bugti hills in the south and the Central Brahui Range in the south-west. There is no sharp boundary in the north-west, where this division extends into Afghanistan. The fish fauna of this division is a mixture of South Asian, High Asian and West Asian forms. There are six species which appear to be endemic to this division. These are: Tor zhobensis, Noemacheilus pakistanicus. N. harnaiensis. N. anambarensis and N. machensis from northeastern Baluchistan, and Garra wanae from southern Waziristan. It is interesting to note that the genus

Schizocypris and the West Asian subgenus Paracobitis (represented by Noemacheilus cristatus) of the genus Noemacheilus are restricted to this division in Pakistan.

4. Indus plain, adjoining hills & South Baluchistan Division

This division comprises more than 50% of the area of Pakistan (see fig. 1). It includes the Indus plain and the adjoining hills (Kohat hills, Potwar Plateau, Salt Range, Sulaiman and Kirthar hills) and the southern part of Baluchistan south of the Marri-Bugti hills and the Central Brahui and Kharan-Makran ranges. The climatic conditions vary from a marine type with moderate temperatures to a continental type with cold winters and hot summers in different parts of this division. The fish fauna as a whole is predominantly South Asian. In the hilly areas surrounding the Indus plain in the north and west, and in southern Baluchistan a few West Asian forms are met with (Cyprinion watsoni, Noemacheilus kessleri and Aphaniops dispar stoliczkai). In the extreme north of the Indus plain two species of the High Asian genus Schizothorax (S. plagiostomus and S. labiatus) rarely descend into the upper parts of the rivers of the Punjab plain. In the coastal areas and in the lower Indus plain some peripheral fishes are known to ascend the river Indus and the rivers along the Makran coast.

5. Northwestern Baluchistan Division

This division comprises the northwestern part of Baluchistan west of the Central Brahui Range and north of the Kharan-Makran ranges (fig. 1). There is no boundary on the northern and western sides. Topographically this area varies from western slopes of the Central Brahui Range to arid basins with a few sailt lakes. The temperature also Varies greatly. The fish fauna of this division is mainly West Asian but a few South Asian forms have penetrated from the south. The fish fauna of the Lora drainage system is exclusively West Asian but that of the Mashkel drainage system is a mixture of West Asian and South Asian forms. Main species are Labeo dero, L. gedrosicus Zugmayer, Aspidopariamorar, Crossocheilus latius diplocheilus, Garra rossica, Cyprinion watsoni, Capoeta capoeta heratensis, Noemacheilus kessleri Günther, N. brahui Zugmayer.

Production potential of fisheries and aquaculture in different Zoogeographical divisions of Pakistan is given below.

a) Coldwater fish production potential

Trout and related species are abundantly found in Coldwater areas of Pakistan and especially the trout fish is very popular fish in local consumption and in international seafood market. It is a high value fish species and being raised in fish ponds, cages in reservoirs, and in natural streams. In Pakistan the trout production potential exists in Coldwater areas of 'High Asian Division' above.

b) Cool water fish production potential

Mahseer and related fish species are found in cool water areas of Pakistan which occurs in the 'Aba-Sinh Division' and North-western Mountain Division. Some of the species in these water are abundant but other like Mahseer are facing existence problems due to changing climatic condition.

Another issues is that fishes of these waters do not have well-developed aquaculture technology and hence are not popular in farming system.

c) Warm-water fish production potentials

Carp, tilapia, catfish and related fish species are found in such water which occurs in the ‘Indus plain, adjoining hills & South Baluchistan Division’ and ‘Northwestern Baluchistan Division’.

These are main fish production areas of Pakistan. Fish in natural water bodies are under great threat from ecological changing conditions and human intervention to water bodies. However, fish farming in these areas is thriving and has much potential in future. Technology for fish farming is available within country or in the region.

6) GOVERNING REGULATIONS IN INLAND AND MARINE FISHERIES

a) Fisheries Related Rules and Acts

Fisheries laws were first enacted during the times of the British in the form of the Punjab Fisheries Act, 1914, Bahawalpur State Fisheries Act 1951 and the Fisheries Act, 1897. Post-independence, fisheries laws were promulgated through the ***West Pakistan Fisheries Ordinance 1961 and Rules of 1965***; despite amendments/additions to these laws subsequently, all 4 provinces and Northern Areas continue to retain most features of the 1961 and 1965 laws. The detail is given in table 5.

Table 5: Various Laws of the Country Related to Fisheries Sector of Pakistan

Federal	The constitution of Pakistan, Fourth Schedule, Article 36
	The Territorial waters and Maritime Zone Act, 1976; Act No.LXXXII of 1976.
	Exclusive Fishing Zone (Regulation of Fishing) Act, 1975 as amended 1993
	The Exclusive Fishing Zone (Regulation of Fishing) Rules 1976, promulgated under section 16 of the Exclusive Fishing Zone (Regulation of Fishing) Act 1975.
	Exclusive Fishery Zone (Regulation of Fishing)(Amendment)Ordinance, 1983(Ordinance No. XXIX of 1983)
	Exclusive Fishery Zone (Regulation of Fishing) (Amendment) Act, 1993 (Act No. V of 1993).
	Conservation of fisheries resources S. R. O. 329(1)/79
	Notification No.DD-75/98/3342-48 dated 24-07-1999
	Port Qasim Authority Act, 1973 (Act No. XLIII of 1973).
	West Pakistan Fisheries Ordinance, 1961
	Fisheries Act (No. 4 of 1897)
	Deep Sea Fishing Policy.1995
	The Pakistan Fish Inspection & Quality Control Act, 1997.
	Pakistan Fish Inspection and Quality Control (Amendment) Ordinance, 1998 (No. XI of 1998).
	The Pakistan Fish Inspection & Quality Control Rules, 1998.
	The Pakistan Environmental Protection Act, 1997.
	The Agriculture Produce (Grading & Marketing) Act 1937.
	The Pakistan Animal Qurantine (Import and Exports of Animal and Animal Products) Ordinance, 1979
Punjab	Punjab Fisheries Ordinance, 1961 (W.P. Ordinance No. XXX of 1961).
	Fisheries Ordinance 1961 (amended uto 2001)
	Fisheries Rules, 1965 (amended upto 2001)
	Punjab Fisheries (Amendment) Rules 1996.
	Punjab Fisheries (Amendment) Act 1999.
	Punjab Fisheries (Amendment) Ordinance 2001.
	Punjab Fisheries (Amendment) Rules 2001.
Sindh	Sind Fisheries Ordinance, 1980 (Sind Ordinance No. III of 1980)Part I.
	Sindh Fisheries (Amendment) Act, 2003 (Act No. VI of 2004).
	Karachi Fisheries Harbour Authority Ordinance, 1984 (No. II of 1984).
	By-laws of the Fishermen's Co-operative Society Limited Karachi.

	Karachi Fisheries Harbour Authority (Amendment) Act, 1996 (Act No. XVI of 1996)
	The Coastal Development Authority Act Sindh Act No. XXVIII 1994
Balochistan	Balochistan Sea Fisheries (Amendment) Ordinance, 1992
	Baluchistan Sea Fisheries (Amendment) Act, 1986.
	Baluchistan Sea Fisheries Ordinance, 1971 (IX of 1971).
KPK	North-West Frontier Province Fisheries (Amendment) Act, 1991
	North-West Frontier Province Fisheries Rules, 1976
GB	Northern Areas Fisheries Act, 1975
	Northern Areas Fisheries Rules, 1975
	Notification No. F.12(5)/2001-NA-II amending the Northern Areas Fisheries Rules
	Notification No. F.O(1)/98. N.A.I. amending the Northern Areas Fisheries Act.

7) INSTITUTIONAL FRAMEWORK OF INLAND AND MARINE FISHERIES

a. Federal Government Institutes

1. Ministry of National Food Security and Research
2. Ministry of Ports and Shipping
3. Fisheries Development Board (FDB)
4. Pakistan Agricultural Research Council
5. Marine Fisheries Department (MFD)
6. Korangi Fisheries Harbour Authority
7. Small & Medium Enterprise Development Authority(SMEDA)
8. Water and Power Development Authority (WAPDA)
9. Trade Development Authority of Pakistan (TDAP)
10. Enivormental Protection Agency (EPA)
11. Mercantile Marine Department (MMD)
12. Maritime Security Agency (MSA)
13. National Institute of Oceanography (NIO)

b. Provincial Fisheries Departments

1. Karachi Fisheries Harbour Authority (KFHA)
2. Fishermen Cooperative Society (FCS)
3. Pasni Fish Harbour
4. Gawadar Fish Harbour
5. Fisheries Department Government of Punjab
6. Fisheries Department Government of Sindh
7. Fisheries Department Government of Balochistan
8. Fisheries Department Government of KPK
9. Fisheries Department Government of GB
10. Fisheries Department Government of AJK
11. Coastal Development Authorities in Sindh and in Balochistan

c. **Fisheries education departments**

I. **Universities having department of Zoology/Fisheries**

1. Quaid Azam University, Islamabad
2. Arid Agriculture University, Rawalpondi
3. Punjab University, Lahore
4. Agriculture University Faisalabad
5. Bahuddin Zakariya University, Multan
6. University of Veterinary and Animal Sciences, Lahore
7. University of Karachi
8. Sindh University, Jamshoro
9. University of Balochistan, Quetta
10. University of Peshawar, Peshawar
11. Centre of Excellence in Marine Biology, Karachi.

II. **Others Fisheries organizations/Association**

1. Pakistan Sea Food Industries Association
2. Sindh Trawlers Owners & Fishermen Association
3. Karachi Fishing Boat and Trawler Owners Group
4. Mole Holder Association
5. Pakistan Seafood Exporter's Association
6. Karachi Fishing Boat and Trawler Owners Group

8) RELEVANT PROJECTS

First Asian Development Bank (ADB) project started in 1979 and was for a 5-year duration. The aim of the project was to develop aquaculture in the Punjab, the KPK and Sindh. The investment was made in fish hatcheries, nurseries, the procurement of nursery equipment and technical knowledge, foreign training, the provision of consultants and the upgrading of existing physical and biological facilities.

Another significant project was funded by Government of Pakistan (GOP) in 1986, the project established Korangi Fisheries Harbour in Karachi.

Second Asian Development Bank project entitle second Pakistan Aquaculture Development Project (Punjab) with a total cost of Rs.147.350 million was started in 1989-90 to 1993-94 and develop additional infrastructure facilities in provinces. The project was later revised as per recommendation of Asian Development Bank for another period of two years i.e., 1994-95 to 1995-96. The revised PC-I was accordingly approved by the Planning and Development Department at the total cost of Rs.266.795 million.

In 1996 FAO sponsored a project, Feasibility of Freshwater Prawn Hatcheries in Sind Province, Pakistan (TCP/PAK/4559), to assess the feasibility of freshwater prawn farming in the southern Sind province.

In 2005 FAO sponsored a project name TCP/PAK/3005 "Support to fishery sector policy and strategy formulation in Pakistan” which formulated a first ever “National Fisheries Policy”

Another significant project was funded by Government of Pakistan (GOP) in 2008 , the project title was Aquaculture and Shrimp farming, the project was terminated under devolution program of Pakistan. Fisheries Development Board was established under the same project.

9) CHALLENGES, OPPORTUNITIES, CONSTRAINTS, GOALS AND TARGETS

SWOT Analysis matric

	Strengths	**Weaknesses**
	1. Large potential water area of which only 1 % is being used	1. Falling output prices and increasing input costs and limited credit flow
	2. Potential cultivable species, shrimp, finfish, crabs	2. weak dissemination of technology
	3. Institutional support for research and development	3. Marine capture fisheries focused exports
		4. Unplanned and unscientific farm development and inadequate policy support
Opportunities	**Strategies of S-O**	**Strategies of W-O**
1. Increasing total fish exports	1. Facilitating increase in area under Fish/Shrimp farming	1. Increasing profitability/productivity, low cost inputs feed, policy analysis support credit
2. increasing income and purchasing power of domestic consumers increased willingness to pay higher prices for seafood and positive	2. Diversification of aquaculture species and systems	2. Capacity building of line departments, consultants and progressive farmers
	3. Public private partnership consultations, technology development, delivery	3. Exploratory studies on new export, domestic, and niche market segments

change in perception of fish as health food	4. Regular monitoring and evaluation process/impact assessment	
Treats	**Strategies S-T**	**Strategies W-T**
1. Negative public perceptions on environmental and food safety aspects	1. Research support to initiatives on quality control mechanism	1. Standardizing and refining location specific BMPs
2. Trade issues- quality issues and levy of antidumping duty and global fish/shrimp price crashes	2. Developing a HACCP control mechanism and sound eco-planning, climate resilience programme	2. Integrating production with value addition and processing
3. Absence of Quality control mechanism for seed and feed	3. Diseases watch and proactive development of preventive protocols and curative	3. Farmers programs on rational chemicals and drugs usage
4. Lake of biosecurity infrastructure in farms, incidence of diseases	4. Market studies for exploration of new export and domestic markets	4. Public and policy makers awareness meets for proper perspective on aquaculture

10) ISSUES RELATED TO FISHERIES SECTOR

The main issues of the Fisheries sector includes as below:

1. Weak institutional management and capacities for strategic planning and implementation
2. Unknown fisheries stock carrying capacity
3. High post harvest losses, low quality of fish/fisheries products
4. Low Productivity of Fishermen Community
5. Underutilized potential of Fisherwomen
6. Low level of investment in the fisheries and aquaculture sector
7. Non conducive environment for private sector investment.
8. Competition of local fish production with low price imported fish
9. Lack of trained manpower, infrastructure and modern technologies for fisheries and aquaculture sector.
10. Low priority of fish products for inclusion in human diet in Pakistan.
11. Aquatic pollution and indiscriminate discharge of effluents in inland and coastal waters.
12. Dependence on low yielding fish species with unreliable genetic potential.
13. Overfishing and destruction of habitat by excessive fishing.
14. Climate change, sea level rise, decreased flow of freshwater in Indus delta and sea intrusion

Immediate and long-term requirements of fisheries sector include

1. sustainability of the fishery resources – marine and inland,
2. continued optimization of fishing gear for marine, inland and the aquaculture sector, in terms of selectivity and environmental footprint,
3. conservation of biodiversity through optimization of fishing effort, prevention of capture of juveniles and non-targeted catches by suitable technical measures,
4. development of harvest and postharvest technologies for the nonconventional deep sea resources,
5. enhancement of shelf fishery resources,
6. value addition along the value chain,
7. utilization of fishery wastes
8. ensuring environmental safety in harvest and post-harvest operations,
9. energy conservation in fish production and post-harvest sectors,
10. ensuring aquatic food safety and traceability,
11. responsible utilization of landed fish,
12. minimizing harvest and post-harvest losses,
13. suitable inputs for policy formulation and
14. effective transfer of technology.

Likely scenario in the fisheries sector during the next few decades may include the following:

1. Further intensification of fishing pressure in the shelf and deep seas is possible in the next few decades, due to addition of fishing units and enhancement of fishing efficiency in terms of vessel capacities, fishing power of gear systems and acoustic and satellite based fish detection systems and electronic navigation systems. This may raise issues of long term sustainability and impact on biodiversity and may result in diminishing returns in terms of landings and catch per unit effort.

2. There will be increasing demand for development and implementation of conservation technologies for minimising negative impacts of fishing on resources, biodiversity and environment. These may include technologies for bycatch reduction, protection of vulnerable species, minimising energy use in harvest and post-harvest operations and minimising environmental impacts and materials protection technologies.

3. Problems of scarcity and cost of timber resources for boat building, biodegradation and corrosion may further aggravate and may require intensive work on alternate boat building materials.
4. Climate change is likely to show its impacts causing regime shifts of certain commercial species which may affect their regional availability and abundance, which in turn may impact on the fish harvesting and processing sectors, either negatively or positively.
5. Requirement for the regionalisation and implementation of the FAO Code of Conduct for Responsible Fisheries, adoption and implementation of Ecosystem based Fisheries Management (EFM) and effective control of illegal, unreported and unregulated (IUU) fishing to management of fisheries may come to the forefront.
6. Fishery certification, ecolabelling and traceability may become important issues influencing international seafood trade from India, in the next few years and expertise and infrastructure may have to be developed to address these issues on national and international level.
7. Reservoir fisheries may get a boost, due to its high potential in enhancement of national fish production. Cluster based integration in harvest and post harvest operations, value addition and marketing, under value chain concept may have to be evolved.
8. Factors affecting riverine fish production such as pollution, destructive fishing and overfishing may aggravate in the next few decades and may need management redressel.
9. Unconventional resources such as oceanic cephalopods and myctophids may become significant sources of seafood supply in the next few decades, in the context of stagnation and shortfall in the availability of traditional fishery resources, and these developments may demand appropriate technology interventions for their sustainable harvesting, value addition and utilisation.
10. Further enhancement in India-based tuna fishing effort may take place in Indian Ocean region and accompanying effort in improving harvesting and processing of high value tuna products may be required.
11. Advanced techniques for seafood preservation such as non-thermal processing may become available and widely applied in seafood processing and preservation. Value addition will be the key principle in guiding product development. A zero-waste approach will be warranted with fishery waste also converted to economical products. Packaging will play an important role in determining consumer acceptability with respect to perceptions on safety as well as maintenance of quality.

12. Newer products that have wide ranging applications may be available from the large aquatic resources, including microbes. These can be exploited for human good.
13. There is need to mainstream fish in the food habits of the Indian population with better understanding of the role of fish in decreasing malnutrition and improving health and creation of awareness about its significance.
14. Seafood safety issues may bring in newer challenges with the emergence of new forms and variants of pathogens. The issue will also come into focus with increasing stress on the domestic market for promotion of seafood products.
15. Increased awareness of consumer regarding the usefulness of fish as a source of nutrition and the changing demands for newer and convenient products that are easy to cook or consume will call for intensified efforts in this area.
16. The national and international policy regimes vis-à-vis trade, climate change, conservation and environment are changing rapidly and these will continue to have an impact on the fisheries sector of the country.
17. The traditional systems of technology transfer will undergo changes and innovative models including public-private partnerships will evolve making the process of technology commercialization more dynamic and a truly two way process.
18. Intellectual Property protection will see new challenges in the face of the need for judicious commercialization and responding to societal needs.

Strategy and Framework

There is a need to formulate research programs with stakeholder participation and prioritization of research programs to be undertaken at organization levels may include:

i. Continued development of responsible fishing systems for inland and marine capture fisheries incorporating principles of bycatch reduction, protection of biodiversity, minimization of environmental impacts and energy conservation.
ii. Standardisation of craft-gear combinations in terms of fishing power and capacities.
iii. Development and standardisation of processing technologies for emerging species from aquaculture and less utilized species from inland and marine capture fisheries.
iv. Continued development of processes for utilization of processing waste and low value bycatch for isolation of novel potentially commercial products.
v. Continued development of appropriate packaging technologies for improvement of consumer appeal and better storage.
vi. Developing food safety standards for the domestic market along the value chain and standards for processes and products.
vii. Rapid techniques for identification of hazards and surveillance of aquatic systems.
viii. Extraction and characterization of bio-molecules and genes for therapeutically and industrially significant biological activities, including anti-inflammatory, antiviral, anti-bacterial, anti-oxidant and anticoagulant activities.
ix. Use of bio-molecules for bioremediation of polluted aquatic ecosystems

There is a need to conduct focused research on green technologies

x. Development of 'green fishing vessels' with built-in energy saving design features, fuel saving technologies and practices for existing fleet and alternate sources of energy for propulsion of fishing vessels and onboard fish processing.

xi. Development of green technologies and practices for the fish processing sector, including fuel saving, recycling and reuse of process water.

There shall be focus on efficient technology transfer and policy analysis for:

xii. Developing innovative models for technology transfer based on need evaluation and impact assessment.

xiii. Technology incubation

xiv. IP management

xv. Sectoral level analysis of impacts of policies

There shall be need for capacity building of stakeholders for:

xvi. Responsible fishing.

xvii. Fish processing, packaging and value addition

xviii. Fishery waste utilisation.

xix. Energy conservation in fishing and fish processing

xx. Food safety and quality.

11) ISSUES RELATED TO AQUACULTURE SECTOR

The main issues of the aquaculture sector includes as below:

i. Lack of Brackish water aquaculture

ii. Lack of diversification in species and systems, only limited nuber of finfish species are under cultivation since very long time.

iii. High input cost is another issue which need policy and research support.

iv. Loss due to diseases is an emerging issue with the intensification of the farming system, but there is no strategy to address this issue.

v. Climate change impact: Potential for salinity and temperature increase over present levels during growout period are the most easily perceived climate changes in the future.

vi. Export market are becoming more and more competative due to introduction of quality standards. No reserch backup will lead us to no market for export of our seafood products.

vii. Growing domestic demand for fish and shell fish may support the production system of aquaculture.

Strategy and Framework

Focus areas of development for aquaculture sector are given below:

1. Environment friendly and cost effective technologies
2. Diversification of species and systems
3. Comprehensive health management plans and infrastrucutre
4. Faster growth and increased disease resistance
5. Utilization of brackishwater resources
6. Socio-economic analysis and support to policy and planning

Strategy for development is as below:

1. Increase aquaculture production through focused research on increasing productivit y, profitability, area under culture and diversification of species and systems while addressing environment, food safety and social equity issues through more on-farm research and extension.
   a) Improving existing culture practices by incorporating science behind best management practices, harnessing natural productivity, bioremediation and better feed management
   b) Provide research input to development agencies for reclaiming abandoned farms and for culture in open brackishwater bodies and diversification of species and systems
   c) Increase awareness of farmers and aquaculture industry about environment, food safety and social equity issues and at the same time educate public about the positive aspects of aquaculture and fish as health food
2. Carry out strategic research to tackle emerging problems of brackish water aquaculture and to strengthen the capacity of key stakeholders to address the various issues that are likely to be confronted.
   a) Preparedness on emerging diseases and advice the development and regulatory departments to address risks
   b) Assess the climate change impacts and increase the capacity of farmers to adapt to climate change and develop policy initiatives which help in adaptation and mitigation of negative impacts
   c) Evaluate risks due to intensification of culture practices and develop an action plan to be implemented by the state
3. Invest in areas of research to utilize emerging opportunities and develop linkages for effective utilization of the research outputs.
   a) Carry out research on genomics of candidate species and ensure that these results are used in captive breeding, increased growth, enhanced disease resistance and better utilization of feed nutrients
   b) Enhance capacity to use biotechnology tools to address difficult to solve problems of captive maturation and disease threats
   c) Develop linkages with universities and industry partners for promoting work on basic and strategic aspects to fill knowledge gaps

4. Partnership with other institutions, large integrated brackishwater aquaculture projects in private and public sector, entrepreneurs and innovative farmers to augment the existing capacity for broodstock and farm testing facilities, scaling up and for commercialization of products.
   a) Carry out on-farm research under a project mode with other institutions, large integrated brackishwater aquaculture projects in private and public sector, entrepreneurs and innovative farmers
   b) Commercialize products in partnership with entrepreneurs
   c) Develop a consultative mechanism with stakeholders for tracking and responding to recent developments in hatcheries and farmer ponds
5. Ensure that stakeholder needs and impact assessment set the agenda for research and awareness building.
   a) Strengthen Priority Setting Process, Evaluation and Monitoring process to undertake multi disciplinary and multi institutional research projects
   b) Increase our capacity for carrying out risk and impact assessment
   c) Increase awareness levels among stakeholders on research outputs

12) VISION STATEMENTS FOR 2050

- **Innovation**
  Continity in inovation is supported in the fisheries and aquaculture sector, especially the development of productive techneque that make best use of land and water and feed resources and that minimize demands on environmental services.

- **Regulation**
  Ensured that regulatory framework keeps pace with sector development and policy analysis and development that internalizes into fishery/aquaculture entierprises costs of environental impact.

- **Monitoring and compliance**
  Capicity is built of national agencies for supporting the development of sector and regulation and for monitoring and complice.

- **Supply and demand analysis**
  Continuity is ensured to monitor carefully how supply and demand for fish is evelving to ensure that support investment is approperiate to the market opportunity.

13) GOALS AND TARGETS TILL 2050

A. Fisheries Sector

Goals	Action	Time Line		
1. Economic returns are optimized	1. Fish stocks and access to use them are managed to maximise the long-term economic return.	by 2025,		
	2. The costs of fisheries management and enforcement are good value for money and shared amongst those who benefit.		by 2035	
	3. The quality, and therefore price, of fish is maximised throughout the supply chain, and waste is minimised.			

	4. Fishermen are rewarded in the market by preferential sourcing and a price premium for products with minimal environmental impact and high quality product.			by 2050
	5. The fisheries sector is internationally competitive.			
2. There are rights of access to fisheries coupled with clear responsibilities	1. Recreational and commercial fishermen share access to fisheries. Economically efficient commercial operators have access to most of the resource; some of the resource is used to deliver wider social benefits and for recreational purposes.	by 2025,		
	2. Those who access a fishery are involved in related decision-making.		by 2035	
	3. Those who access or manage fisheries quota have clear responsibilities and are held accountable for their actions.			by 2050
3. Stocks are plentiful and sustainably harvested	4. Catch levels optimise the long-term economic benefits including ensuring that stocks are not over-exploited.	by 2025,		

	5. People who catch fish respond to changing stock levels to prevent the risk of over-exploitation.		by 2035	
	6. Fish and fish products (including those not for human consumption) are bought only from sustainably managed stocks or sustainable aquaculture operations.			by 2050
4. Fishing activity contributes to coastal communities	7. Fisheries contribute to the local economies and culture of coastal communities.	by 2025,		
	8. Fishing communities are resilient and diverse enough to withstand fluctuations in the availability of fishing opportunities.			by 2050
5. The environmental impact of producing and consuming fish products is acceptable	1. There are clearly defined criteria for the acceptable level of environmental impact caused by the fisheries supply chain, from sea to plate.	by 2025,		
	2. Only environmentally acceptable methods are used and the environmental cost of producing fish products			

	throughout the whole supply chain is included in their price.			
	3. Discarding is not at a level that has any significant impact on fish stocks or the marine environment and methods to improve catch selectivity and reduce the environmental impact, including greenhouse gas emissions, of the whole supply chain, are continually developed and used.	by 2035		
	4. Processors, retailers and others invest only in those fisheries operations in Pakistan or overseas those are environmentally acceptable.			by 2050
6. Management is integrated and devolved to the most appropriate national, regional or local level	1. Fisheries are managed as one of many activities in the marine environment, using an ecosystem-based approach, and are taken into account properly in marine planning.	by 2025		
	2. Fisheries are managed within a flexible framework that allows local and regional managers to		by 2035	

	anticipate and respond quickly to changing circumstances.			
	3. Those with a stake in the marine environment have a role in decisions that affect them.			by 2050
7. Management is responsive and based on agreed criteria for assessing impacts on stocks and the environment more widely	1. Fisheries management is informed by good data and understanding of fish, stocks, fisheries industries and ecosystems.	by 2025		
	2. Stakeholders play a part in the science and in collecting data – their input is valued by scientists and they respect science-based management.		by 2035	
	3. Fisheries policy takes into account the impacts of climate change.			by 2050
8. Fish are a readily available and valued source of protein	• Fish are an important and accessible part of people's diet.	by 2025		
	• Consumers are informed about, and understand, the impact of their choices and choose environmentally acceptable options.	by 2025		

	• Fish and fish products are traceable to demonstrate that they are safe and were legally and sustainably caught.		by 2035	
	• Consumers choose locally caught fish wherever possible.			by 2050

B. Aquaculture sector

Goals	Action	Timeline		
1. Identification of suitable agro-ecological zones for aquaculture development completed.	1. District level freshwater aquaculture suitability maps completed in priority districts (using updated statistics), observation and consultation with local stakeholders) 2. Brackishwater suitability maps prepared and validated through consultation with stakeholders at the local level 3. Mariculture suitability maps prepared and validated through consultation with stakeholders at the local level 4. All aquaculture suitability maps updated using most recent bio-physical, social, economic and statistical data	by 2025,		
	5. Sub regional interactive maps developed and updated on webportals		by 2035	
2. Viable aquaculture technologies developed and disseminated;	1. Accelerate uptake of viable freshwater aquaculture technologies for commerical fish species 2. Implement strategy for integration of fish into small scale irrigation/pond digging investments in ways that build food production capacity, better nutrition and resilience in resource-poor regions.	by 2025,		
	3. Mariculture technology tested and adopted		by 2035	

	4. Re-circulatory aquaculture technology tested and adopted in Pakistan			by 2050
3. Institutional capacity strengthened	1. An institutional system exists to impart advance training to all fisheries/aquaculture staff in extension skills . 2. Regular advanced academic degree trainings	by 2025		
	3. Extension services developed for supporting rural households and enterprises in development of aquaculture			
	4. Aquaculture statistical system established and statistics collected on a regular basis.		by 2035	
	5. Virtual monitoring and delivery of services to fish farmers thorogh IT			by 2050
4. Sustainable input supply systems established	1. Fish seed widely available to fish farmers through a self-sustaining network of hatcheries, nurseries and trading 2. Fish feeds based on locally available resources widely available to fish farmers	by 2025		
	3. Seed of all commercial fish speccies available in Pakistan		by 2035	
	4. Pakistan is exporting fish seed and feed to regional countries.			by 2050
5. Aquaculture producers connected to markets	1. Fish marketing facilities are developed in all districts/sub districts and fish farming production groups are linked to these markets. 2. Fish campaigns implemented to raise awareness of the nutritional value of fish consumption	by 2025		

	3. Fish farmers are connected to international buyers through web	by 2035		
	4. Computerized production and marketing systems developed and implemented			by 2050
6. Household food and nutrition security improved by aquaculture	1. Testing the feasibility of fortification of food items through the incorporation of fish	by 2025		
	2. Development of systems for inclusion of suitable fish species within small-scale irrigation farm pond programs			
	3. Fish consumption and nutrition survey of households with and without fish farming			
	4. Nutrition education campaign to raise awareness of nutritionally balanced diets held at community level			
	5. Fish supply increased to match internatinal percaptia fish supply.		by 2035	
	6. Fish consumption increased to match internatinal percaptia fish consumption			by 2050
7. Effective partnerships between government agencies, NGOs, communities, the private sector and donors created	7. Strengthen relationships among public and private sector stakeholders through the promotion of collaborative aquaculture research and development programs/projects	by 2025		
8. Aquaculture farmer groups and representative institutions empowered	1. Tested and implemented organizational arrangements among fish farmers into production, marketing and service provision groups/clusters	by 2025		
	2. Develop fish farmer groupings/cooperatives managed and owned by the members based on lessons		by 2035	

	3. Explore and support development of a federation of fish farmer groups/cooperatives at the national level			by 2050
9. Favorable policies in place for environmentally responsible aquaculture development	1. Guidelines established on land, water and habitat use for aquaculture	by 2025		
	2. Government policy established for land and water use in aquaculture development			
	3. Aquaculture legislation developed and implemented			

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